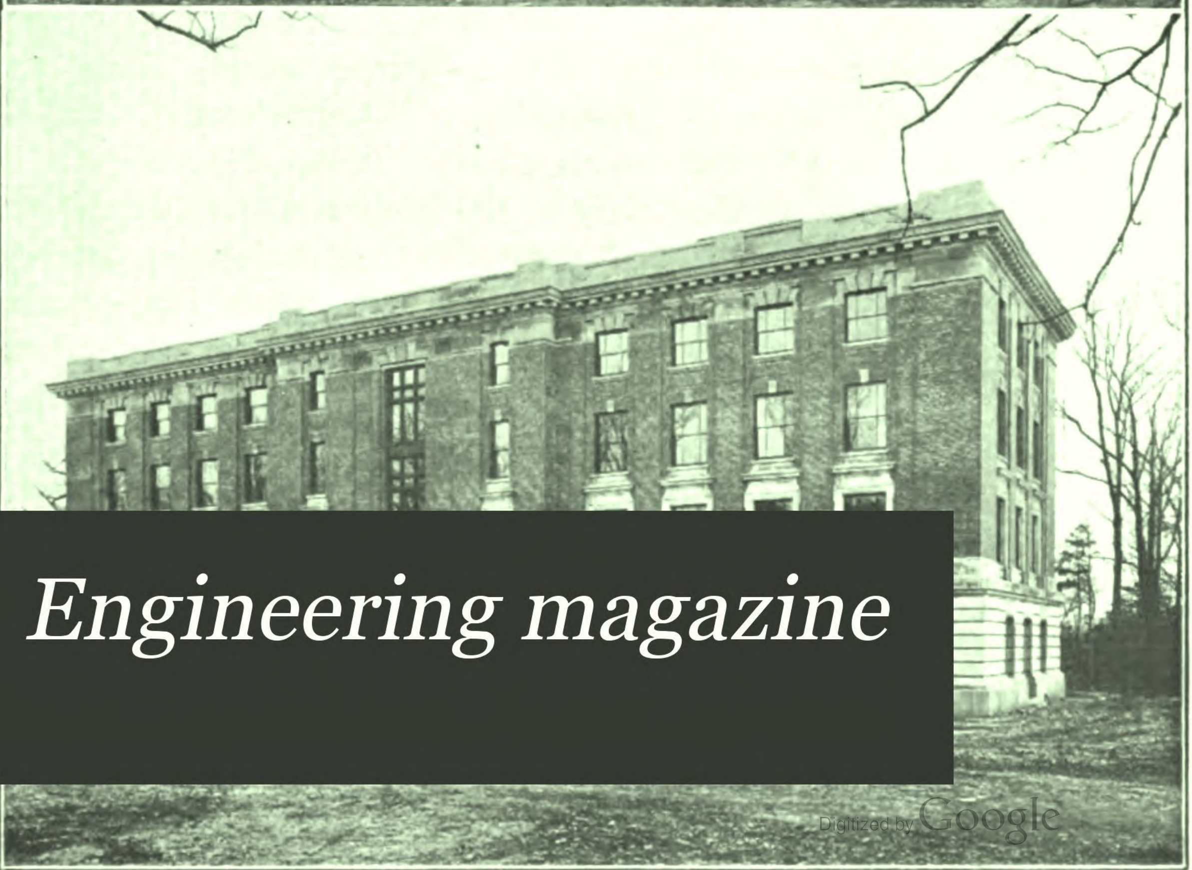
Engineering magazine



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REVIEWS, INDEX, AND EDITORIALS.

THE ENGINEERING MAGAZINE

"THE WORLD IS ITS FIELD"

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THE UNITED STATES NATIONAL BUREAU OF STANDARDS.

By Herbert T. Wade.

In a following article, Mr. Emerson calls attention to the surprising neglect of the Congress of the United States to establish legal standards of weights and measures. It is therefore of especial interest to study, through Mr. Wade's review, the practical results accomplished by the director and officers of the Bureau of Standards in securing standards, enabling comparisons, determining constants, and co-operating with manufacturers to establish substantial and proper uniformity throughout the States.—THE EDITORS.

BY the Constitution of the United States the power to fix the standard of weights and measures is expressly and specifically conferred upon Congress, but this power has seldom been exercised by that body and the present condition of American weights and measures is more the result of a natural and unrestricted development and evolution than of any legislative policy of the Government. Although the subject of weights and measures has received so little attention from Congress, yet a great deal has been accomplished by the executive branches of the Government towards securing a practical and proper uniformity. In fact this was most essential under the Constitution which provides that taxation shall be uniform throughout the nation. Now since a large part of the national revenue is raised by internal revenue or customs taxes levied specifically on quantities of commodities, not only the necessity of complying with this provision of the Constitution but justice and equity demand that the Government everywhere should use uniform and correct weights and measures. This of course can be accomplished only by having certain definite and concrete standards duly recognized by statute, to which all other weights can be referred, and by providing proper facilities for their construction, custody, and comparison with other standards.

In the United States the National Bureau of Standards is responsible for thus securing uniformity of weights and measures, and for certain other scientific duties, mainly those in which measurement is the prime consideration. As this bureau was founded only in 1901 it will be of interest to trace briefly the development of the work which finally called for its establishment. In the early days of the republic there was no particular uniformity of weights and measures, and most of the States which had standards employed those legalized in the colonial days and derived in the main from the standards of the Exchequer in London. Aside from revenue and commercial considerations the National Government realized this lack of uniformity and harmony in the various standards of length when the Coast Survey was established in 1815. Now as one of the first essentials of a survey is the accurate measurement of linear distances, it was necessary at the outset to obtain standards not only for use in the actual measurement, but from which other standards could be made and to which all measurements could be referred. The standard selected for this purpose, strange as it may seem, was a metre bar which had been constructed by the first International Metric Committee, and this standard was employed by the United States Coast and Geodetic Survey until the new National Prototype Metre was substituted as a standard on its receipt from the International Bureau of Weights and Measures in 1890. In addition to the metre an 82-inch bronze bar was secured from London as a standard of length for the customary measures, and these two bars, originally in the custody of the Coast Survey, mark the beginning of standards of length in the United States. The Coast Survey, it should be noted, was then under the Department of the Treasury, which on account of its collection of customs and internal revenue taxes was the branch of the Government most concerned with weights and measures.

As regards weights and measures of capacity the conditions were even more unsatisfactory than with the standards of length, and realizing the lack of uniformity at the various ports and collection districts, the Department called in for examination the various standards in use and found a surprising absence of harmony. It was ascertained that State, county, and town standards were used indiscriminately and in many cases substantial losses to the Government were involved. As a result of these revelations steps were taken to construct secondary standards, the duty becoming a recognized part of the work of the Coast Survey, whose superintendent for many years was usually head of the Office of Weights and Measures. Suitable standards of length and weight for the custom houses were provided, and later Congress decided that standards and balances of precision should be made by the Survey and sent to the various States and territories. These in most cases by act of legislature became legal standards from which county, city or town standards were derived, and in this way the weights and measures of the United States gradually became assimilated to a common standard.

Little by little the work of the Office of Weights and Measures developed, until in addition to safeguarding the standards of the nation and making such tests and verifications as were required by the various branches of the Government, there came demands for comparisons with the national standards not only from makers of weights and measures, but from manufacturers of machinery, tools, and gauges, especially where standardization and interchangeability were essential. Then again there was the construction of standard sets of metric weights and measures which Congress when it legalized the metric system (July 28, 1866) provided should be distributed to the various States and territories. Mechanical work of the War and Navy Departments often involved reference to standards of weight and length, while the base bars and tapes used by the Coast and Geological Surveys stood in constant need of graduation or verification. Then when it became necessary for the Government to assume control of electrical standards, the determination and care of these were included in the duties of the Coast and Geodetic Survey. Furthermore it was recognized that there was other fundamental scientific work that properly could be done by the general Government, involving as it did careful physical or chemical investigation in connection with standards of measurement. Moreover it was realized that the greatest practical benefit to manufacturing, and industrial trades and commerce had resulted from such government scientific bureaus in Europe, especially in the case of the Normal Eichungs Kommission and the Kaiserliche Physicalisch-Technische Reichsanstalt in Germany. Accordingly with the approval of scientific, engineering, and manufacturing interests by Act of Congress approved March 3, 1901, the National Bureau of Standards was established under the jurisdiction of the Treasury Department.

In order that there should be no opportunity for future misunderstanding or any curtailment of the efficiency of the new bureau, care was taken to define its functions with considerable precision, yet

THE MECHANICAL LABORATORY AND POWER PLANT (ABOVE) AND THE PHYSICAL LABORATORY, NATIONAL BUREAU OF STANDARDS.

at the same time to permit a wide range of activities. These functions are in substance as follows: the custody of the standards; the comparison of the standards used in scientific investigations engineering, manufacturing, commerce, and educational institutions with the standards adopted or recognized by the Government; the construction, when necessary, of standards, their multiples and subdivisions; the testing and calibration of standard measuring apparatus; the solution of problems which arise in connection with standards; the determination of physical constants and the properties of materials, when such material data are of great importance to scientific or manufacturing interests and are not to be obtained of sufficient accuracy elsewhere. The Act further provided that the bureau should exercise such functions not only for the National Government, but also for the various State and municipal governments, and for institutions, societies, corporations and individuals according to proper regulations and, except in the case of the United States or State governments, on payment of reasonable fees. Likewise provision was made for a suitable scientific staff whose salaries were made sufficient to attract competent scientists to the establishment, while an appropriation was made for the purchase of ground and the erection of buildings.

Professor S. W. Stratton of the University of Chicago was appointed as the first director of the Bureau of Standards, and the organization of its work was commenced immediately under his direction. The standards and apparatus of the Office of Standard Weights and Measures were turned over to the new bureau, and the laboratories and other rooms in the Coast and Geodetic Survey Building were retained temporarily pending the erection of new buildings. By the Act of May 14, 1903, establishing the Department of Commerce and Labor, the Bureau of Standards was put under its jurisdiction but no change in organization or plan occurred. While considerable scientific work was accomplished at this time, yet it was in the main preparatory to the equipment of the new laboratories, as modern scientific work, especially that concerned with weights and measures, depends very largely upon apparatus and other facilities. The buildings were completed in 1904 and occupy a tract of about 7½ acres in a suburban neighborhood in the northwestern section of Washington, 3½ miles from the White House. The site occupies a high hill about 350 feet above the Potomac and is quite free from vibrations from street traffic or from the magnetic effects caused by electric railways, except for refined magnetic experiments which ordinarily would be performed in the Government magnetic observatories in rural regions far away from such disturbances.

The chief building of the group belonging to the Bureau of Standards is the physical laboratory containing the offices, library and laboratories for investigation and the testing of standards and measuring instruments. It faces the mechanical laboratory which includes also the instrument shop and power plant. Near the latter building is the low-temperature laboratory, while a new building for mechanical testing and investigation upon the properties of materials, for which Congress has appropriated $175,000, is to be erected to the west, forming the third side of a quadrangle. The physical laboratory is four stories in height with an attic, and is built of dark red brick and buff Bedford limestone, the latter material being used for the first

THE LOW-TEMPERATURE LABORATORY.

story and the trimming. The building faces to the south or towards the city of Washington, thus affording ample illumination and direct sunlight for the optical and other laboratories where it is essential. It is 172 feet in length by 55 feet in breadth and is connected with the power plant in the basement of the mechanical laboratory by an underground passage or tunnel through which pass all pipes, conductors, ventilating flues, etc. It is of course a prime requisite for such a building that it should be massive and stable in its construction in order to avoid vibration and that it should contain no large moving machinery; consequently all engines, dynamos, pumps and apparatus of this nature are located in the mechanical building, but direct connections are made through a complete system of pipes and wires with all parts of the physical laboratory. Double windows protect the laboratories from outside temperatures and draughts and air currents, and an elaborate system of heating and ventilation controlled by automatic thermostats secures within suitable limits any desired degree of dryness or temperature. This is not only for the comfort of the investigators during a Washington summer, but also to enable certain experiments to be carried on independent of atmospheric conditions and to preserve from rust and deterioration many valuable instruments in use during the summer months. To provide a suitable and easily regulated temperature, hot air is used, as this saves valuable space that would be occupied by steam pipes, which also on account of their magnetic properties, varying both with time and temperature, often prove very annoying in refined electric and magnetic experiments. The hot-air system possesses the further advantage of allowing the air to be cooled in summer and the moisture to be removed as well, being then heated to any desired temperature so that the windows of the laboratories need never be raised. In addition the air thus supplied is first filtered and the amount of dust is kept at a minimum. As the air is constantly being drawn out and replenished there is no chance for the moisture produced by the respiration of the workers or by evaporation to remain.

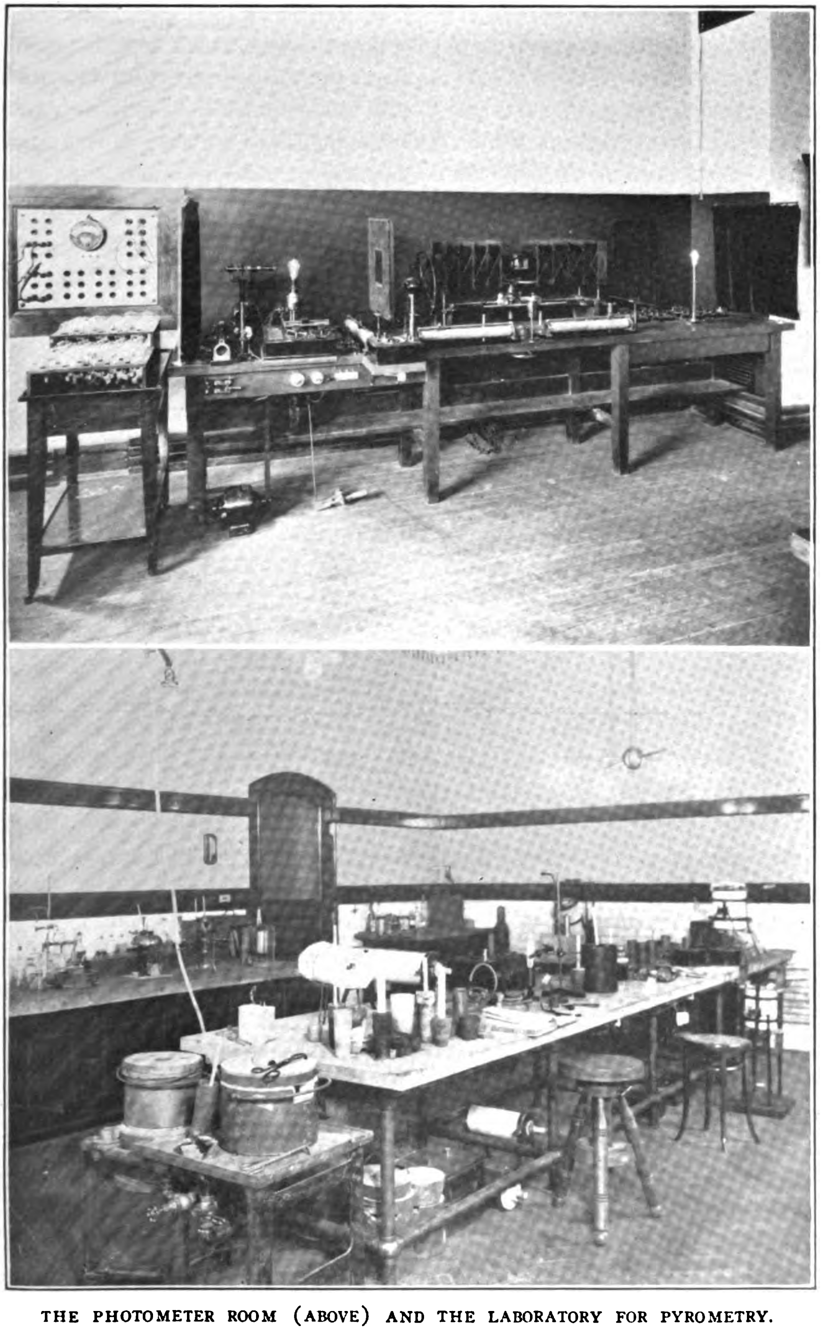
The stability of the building enables the bracket tables or shelves attached to the structural walls to furnish a firm support for instruments, thus obviating the separately founded masonry piers extending through one or two stories which often act as inverted pendulums with periods of vibration of their own. There are, however, piers resting directly on the ground in the laboratories on the ground floor on which such instruments as the comparators and the precision balances and their telescopes can be mounted.

To supply the necessary electric current, gas, steam, compressed air, exhaust, ice water, distilled water, cooled brine, etc., all of which are produced in the power plant, pipes and conductors after passing through the connecting subway to the physical laboratory are led to four vertical shafts, one at each corner of that building, which in the main partition walls extend from cellar to roof. On each floor connections are made for the regular service, while for special purposes any temporary arrangement of piping or wiring desired in any of the special laboratories readily can be effected. There is a small switchboard for each set of two or three adjacent rooms so that current can be led direct to any particular work table, while the mains running through the building are all connected with a switchboard on the ground floor from which trunk lines run to the main switchboard in the dynamo room. Thus any current, direct or alternating, of any potential or phase desired by an experimenter, can be furnished without disarranging any other circuits.

The scientific work of the Bureau is divided among a number of sections, each under the direction of a specialist. The arrangement while elastic indicates in a general way the range of activity of the Bureau. The sections are as follows: Electrical resistance and electromotive force; inductance, capacity and absolute measurements; electrical measuring instruments; magnetism; photometry; weights and measures; thermometry, pyrometry and heat measurements; spectroscopy; radiometry; polarimetry; chemistry; engineering instruments; and properties of materials.

The room of chief interest in the physical laboratory is the vault where are preserved the national standards of length and mass—the prototype metre and kilogramme—and various other standards and historic bars, weights, and measures. This room can be entered only through steel double doors, and though heavily walled is lighted by electricity and is ventilated for the reasons already mentioned. In addition to the national standards made under the direction of the International Commission of Weights and Measures, it contains such historic standards as the old "Committee metre" dating back to the founders of the metric system, the Troughton and Simms 82-inch scale, 36 inches on which furnished the first official yard for the United States, and the bronze copy of the imperial yard of Great Britain which served as a standard of length until the arrival of the standard metre and kilogramme from the International Bureau of Weights and Measures at Sèvres. In this vault it is believed that almost ideal conditions of temperature and dryness of the atmosphere are obtained, so that the standards remain at a constant temperature and are not exposed to changes which might act to alter their molecular arrangement and thus affect their absolute length.

For the most precise comparisons, such as would be involved in the verification of the secondary standards of the Bureau, the national standards can be removed to a special comparator now in course of construction in the instrument shop of the Bureau and designed to embody all the refinements of construction of which metrology and mechanical science are capable. Its striking and most original feature is a massive composite bar of invar, a form of nickel steel with a remarkably small temperature coefficient, on which the micrometer microscopes are to be mounted.



THE PHOTOMETER ROOM (ABOVE) AND THE LABORATORY FOR PYROMETRY.

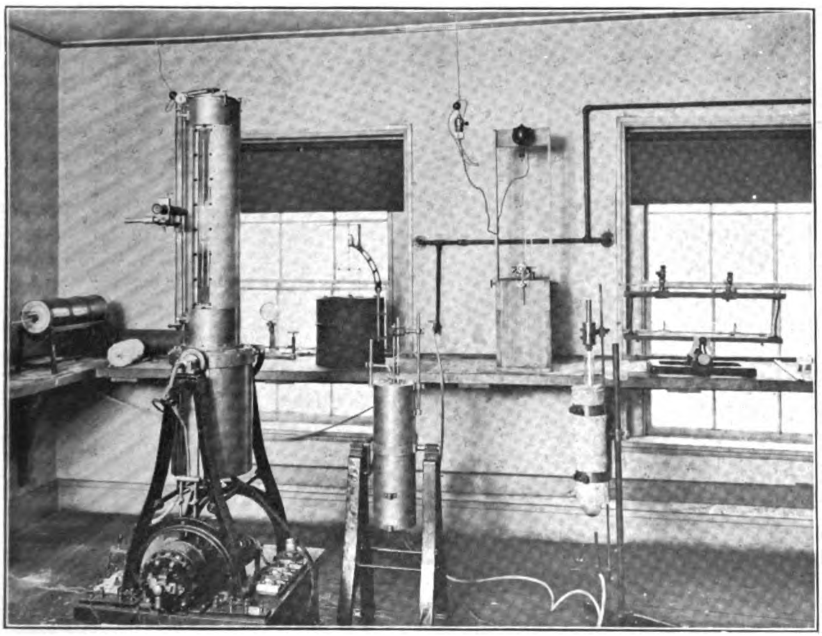
Comparisons of geodetic bars, tapes, and longer standards of length are most effectively carried on in the special laboratory located in the tunnel connecting the physical laboratory with the power plant. This laboratory is formed by a longitudinal wall dividing this tunnel or passage, and in addition to containing permanent mountings for the instruments it has a system of brine and steam coils regulated by thermostats, so that any desired temperature between 0 and 40 degrees centigrade can be maintained. For testing and comparing the geodetic standard bars and tapes there are a series of pillars on independent foundations placed in line at distances of 5 metres, on which micrometer microscopes can be mounted so that by the use of a standard bar of 5 metres in length other bars and tapes can be standardized with great accuracy, the original bar being surrounded with shaved ice and supported in a movable carriage which is passed successively under each pair of micrometer microscopes. At one of the 5 metre intervals there are pillars spaced a metre apart on which microscopes can be similarly mounted and the 5-metre bar standardized directly from the national prototype. On one wall of the tunnel is mounted the 50-metre bench standard for the verification of ordinary steel tapes. This consists of a strip of cold-rolled steel which by the use of thermit has been welded into a continuous bar 50 metres in length; it is mounted perfectly horizontal and free to move on brackets and rollers. This strip of metal has been carefully standardized both for customary and metric measures.

Here now are standardized the base bars and tapes of the United States Coast and Geodetic Survey, so that all its measurements can be reduced to a single standard with the highest possible precision. It was in this tunnel that the new invar tapes of the Coast Survey were recently studied and standardized. As these tapes have only 1-28 of the expansion of steel tapes, they are available for use without a temperature correction and consequently are far better suited for measuring base lines, especially as the measurements can be made in the day time and not at night as is essential in accurate work with ordinary steel tapes.

In rooms on the ground floor of the physical laboratory may be seen a considerable equipment of balances of precision, one of which is arranged for weighing in vacuo by connection with an exhaust. They are supplied with various devices enabling the observer to control their operation from a distance of about 12 feet, so that the heat of his body will have a minimum effect.

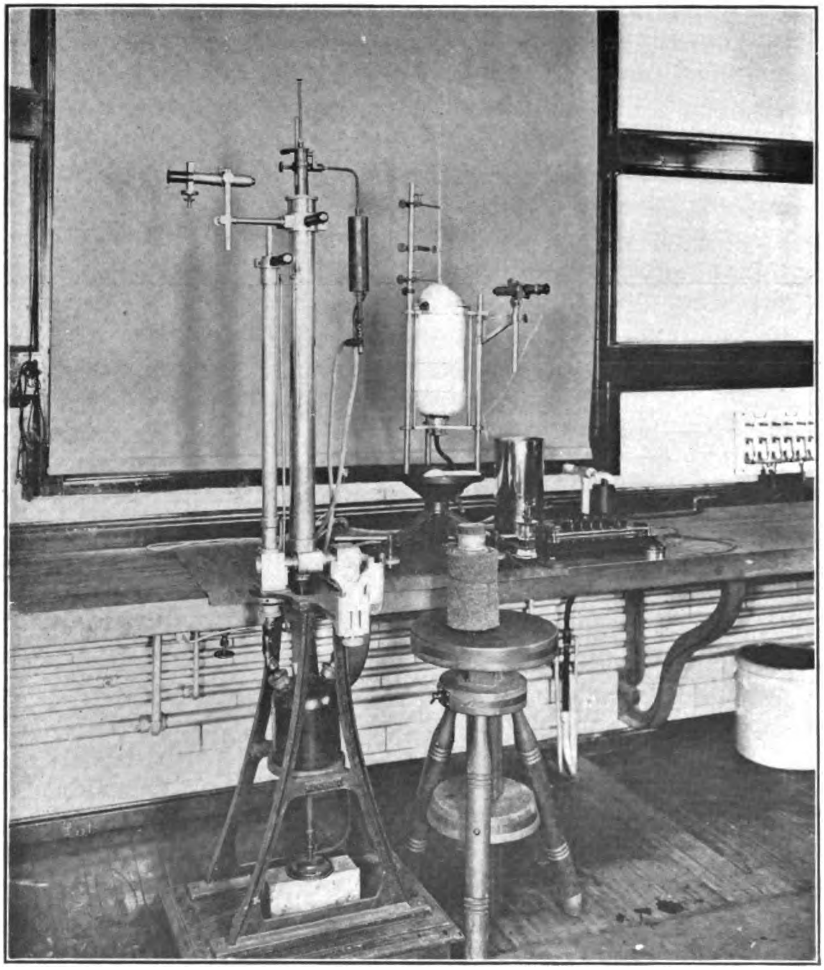
The principal duty of the Bureau as regards weights is to verify the secondary standards and the finer sets of weights made by manufacturers, and to examine State and other legal standards. Lately the Bureau has endeavored to secure greater uniformity in weights and measures throughout the country at large by co-operating with and advising the State and local sealers and inspectors of weights and measures, and three conferences of such officials have been held at the Bureau.

The work with measures of length varies from the verification of test pieces and gauges used in mechanical engineering to the comparison and graduation of standard bars, as has been done for the Governments of Canada, Japan, Chile, and Mexico. Most of the test pieces or gauges used in shop testing are end standards and special apparatus has been devised in many cases to verify them, an exceedingly accurate instrument having been constructed at the Bureau to compare line with end standards.



APPARATUS FOR THE COMPARISON OF THERMOMETERS.

In thermometry, pyrometry, and high-temperature measurement the Bureau carries on work of great importance to both science and industry, especially as instruments for high-temperature measurements now figure in many important manufacturing processes. The temperature as given by the Bureau is defined by Baudin and Tonnelot primary-standard thermometers, standardized according to the international hydrogen scale adopted October 15, 1887, in which the



STEAM-POINT AND ICE-POINT APPARATUS FOR TESTING OF THERMOMETERS.

scale of temperature is defined by the expansion of a given volume of hydrogen between the temperatures of melting ice and boiling water. The Bureau tests mercurial thermometers of all descriptions that conform to its specifications, and in addition to determining the ice and boiling points, the thermometers not properly aged or annealed are placed in an electric heating apparatus where they are subjected to comparatively high temperatures. Electric heating is used throughout this department for regulating the temperatures of the various baths in which the thermometers are immersed and wherever any constant or desired temperature is needed. Tests are also made of special high-temperature mercurial thermometers made of very hard borosilicate glass thoroughly annealed and capable of measuring temperatures up to 550 degrees centigrade and used for such industrial purposes as the determination of the temperature of various chemical reactions, galvanizing baths, hot blast, flue gases, etc. In these thermometers for reading above 275 degrees centigrade the space above the mercury is filled with some inert gas such as nitrogen or carbonic acid under a pressure of about twenty atmospheres, thus preventing the mercury from boiling as it would were the pressure normal.

The Bureau also standardizes platinum resistance thermometers which can measure from the lowest temperatures up to 1,000 degrees centigrade (1,800 degrees F.). As these instruments depend upon the measurement of the resistance of platinum at different temperatures, the experts of the Bureau test such thermometers by determining their resistance at the temperatures of melting ice, steam, and sulphur vapor, or if it is to be used for low temperatures at the temperature of boiling oxygen, and then constructing a table referring these resistances to temperatures on the scale of the standard gas thermometer. The Bureau also tests thermo-couples and issues certificates showing the correct readings at different temperatures, which for this instrument range from that of liquid air to 1,500 degrees centigrade. For the lower temperatures (600 degrees to liquid air) a couple of copper-constantan or iron-constantan is used, while for the higher portion of the scale a thermo-couple formed of pure platinum fused to an alloy of platinum with iridium or rhodium is used. These couples, which are first annealed at white heat, operate by using a galvanometer to measure the electromotive force produced when the two junctions of the couple are at different temperatures. Following the methods tested and recommended by the Bureau and observing suitable precautions, the thermo-couple affords an accurate and convenient means for measuring temperatures.

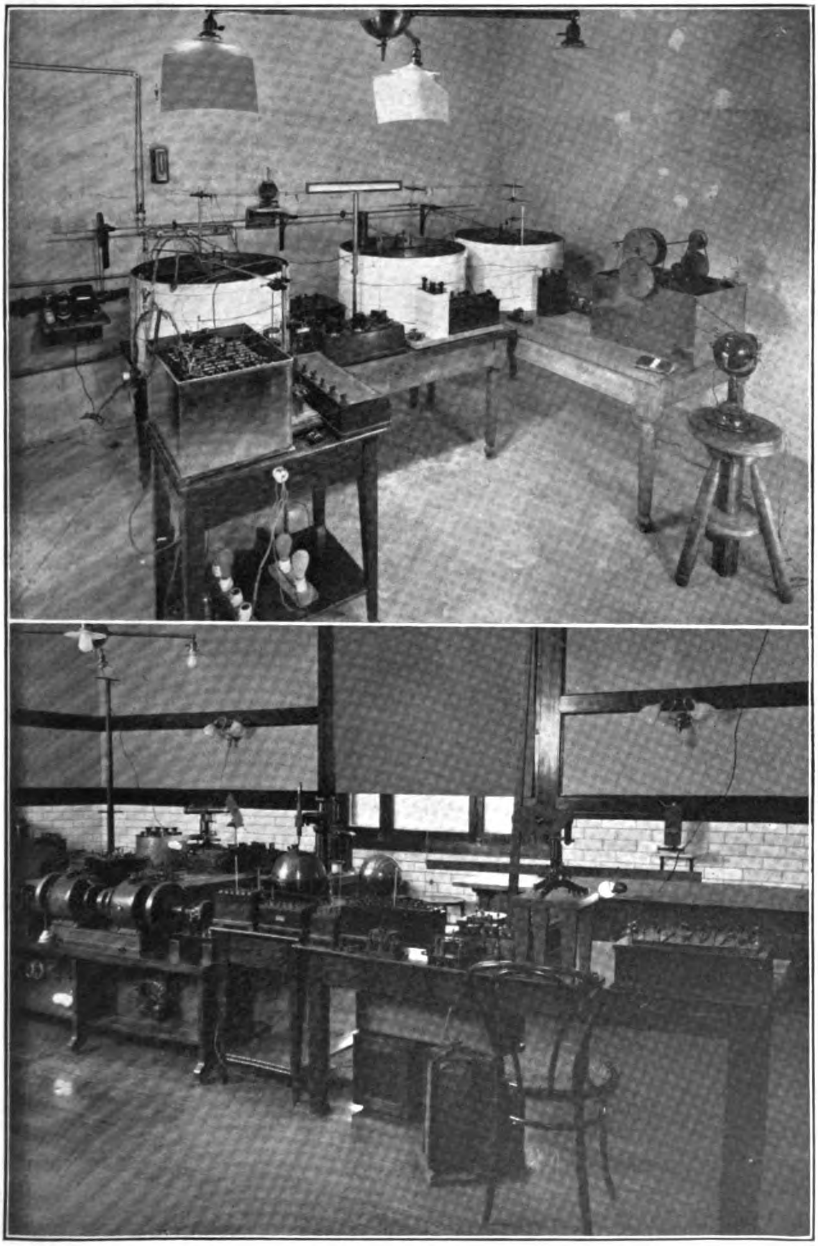
For the highest temperature measurements, even in industrial operations, optical pyrometers are employed, so it has been necessary for the Bureau to study these instruments carefully and it is now in a position to test and calibrate them. They have a range from 600 degrees centigrade to the highest attainable temperatures, such as that of the electric arc, and consist essentially of two kinds: those in which the temperature of the incandescent body is measured by the intensity of the light emitted by the body, and those in which the temperature is measured by the heat emitted by the body, which includes the energy of the visible light waves as well as that of the invisible heat waves. Optical pyrometers find application in determining the intensity of temperature in the hottest furnaces, and are beginning to be widely used in industrial work, as in measuring the hardening or annealing temperature of steels where a difference of 25 degrees centigrade in the hardening temperature is often sufficient to change entirely the properties of the steel. As a result of the pyrometer being better understood, and instruments that can be calibrated accurately being available, the old method of guessing at the proper temperature at which various industrial operations should be carried on has been largely abandoned, and the pyrometer or some similar instrument is employed. The Bureau now knows the relative accuracy and availability of the various types of pyrometers and is prepared to standardize such instruments for manufacturers.

It is for such standardizing among other purposes that the Bureau must determine the melting points of such metals as iron, tin, nickel, cobalt, palladium, platinum, etc., for the melting points of these metals serve as fixed points on the temperature scale, just as the melting point of ice and the boiling point of water serve as fixed points for thermometers at ordinary temperatures.

The Bureau has also done important work in determining the temperatures of the arc (3,700 degrees centigrade), and in studying the filaments of incandescent lamps in order to determine the cause of the efficiency of the new metal-filament lamps such as the tungsten and tantalum, over the carbon-filament lamp. It was found that the great gain in efficiency was to a great extent due to the higher temperature at which these lamps could be used.

The work of the heat section includes the determination of important thermal constants used in scientific and engineering work, as for example the specific heat of brine, a constant of great importance to refrigerating engineers. Such an investigation and re-determination is at present under way. Another important determination involves the heat value of a number of substances that can be used in the standardization of combustion calorimeters. Calorimeter tests are now being increasingly used to determine the heat value of coals, as this seems to be a most satisfactory basis for the purchase of such fuel, and has been adopted by some departments of the United States Government. The accurate thermometers of the Bureau also are used for testing oils for their flash points, a very important matter, as this quantity figures in many statutes

In the electrical laboratories standard and other resistances are checked and calibrated and standard cells are tested. Here, as in the



ABOVE, INSTALLATION FOR TESTING OF STANDARD CELLS; BELOW, ELECTRICAL LABORATORY.

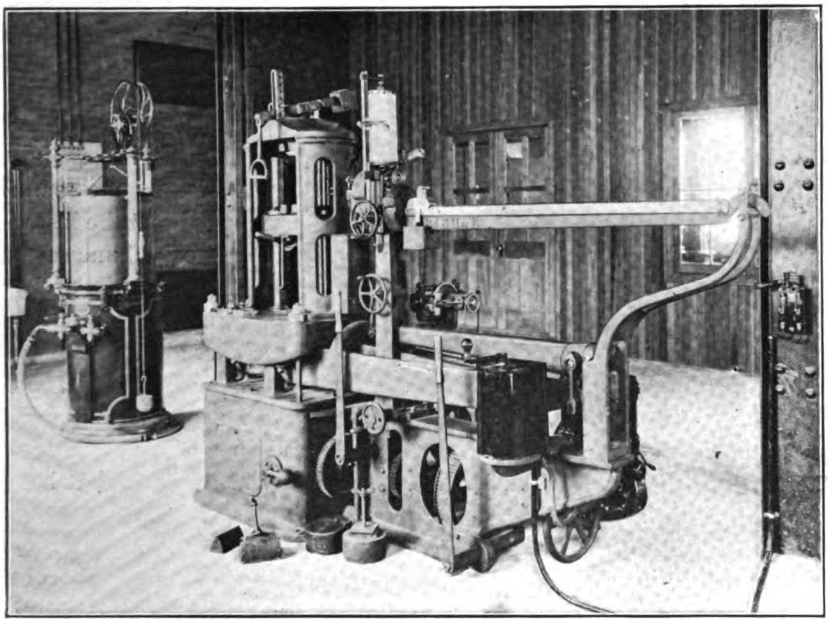
National Physical Laboratory in England and the Physicalisch-Technische Reichsanstalt near Berlin, investigations have been conducted to determine the accuracy with which the Clark and Weston cells can be reproduced from specifications involving the mode of preparation and the purity of the materials employed.

This work will have an important bearing in an international conference on electrical units which has been called to adopt definitions for the fundamental electrical units to be recommended for universal adoption.

Preliminary steps have been taken by the Bureau to construct a primary mercurial standard ohm, as by the definition of the electrical units all measurements are expressed in terms of a mercury column of resistance of specified length and cross section. Another important investigation in progress at the Bureau is the determination of the conductivity of copper, which has been requested by the standards committee of the American Institute of Electrical Engineers in order to re-determine the temperature coefficient and the specific conductivity. Both of these constants are most important in all electrical engineering, the former especially being used in determining the rating of electrical machinery. At the same time these constants for aluminum and other metals used in the electrical arts will be determined also.

The Bureau carries on important work in chemistry, which consists in the main in co-operating with the other branches in their investigations. In fact, this is characteristic of the entire work of the institution. The samples of standard irons formerly prepared and distributed by the American Foundrymen's Association are now issued by the Bureau of Standards to which this duty has been transferred. A similar arrangement has been completed with the American Steel Manufacturers' Association for the preparation of standard samples of steel of three types—bessemer, basic open-hearth, and acid open-hearth—and these have been analyzed and are ready for distribution.

In an independent building is housed the low-temperature laboratory which contains among other apparatus that for producing liquid air and hydrogen. Most of this apparatus was a part of the British exhibit at the St. Louis Exposition. It is of the same type as that used with such success by Professor Dewar at the Royal Institution in London. The outfit includes a two-stage air compressor for pressures up to 3,000 pounds; a single-stage carbon-dioxide compressor for auxiliary cooling; a hydrogen compressor of the two-stage type working up to pressures of 3,000 pounds; also an apparatus for generating large quantities of pure hydrogen by the action of sulphuric acid on zinc; all manufactured by Lennox, Benton and Reynolds, of London. The Bureau has added a direct steam-driven, four-stage Norwalk compressor, capable of compressing 70 cubic feet of air per minute to 5,000 pounds pressure. The plant can supply the liquefied gases in substantial amounts for laboratory experiments.



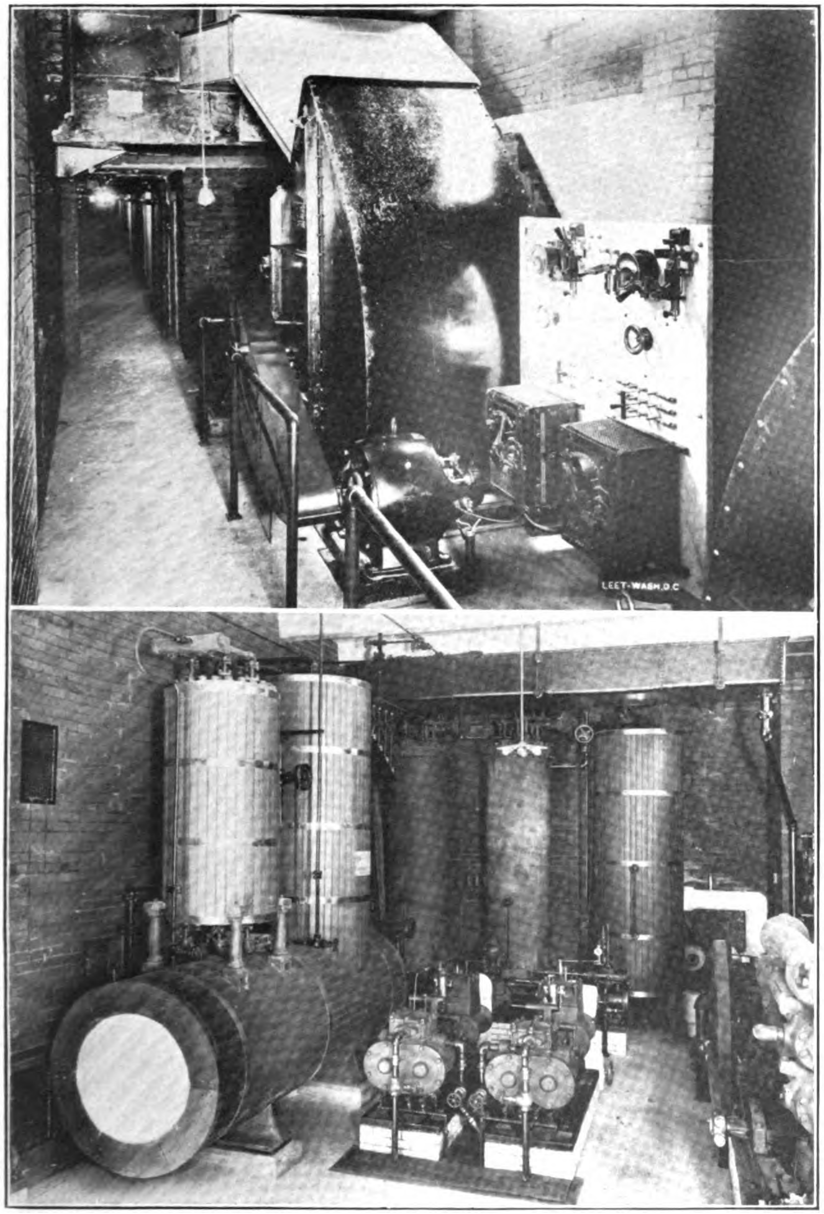
RIEHLÉ TESTING MACHINE AND METER PROVER, MECHANICAL TESTING LABORATORY.

The work of the Bureau in testing engineering instruments and the properties of materials has developed greatly, and Congress has appropriated funds for the construction of a new four-story building, 160 x 60 feet, to be devoted entirely to this work, the erection of which shortly will be commenced. In mechanical testing the activities of the Bureau lie in three main classes; the determination of physical constants, the testing and development of engineering instruments, and the testing of the properties of materials. Now there are many physical constants of great importance to engineers, underlying many plans and calculations. These must be determined most accurately by special experts versed not only in physical science but in some special field.

In the present quarters of the mechanical laboratory the testing of engineering instruments consists more in the study of new instruments and methods of testing than in commercial or routine testing. The aim is rather to test and standardize instruments as for a central city testing bureau, for example, or for a gas or water company, than to test the individual house meters. In testing a water meter, for instance, a measured quantity of water weighed in a tank can be passed through the meter under various conditions of pressure, piping, etc. The instruments and methods studied for central testing laboratories and for inspectors, operate to raise the standard of measuring water and gas supplies and give the Bureau an ultimate control of such testing apparatus, not to mention the training of men competent to supervise this work for many cities and supply companies.

The testing of gas and electric meters is quite as thorough, and the meter provers of the gas companies are sent here by the manufacturers in order to have the graduations determined and the instruments calibrated after comparison with the standards of volume of the Bureau. Such a tested meter prover and its use thoroughly understood by an inspector at a central testing station, enables individual meters to be tested and the accuracy of their readings checked. Pressure and vacuum gauges, steam indicators, anemometers, and various types of standard testing machines are but a few of the instruments under test in this department, and in all cases the tests are made with measures of length or time, or with weights that have been standardized absolutely.

In the testing of materials the work carried on is rather in the direction of investigational tests than to see whether the materials comply with specifications as is done by the commercial testing laboratory. The Bureau in no way aims to supplant the testing laboratory, but to study new methods, supply standards, control apparatus, and standardize instruments, all in such a way that commercial testing will be facilitated and made more accurate. This comes out very forcibly in the attempt to secure uniform standards and specifications through co-operation with manufacturers and producers, and also through studying the supplies furnished to the United States Government. In its various departments the Government is a large purchaser of many materials, and a number of these are tested at the bureau, both to determine whether they comply with specifications and to study the manufacturers standards and tests. Accordingly a number such as paper, cloth, cement, lubricants, ink, mucilage, etc., are being studied so that standard specifications can be prepared by the Government, which each bidder can understand and which will be definite as well as fair to both parties.

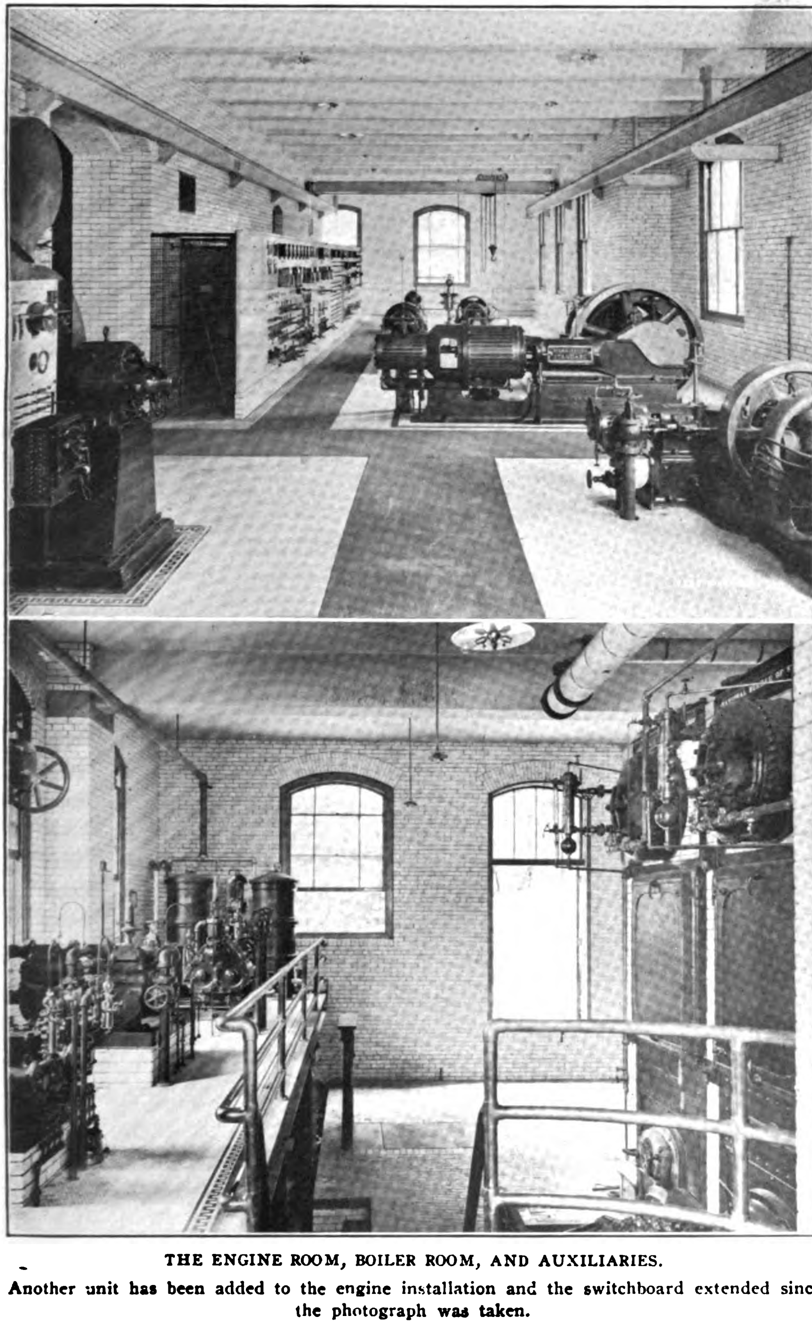


THE VENTILATION PLANT, AND THE REFRIGERATING PLANT FOR BOTH COOLING AND TESTING PURPOSES.

The connecting tunnel between the buildings is seen in the background of the upper picture.

The mechanical building, directly opposite the physical laboratory, contains the power plant, which while not remarkable for its size is a model of arrangement and has an unusual diversity of functions as it must supply all electricity, gas, steam, ventilation, heat, water, etc., to the various buildings and laboratories of the Bureau. It also is of red brick and limestone, but is two stories in height though the large basement, owing to the slope of the land in the rear, is entirely above ground. The building is 135 feet in length with a width of 48 feet increasing to 58 feet in the centre. There are two water-tube boilers, each with 125 horse-power capacity, and these supply steam to three horizontal engines of 120, 60 and 50 horse power, respectively, directly connected to direct-current dynamos, each unit being mounted on a separate concrete foundation independent of the building. There are also various auxiliary engines and pumps which are placed on a platform, level with the floor of the engine room and directly in front of the boilers. Forced draught is provided so that only a short stack is required, while so perfect is the combustion that practically no smoke is emitted. In both boiler and engine room space has been reserved in case it is necessary to add to the plant at any future time. Everywhere there is most abundant light and ventilation, while the use of white vitrified brick and of ceramic floors adds a most attractive appearance to the installation.

Through a three-wire system current at 120 volts is distributed for lighting the buildings, charging the storage batteries, driving the ventilating fans, operating the various motors, and such other power purposes as are required. Adjoining these generators are a number of alternators driven by motors on the main power circuit and furnishing single and polyphase current for experimental purposes, as well as dynamos giving direct current of high potential. All these generators are susceptible of various combinations and transformations for purposes of experiment and investigation. The switchboard panel, 57 feet in length, is adapted for the many experimental requirements as well as the ordinary service of the buildings. Thus there are trunk lines running from this switchboard to other switchboards either in the physical laboratory or in the various laboratories on the floors above, and an experimenter desiring a special current of any frequency or phase has only to telephone the engineer, and by arranging the proper connections secure the same at the outlet in his own laboratory. There is a large storage battery not only for experimental purposes but to carry the load when it is



THE ENGINE ROOM, BOILER ROOM, AND AUXILIARIES.

Another unit has been added to the engine installation and the switchboard extended since the photograph was taken.

desired to shut down the engines, it being of sufficient capacity to meet all of the needs of the building temporarily. The refrigerating room is another instance of the use of machinery both for the ordinary service of the buildings and for scientific experimentation. It includes an absorption refrigerating machine and ice plant, the former having a capacity equivalent to the melting of 30 tons of ice per day. This cold is absorbed by brine which flows through coils in the air chamber of the ventilating plant or through a series of pipes in the tunnel where the base bars and tapes are compared. The brine piping extends throughout the buildings wherever it may be needed, as does water artificially cooled for drinking and for various experimental purposes. In this refrigerating room it is possible to store up cold brine which can be used when the refrigerating machinery is not running. The cooling chamber of the ventilating system is in close proximity to the refrigerating machinery, and the air from the outside, after having been filtered, is forced over a coil containing brine. This removes the moisture and permits dry air to be delivered through the ventilating flues. This cooling chamber can also be used as a low-temperature laboratory where experiments may be performed. A gas machine which produces a high grade of fuel gas from gasoline is also located in the basement of the mechanical laboratory and the gas is piped to all the laboratories.

The instrument shop, well arranged and equipped, permits much of the apparatus to be made under the personal direction of the experts of the Bureau. The machinery is driven by independent motors and skilled instrument makers are employed so that the finest work can be done in the shop.

It is the aim of the Bureau to be a centre of information on scientific testing and measurement, and to stand in the same relation to the manufacturing industries that the United States Department of Agriculture does to the farmers. Already wide use has been made of its facilities, and a most noticeable improvement has taken place in the measuring apparatus and instruments of American manufacturers. The favorable reception by the scientific world of the published researches of the Bureau of Standards seems to indicate that the work is being conducted on a high scientific as well as most practical plane.

STORAGE BATTERIES, THEIR CONSTRUCTION AND USES.

By Percival Robert Moses.

Mr. Moses here concludes his discussion, begun in our September issue, of the application of the storage battery as a means of energy storage in isolated electric plants. The preceding instalment treated of the conditions to which the storage battery system is best adapted, and described the construction and operation of the leading types of batteries on the market. In the following pages the storage battery is considered as an actual part of the generating equipment, under the general heads of the phenomena of charge and discharge, the various types of boosters and other auxiliary equipment adapted to various conditions, and the economies which may be effected by the use of the system. An interesting supplement to Mr. Moses' discussion will be found in a review entitled "The Care and Maintenance of Storage Batteries," on another page of this issue.—THE EDITORS.

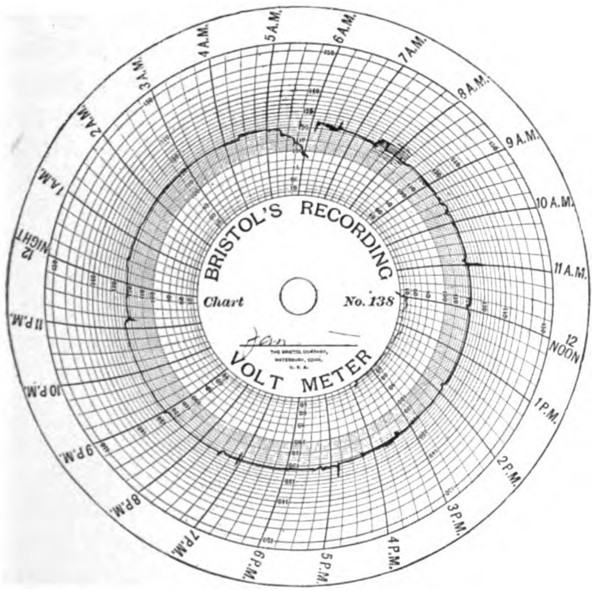


FIG. 15. RECORDING VOLTMETER CHART SHOWING DROP IN VOLTAGE AT END OF DISCHARGE.

IT has been stated that batteries operate automatically to take the fluctuations of the load so that little comes to the engine or dynamo. This condition is technically known as "floating on the line," and the batteries are said to be regulating. This result is obtained by various methods, but all are variations of the general principle of reducing the voltage supplied by the electric dynamo and the booster in series, as the overload goes on, in order that the battery voltage may be sufficiently higher than the combined voltage of dynamo and booster to take all load in excess of the average steady load.

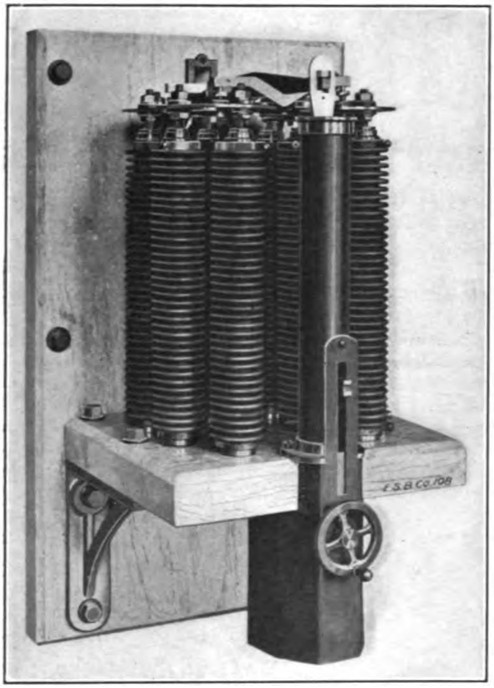


FIG. 16. CARBON REGULATOR.
Electric Storage Battery Co.

It should be explained that while the voltage of each cell is about two volts on discharge, it varies with the state of discharge from 2.08 volts down to 1.8 volts; below this it would drop suddenly as sulphating increased to 1.65 volts and to zero. In charging, the voltage jumps rapidly from 1.9 volts to 2.2 or 2.3 volts, remaining at this point until it rises rapidly toward the end of charge to 2.6 volts. The recording voltmeter chart, Figure 15, shows clearly the varying voltage conditions. This chart shows the voltage of the battery during a 24-hour run under regular working conditions. From 7.45 A. M. to 7.30 P. M., the battery is floating on the line, charging when elevators are not taking current, and discharging when they are. From 7.30 P. M. to 11 P. M. the battery is being charged in order to get it full before the whole load is thrown on. From 11 P. M. to 6 A. M. the battery carries the whole load, including a 15-ton electrically-driven refrigerating compressor, a brine-circulating pump, elevators, and lights. At 5.15 A. M. the voltage begins to drop suddenly, showing that discharge is approaching the danger point, and the plant is started up and the battery put on to charge. If 60 cells are in circuit at the beginning of discharge, they will give 125 volts, and at end of safe discharge this will have dropped to 108 volts. On charge the cells would require after a short period 138 to 140 volts, increasing to 156 near the end of charge; and it follows that the ordinary direct-current dynamo which operates at a steady voltage of say 120 volts would not of itself be able to charge the battery, and if the voltage of the dynamo were raised, it would result in burning out all the lights, etc., on the circuit. Hence, recourse is had to an auxiliary dynamo inserted between the main dynamo and one side of the battery and designed to give voltages varying from a minimum up to the maximum required for charging, and automatic devices are installed designed to vary this voltage as the load to be carried increases or decreases. The voltage generated by this dynamo is added to that of the main dynamo, and for this reason the auxiliary dynamo is called a booster, the automatic device is called a regulator, and, as the main dynamo is only required to deliver a steady load, the system is called the constant-current system.

The Electric Storage Battery Co. use a carbon regulator consisting of carbon piles (Figure 16), the resistance of which is changed as pressure increases or decreases. An increase in current demand causes the pressure on the carbon piles of the regulator to change, and this causes a flow of current in one section of the booster field-winding opposed to the regular winding, resulting in reducing the strength of the magnetization of the booster field and causing the voltage given by the booster to decrease. The result of this decrease, of say from 20 volts to 4 volts, is to leave the battery voltage higher than the voltage of dynamo and booster, and the current flows from the battery to the load; *vice versa*, when the current decreases, the booster

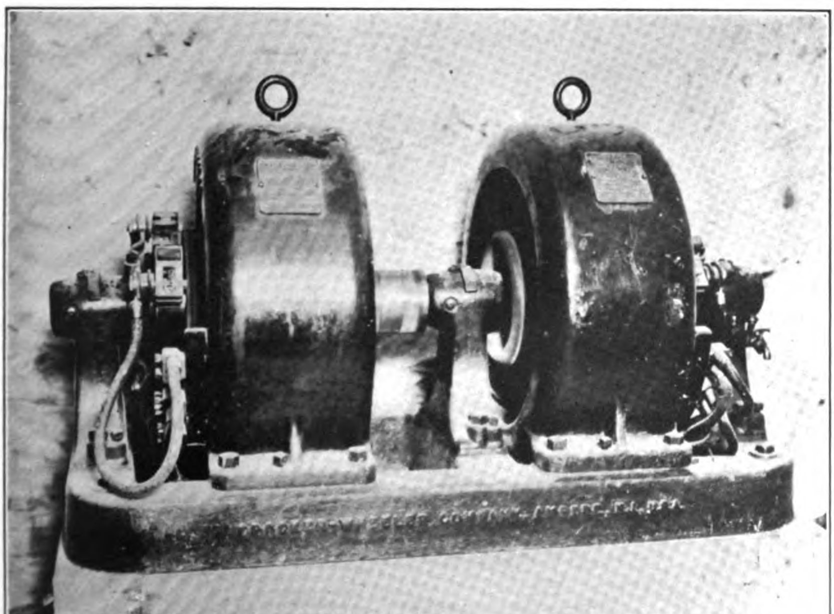


FIG. 17. BOOSTER FOR AN INSTALLATION BY THE GENERAL STORAGE BATTERY COMPANY.
Made by the Crocker-Wheeler Company.

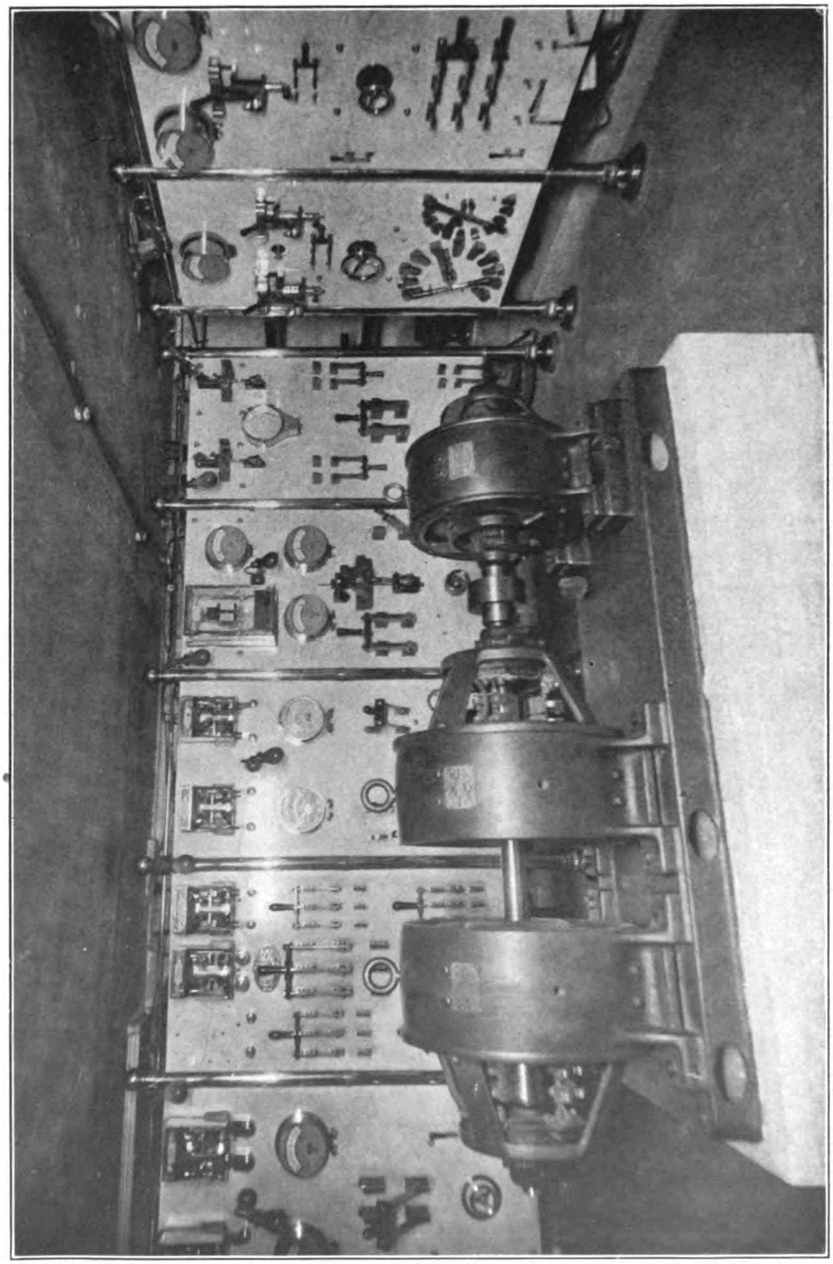


FIG. 18. BOOSTER SET, GOULD STORAGE BATTERY COMPANY.

voltage is increased, and current flows from dynamo and booster to the battery. This arrangement involves a divided field-winding on the booster, and as there is a possibility of the battery reversing the booster and driving it as a series motor, a governor is necessary to prevent its running away.

The General Storage Battery Co. use a shunt-wound booster (Figure 17) and a regulator consisting of a current-carrying coil, or solenoid, exerting a pull on a pivoted arm constant throughout the length of travel, but varying as the current varies (Figure 19). The end of the arm has fingers of unequal length dipping into mercury and the number of fingers in contact with the mercury bath determines the resistance in the booster field. The pull of the solenoid is resisted by a spring. As the load tends to increase, the current around the solenoid increases, the balance between the pull of the spring and the pull of the solenoid is destroyed and the arm starts to move and continues to cut resistance into the booster field until the current delivered by the booster and, therefore, by the main dynamo is reduced to the required amount, when the balance is again restored. As a matter of fact, the increase in current never reaches the dynamo, as the action of the regulator is instantaneous.

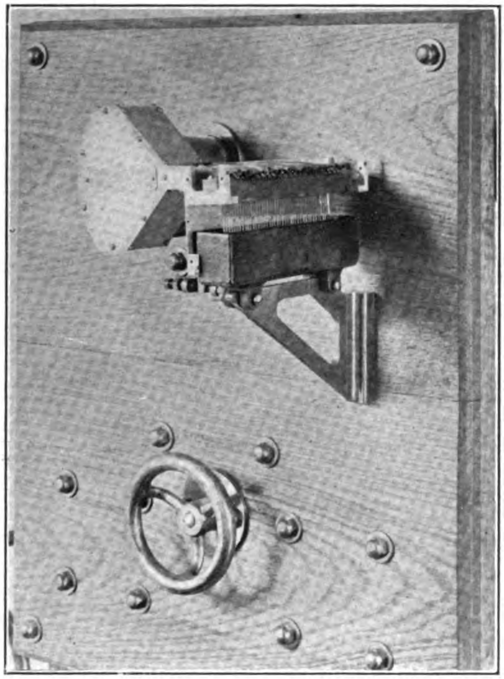


FIG. 19. BIJUR CONSTANT-CURRENT SINGLE-ARM REGULATOR.
General Storage Battery Co.

The Gould Storage Battery Co. use a second dynamo to cut down the voltage (Figure 18), and there are many other ways more or less simple and effective, but all designed with the same object in view. The Westinghouse booster and regulator are shown in Figures 20 and 21.

Boosters for this work require a special design because of the widely varying voltage requirements, and the consequent wide range in magnetization. It is important that they be built by manufacturers thoroughly familiar with the requirements and conditions.

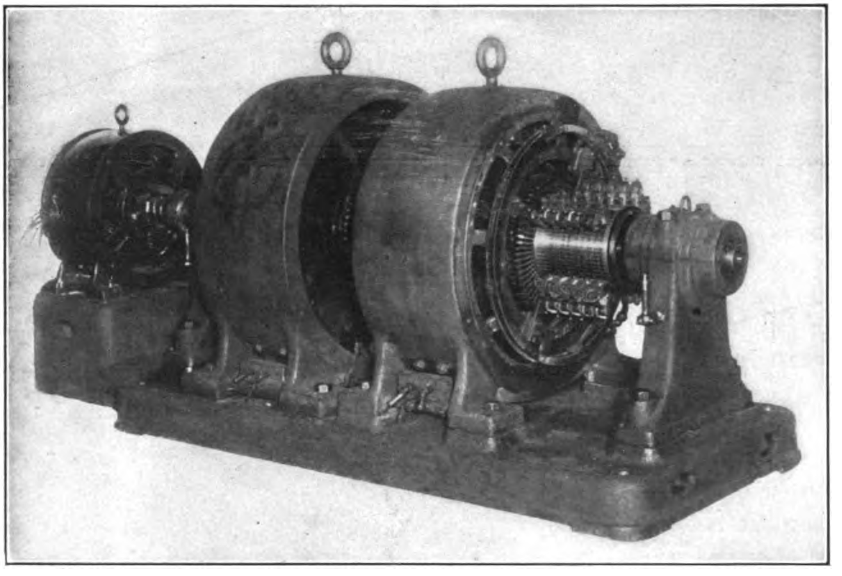


FIG. 20. WESTINGHOUSE BOOSTER.

Where the battery is to be used for regulating during the day, and after regular hours for lighting, etc., it is evident that the booster must not only have a capacity sufficient to give the average of the day load, but sufficient additional capacity to supply the load taken out during the night, unless it is possible to cut the battery out of regulating service for a considerable time after discharging. Where the battery is only to be used for regulation, its capacity need only be equal to the average demand.

If the battery is not to be used for regulating, but is intended merely to supply peak loads or night lighting, an ordinary shunt-wound booster controlled by hand is all that is needed.

Note has been made of the drop in voltage from 2.08 to 1.8 volts on discharge, and this necessitates the use of additional cells known as "end cells," to be thrown into circuit as the battery becomes discharged, in order to maintain the original voltage on lamps. A special form of switch (Figure 24) is required to prevent short circuiting of the cells when they are being thrown in; and where cells are large, the switch is operated by a motor—in some cases automatically.

Batteries are rated generally by their ampere-hour capacity on an 8-hour average discharge rate; for example, 320 ampere hours is 40 amperes for 8 hours with a final voltage of 1.8 or over per cell. If it is desired to discharge the battery in one hour, the capacity will be about one-half this amount, that is, 160 amperes for one hour, but the momentary permissible discharge on regulation is equal to the full capacity for 8 hours, that is, 320 amperes, and even greater momentary discharges may be taken without damage.

The cost of batteries installed with switchboard panel varies with the voltage required; i. e., a 240-volt battery with a capacity of 160 ampere hours will cost more than a 120-volt battery with 320 ampere-hours capacity, because of the greater relative cost of supporting racks, and the larger number of connections and cells.

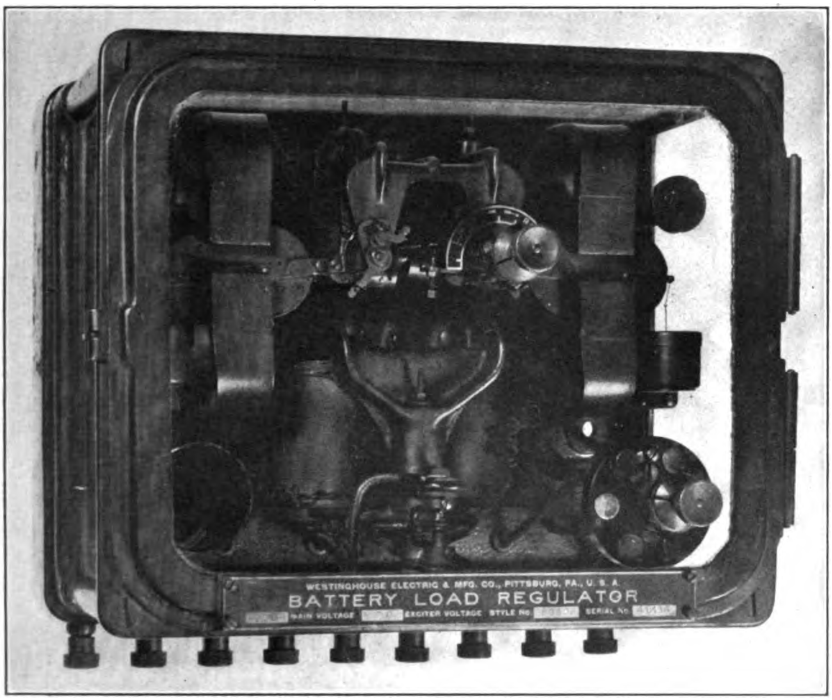


FIG. 21. WESTINGHOUSE BATTERY LOAD REGULATOR.

For small batteries used in connection with the regulation of elevator loads, the cost will be between $100 and $125 per ampere-hour capacity at 8-hour rate at 250 volts; or between $400 and $500 per kilowatt capacity at 8-hour rate; for example, a battery giving 40 amperes at 250 volts for 8 hours would have a kilowatt capacity at 8-

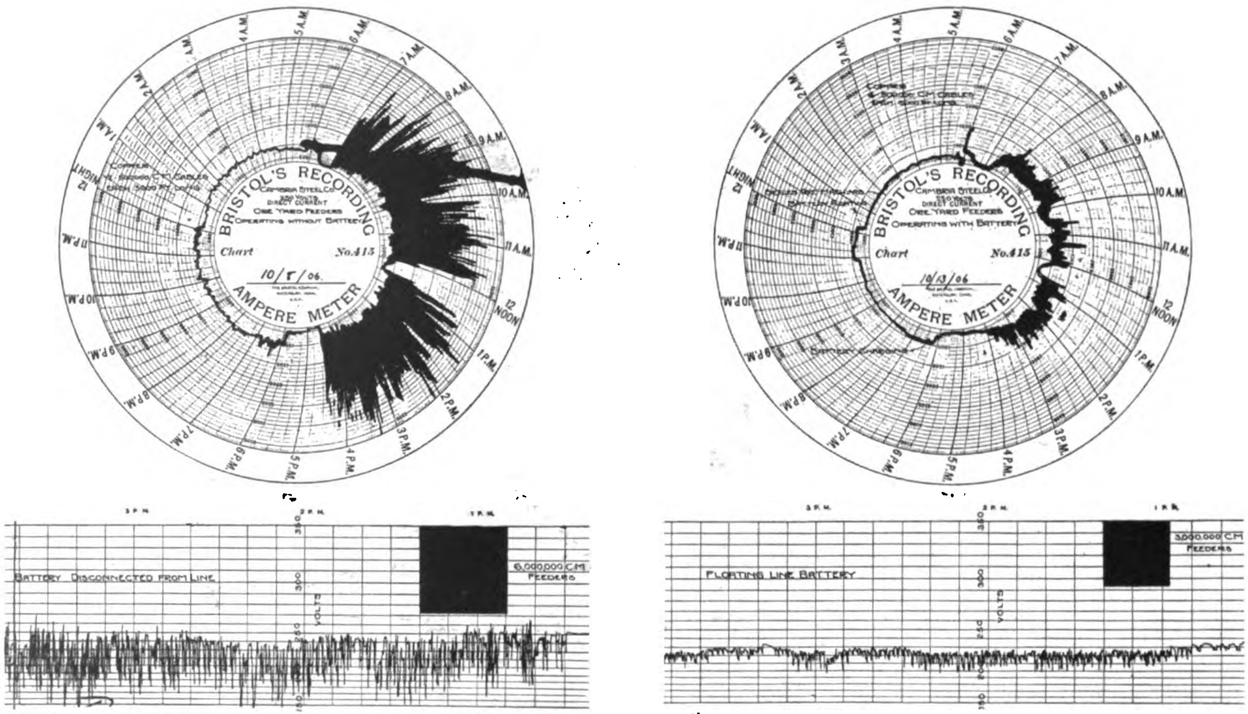


FIG. 22. VOLTAGE AND AMPERE CHARTS, WITHOUT AND WITH BATTERY ON END OF FEEDER TO ROLLING-MILL MOTOR. Without battery, on the left; with battery, on the right. Greene Storage Battery Co.

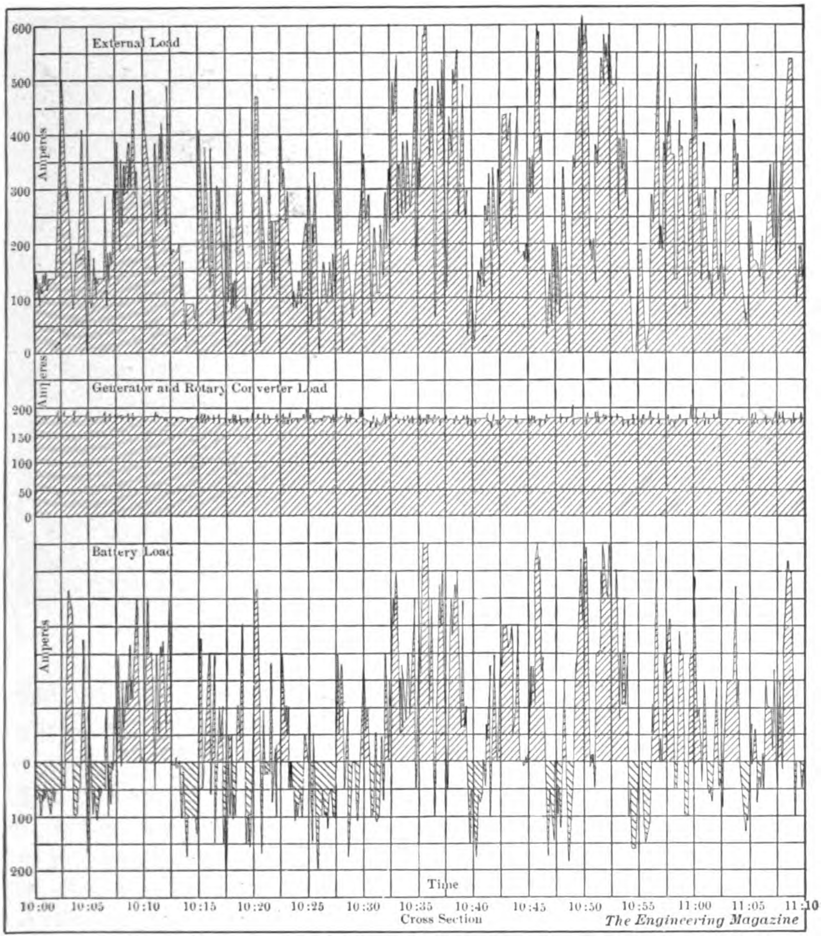


FIG. 23. CHART SHOWING DIVISION OF LOAD BETWEEN DYNAMOS AND BATTERIES IN COLORADO PLANT; WESTINGHOUSE MACHINE COMPANY.

Top indicates total load, middle the almost steady load carried by dynamos and rotaries, bottom the wildly fluctuating load carried by battery.

hour rate of 10 kilowatts, and would cost between $4,000 and $5,000. Such a battery, however, would be capable of safely taking care of fluctuations up to 100 kilowatts, and if the plant capacity to take care of this amount of fluctuation had to be provided, it would cost between $6,000 and $7,000, so that the first cost would be less with the battery than without, unless part of the plant capacity, such as boilers and stack, were required full size to take care of heating or other low-pressure-steam requirements.

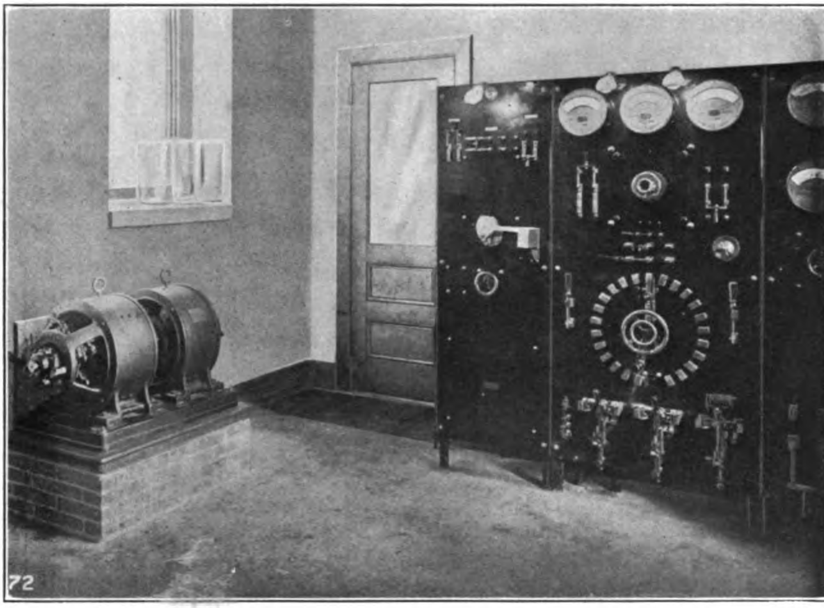


FIG. 24. B[illegible]R AND BATTERY PANEL, ST. URBAN INSTALLATION, NEW YORK.
General Storage Battery Company.

In general, if fluctuating load propositions are carefully designed, the total installation cost with a battery will be a little higher than without but the operating cost will be much less.

In street railway or rolling mill work, there is a further advantage derived from the use of a battery, viz., the reduction in size of feeders, control switches, etc., made possible by the installation of the battery close to the fluctuating load. In such instances the feeder from the generating plant to the battery may be designed for the charging current, i.e., the average current, instead of for the maximum current, an important factor where power is to be transmitted any distance. The two charts in Figure 22 (General Storage Battery Co.) show these facts clearly in connection with a rolling mill installation. The chart on the left shows the size of feeder to be 6 million circular mills, and a variation in voltage at apparatus of over 100 volts, from 250 to 150, while the chart on the right shows a feeder half the size, and a maximum variation of 25 volts.

EFFICIENCY AS A BASIS FOR OPERATION AND WAGES.

By Harrington Emerson.

IV. STANDARDS; THEIR RELATIONS TO ORGANIZATION AND TO RESULTS

The first part of Mr. Emerson's essays called attention to the general inefficiencies existing everywhere; the second, to the peculiar national qualities that have thus far helped industrial countries to mitigate the losses due to inefficiency. The third paper pointed out the great need of supplementing the old and cumbersome line organization that pervades industrial management with modern staff organization. This fourth part shows that the inspiration of staff lies in severe and high standards of great minuteness. The fifth and sixth instalments of the series will give the practical results secured by supplementing the usual line organization and current methods with staff organization and staff ideals.—The Editors.

PRESERVATION and perpetuation is one of Nature's most important laws; therefore line organization, which is self-perpetuating, is essential, it being a detail whether the chief and officers of the line are individuals or commissions or a semi-staff. Line organization, from its nature, will always be mediocre and inefficient unless handled by an extraordinary genius like Napoleon. The mediocrity is not one of individuality but of organization. Promotion is not by merit, since this would destroy the essential feature of line (its property of self-perpetuation), but advancement is by seniority. The youngest member is as capable potentially as the highest, and whether he rises to supreme command in five years or in forty-five depends on opportunity. When he has reached the age of retirement he gives way to a junior as one day gives way to another. There was nothing worth preserving and the elimination of the temporary head produces a desirable wriggle of life all the way down the line.

Line organization needs few standards, usually crude and often fictitious. Seniority or precedence is one of its standards, and closely interwoven is the fundamental standard of immediate and unquestioning obedience almost as automatic as the obedience of sheep to the leader. This simplicity of standard eliminates mental, moral, and physical perplexity. A chief of line may have many personal standards. He may not permit men to be recruited for his guard unless seven feet tall, the idiosyncrasy of the first king of Prussia, or he may uniform them in tall beavers and scarlet coats, or he may dress them like cowboys and call them rough riders, or as in the German and French and Russian armies there may be most punctilious standards imposed as to dueling.

Line organization can be defined as a self-perpetuation of a good average with the one standard of obedience.

Because it is the exact opposite, staff is a strengthener to line. It is not self-perpetuating but distinctly selective. The youngest captain in the German army assigned for staff duty, is perhaps the highest special authority on aeroplanes. Promotion is not upwards but outwards, just as the Wright brothers, who began by specializing on aeroplanes in their home field in Ohio, are now the recognized authorities in the United States, France, England, and Germany, in aeroplanes, but in nothing else.

Instead of there being one main standard, obedience, causing no perplexity—instead of subsidiary fanciful standards—there is an unlimited multiplication of scientific standards, higher than all personality; and the staff expert, instead of receiving all the law and gospel from his chief, receives general principles only, but himself furnishes his chief with personally perfected standards, which it is the duty of the chief to adjust and incorporate in the general plan.

A staff without general standards, a staff officer without special standards, either expressed or felt, is a misnomer.

The standards of the staff are not scientific abstractions, but are evolved for the use of the line, the sole justification of the standards being that they will make line work more efficient. Staff standards being for the benefit of the line and often intrusted to line officials, must be put in the form of permanent instructions so that all may understand what is being aimed at, and deviations by the line be marked and reprimanded.

During the Cuban campaign, in a road over which many hundred army wagons were to pass, there was a mud hole. The first transport wagon, obeying the command to proceed to destination, floundered into the hole, had to be unloaded, dragged out, and reloaded. The crew had neither authority, skill, nor equipment to mend roads, so they passed on. Also there were no written staff instructions as to what a line official should do when he found the road impassable, so the second wagon coming along a few hours later, plunged into the same hole and experienced the same delay and trouble. In turn each of the several hundred wagons repeated the same performance, and although this road was in constant use for several months no attempt was made to mend it. Had there been as much sense of staff as in ant-hill activities, the first wagon would not have passed on without bettering the conditions for those who follow, instead of leaving them worse; had there been even elementary staff, one wagon only would have gone into the hole, which would then as a matter of course have been eliminated. Had there been perfected staff, even the first wagon would not have passed over the road until it had been put in condition.

A sign post definitely stating distance, character of road, steepness of grades, to next town, is not in any way an imposition on or impediment to the wayfarer, whether on foot or in automobile, but is a valuable help. The sign post is a staff, without authority, except as imposed on the line by a line officer, a staff without value except as to its own special and limited information.

Staff standards are infinite and ever-changing. The best practice of yesterday is the laughing stock of today. The work of the expert is never done. The aeroplane flight of 6 miles last year becomes 60 miles this month, 600 miles next year. The chief of staff, who is to inspire the search for higher standards, who is to handle them with common sense, must himself be governed by elemental natural truths, his standards, used as a test for all the others, and these highest standards are psychical and physiological rather than physical. The four psychological requisites for a chief of staff are: (a) Faith, in men, in equipment, in methods and in standards (b) an enthusiasm that inspires and creates confidence, (c) ultimate highest ideals, (d) very great rapidity of action.

Faith in men, faith in equipment, faith in methods, faith in standards must be so great as to inspire a contagious enthusiasm not only in the junior staff members but also in all the members of the line from commander-in-chief down to private. No man is fit to be a member of a staff who does not delight in his work, who does not consider it quite the keystone of the arch, who does not bend it wholly to the interests of the line, so that the line will recognize that through staff presence and staff endeavor, line work is made safer, higher, more pleasurable and more profitable.

The chief of staff must believe that the great majority of employees, nine-tenths, at least, can be easily influenced to do what is right, and prefer to do what is right, and that if the right course is made easy, it will be automatically followed, just as most people naturally keep to the sidewalk, although there are no rules ordering them to do so. Policemen are armed with clubs not to intimidate the well behaved many but to terrorize the exceptional few. After the first prejudice against any innovation is overcome, staff standards must continually appeal to those for whom they are set up.

The chief of staff must assume, until the contrary is proved, that existing equipment and existing facilities utilized to fullest efficiency can meet most requirements, that it is better to improve than to substitute, that Goliath can be slain with a sling and that the western road to India can be discovered with a caravel.

No man is fit to be either chief of staff or staff junior who does not have and adhere to high ideal standards. This fidelity to abstract principles is necessarily foreign to the line. A type setter is a member of the line. He achieves, obediently following the manuscript; but the proof reader is a member of the staff and maintains standards. Between them, perfect work is turned out.

The chief of staff and all his juniors must be alive to the value of rapidity of action. Seconds, minutes, hours and days are to the staff what hours, days, months and years are to the line. Staff ideals of the value of rapidity are found in the instantaneous action of a boxer or fencer where delay of the hundredth part of a second to meet an expected condition may result in death; are found in the activities of the weather service which receives reports from territory 6,000,000 miles in extent, compiles and digests the information, and publishes tomorrow's weather before noon today, to all the world over land and sea; a delay of a few hours would make the whole work valueless. Staff ideals of speed reacting on all the line are found in the work ot a daily paper which collects the news of the whole world until the night is half gone, goes to press at two in the morning, and reaches distant customers at 6 a. m.

A proposition was made to the line officers of a large corporation to reduce expenses $2,000,000 per annum. Whatever the time required to accomplish this, every day's delay caused an irretrievable loss of $6,666; yet details that ought to have been decided in 8 minutes were allowed to wait for 8 months. Line traditions vitiated staff ideals and as the line lasts forever it is not imbued with speed ideals. It was quite in accordance with line tradition that the wars between France and England lasted 100 years, that the religious wars in Germany lasted 30 years, that the wars of Frederick the Great lasted 7 years, that the French European wars lasted 26 years, that the war of the American revolution lasted 7 years, the wars of the Rebellion 4 years—but that the staff-prepared war of Von Moltke's Prussian army against twice as strong a territorial and numerical coalition lasted 2 weeks, and Von Moltke's staff-prepared war of Germany against France captured the French emperor and the French armies and ended the French empire in 7 weeks after outbreak.

In line, there is very little planning but a great deal of organization; in staff, it is all planning and very little organization.

Owing to absence of staff as part of their own organization, lines, all over the world, have been forced to depend on outside staffs, whose inspiration was generally tinged with pecuniary self-interest, so that the great shops and railroads and other industrial concerns have been as to men, machines, materials, and methods over-supplied and over-equipped, as when a $100,000 saw mill is erected to handle a $50,000 lumber tract. Many hundred million dollars have been spent in the last decade on fanciful betterments, when greater returns could have been obtained by standardizing what was.

In marked contrast to the lavish expenditure for inadequate returns from improvements in industrial and transportation concerns is the small expenditure and enormous return brought about in agriculture. The present depression in the great industrial division of American activity and the almost giddy prosperity of the agricultural division at once illustrate the fundamental difference in results and in methods obtained from line and staff activities respectively. The farmer is not lazy, he is not troubled by union limitations, and he has the enormous spur of direct and personal increase of reward for increased or more intelligent effort; he has moreover been at his business from birth; but the average result in crops is only about 30 per cent of what it ought to be.

There is no reason for assuming that industrial activities, entrusted to men whose interest goes no further than their daily wage, who were not born to the business, will average any higher in efficiency than the farming class, and in fact there is just as much difference between the average crop and the expert's crop as there is between the average output of a man and machine and the expert's output from the same man and machine. Two different influences are revolutionizing agriculture—the isolated special genius, and the staff adviser. The industrial field has had the isolated special genius but as yet very little staff assistance.

Because these essays on efficiency are applicable particularly to shops and railroads it is better to use illustrations from agriculture, since it is much easier to see the mote in the brother's eye than the beam in our own. Therefore the yield of potatoes will be used in illustration. What is the limit of yield of potatoes from an acre of ground in the United States? The average yield per acre over a series of years is 96 bushels. Shall we therefore set 100 bushels as standard 100 per cent efficiency?

The lowest average in 1907, 65 bushels, occured in the great agricultural State of Kansas; the highest average was in the desert State of Wyoming, 200 bushels to the acre. The highest average in Wyoming is due to one man, who issued a challenge of $1,000 open to all the potato growers of Colorado, that he would raise on his Wyoming farm more potatoes per acre than any one could raise in Colorado, provided further that if he won the contest yet failed to raise 1,000 bushels per acre, he would forfeit the whole of the stakes, $2,000, to charity.

It is psychology, not soil or climate, that enables a man to raise five times as many potatoes per acre as the average of his own State, ten times as many per acre as the average of the United States, thirteen times as many as the average in the better soil and climate of Kansas. An easily attainable standard of potato raising is therefore not 100 bushels but 500 bushels which can be called 100 per cent efficiency.

On this basis the average of the United States is 19 per cent, the average of Kansas 12 per cent, the production of the Wyoming champion 200 per cent efficiency. If the United States attained as to potato raising an average efficiency of 50 per cent, the increased value of the crop in one year would be sufficient to pay for the Panama Canal; or, the acreage and labor devoted to potatoes could be reduced to 40 per cent of what it now is, and still yield as many potatoes.

Undoubtedly the potato champion, in a more favorable climate, where, with irrigation, three crops are possible, as in the Yaqui Valley in Mexico, would raise 3,000 bushels per year per acre. They would cost him more per acre but less per bushel than any other potatoes in the world.

Individuals of this kind have inspired the Agricultural Department at Washington, working in conjunction with State agricultural staffs, to standardize conditions for all staple agricultural products.

It has recently been asserted that with selected seed a standard attainable yield of wheat is 50 bushels per acre per year. The actual yield is 14 bushels; the total 650,000,000, when it ought to be 2,500,000,000 bushels—yet there are charity bread lines in New York.

With a standard of 50 bushels per acre the efficiency average of the United States is only 28 per cent, the money loss at constant price over $1,000,000,000 per year.

The staff experts of the Agricultural Department have enabled Texas cotton growers to raise one bale per acre. Selected seed, suitable fertilizer, systematic cultivation is all that is required. The acreage of cotton is 32,000,000 the production only 12,000,000 bales; the efficiency is 37.5 per cent and the annual loss due to inefficiency about $1,000,000,000.

Italian bees in California raise twice as much honey as they do in Italy. The Californian bees do not work as hard, they live longer because most of the disagreeable work is eliminated. The staff experts advising the bees are men who standardize conditions both simply and effectively. The bees make honey instead of wasting time on hives, on foundations, on comb, and on long journeys to semi-barren flower fields.

The potato expert increased the efficiency of his fields to ten times the average; the owner of Alaskan seed wheat increased his yield to fourteen times the average; the corn and cotton staff experts have through their advice enabled whole counties of farmers to double the average yield of corn and cotton; the making of better conditions has increased the average yield of honey 100 per cent.

If we could put ourselves in touch with the feelings of plants we should probably find that there was much more enjoyment to potatoes in growing 1,000 bushels to the acre than in growing 67 to the acre. Intensity of production does not mean physical exhaustion, but favorable conditions. Similarly, intensity of human production does not legitimately mean, and ought never to mean, the physical exhaustion of an over-worked victim, but should be due to the joyous stimulus of perfectly standardized conditions.

Examples from agriculture have been selected because far more has been done to establish standards of attainable production in agriculture than in factories, shops, and mechanical trades. The plant also will always do the best that circumstances permit and the circumstances are largely controllable. A man will rarely do his best even if circumstances are favorable; but as an offset it is more easy to control factory, transportation, shop and handwork conditions than to control seasons, climates, diseases, and insect pests. On the whole, the efficiencies of industrial organizations are no higher than those of farming activities, and as staff standards indicate possible increases of 200 per cent in agricultural yields, so staff standards and staff assistance will bring about 200 per cent increased efficiency in materials and services in industrial organizations, including railroads. Tests show that this can be done.

The standardizing of belt practice by staff study has increased the average life of belting more than six-fold, has reduced belt failures to one-sixth of what they were, has decreased annual cost to less than one-seventh.

The discovery and perfection of high-speed steels did not originate in any shop but was exclusively developed by men whose ideals and practices were those of the staff, and high-speed steel accomplishes four or five times as much as the old carbon steels.

Staff selected and designed abrasive wheels cut four times as fast as the old grindstones and every grade needed can be made to order, standardized for each different kind of work; files that are standardized as to quality last five times as long and cut much faster than the usual good commercial files.

Wherever the staff expert turns, he finds that standard time and cost for some units of work can be reduced to one-half, for other units to one-quarter, occasionally to one-tenth, the average time for the unstandardized work.

Railroad practice has many standards, chiefly those of specification, construction, and times for passenger trains. No railroad has ever determined any cost standards either for maintenance or operation of equipment, maintenance of way, or consumption of fuel; yet there is no railroad in the country on which each one of these cost standards could not be determined in a very short time and with very close accuracy, at a cost equal to the saving effected in a single month.

When each unit of locomotive repair is standardized, the sum of the units shows a cost between $0.03 and $0.06 a mile for maintenance. The actual average costs on the railroads are between $0.06 and $0.12, therefore twice what they ought to be. The standardized cost of maintaining freight cars is as low as $30 per annum. Actual average costs run from $45 on some roads to over $100 on others. Standards of maintenance of way vary, but innumerable assays of actual work show a maintenance-of-way labor efficiency of scarcely more than 30 per cent.

Staff determinations with a dynamo car showed that 1,000,000 B. t. u. in the coal were amply sufficient to furnish power to move a 1,000-ton train one mile. The actual coal charged to locomotives always contained more than twice as many, often three times as many, B. t. u.

The average mileage of the locomotives of the United States is close to 30,000 per year, about 82 miles per day. Average mileage of a freight car is about 25 miles per day. Staff standardization in locomotive repairs not only decreases the cost to one-half as much per mile, but also increases the mileage at least 33 per cent.

Locomotive repairs cost twice what they should, not because men in charge are not of the highest ability and experience, but because these men are so hampered by line organization that it is almost impossible for them to evolve standards or to maintain standards when evolved. Standards are always of the microscope, of the assayer's balance, of infinite patience applied to the smallest of details. It is not important that absolute zero is at — 273 degrees and that the highest temperature in the sun is 10,000 degrees, but it is important that human life is snuffed out if the temperature of the body rises 5 degrees centigrade.

It is not important that space is so vast that it takes hundreds of light years for the light of distant stars to reach us, wireless telegraphy on a stupendous scale, but it is important that the yellow fever bacillus may lurk in the saliva of a mosquito, so small that the microscope has scarcely yet discovered it.

It is not important that pressure varies from nothing in vacuo to so much at the deepest spots in the sea, that an air bubble taken down there becomes heavier than water and cannot rise to the surface, to so much at the earth's center, even if there were free opening to the surface, that the air would be heavier than gold, harder than titanium, so that a needle could not be driven into it, yet if in it, would slowly move surfacewards until specific gravity of air and needle were the same. These facts, interesting though they are, do not concern us as much as the fact that men cannot work on high mountains without danger nor in caissons without risk of the "bends," and that half the power put into air compression is lost in pipe leaks.

The staff chief and his assistants in search of standards, are not using bolometers to measure the ten-thousandth part of a degree, nor the spectroscope to measure the speed of advance or recession of the fixed stars, nor ruling diffraction gratings 900,000 lines to an inch, nor are they interested in either the North Pole or in the transit of Venus; but they are searching for common, every-day, practical and attainable standards of which astounding few have been determined.

Time is infinite, but that does not concern us so much as that five minutes of suspension of breathing or heart beating carries us over the boundary that separates life from death.

Congress has determined that a dollar (not now coined) shall consist of 25.8 grains of gold nine-tenths fine, but it may be a shock to learn that Congress has never determined the grain or any other standard of weight or of length or of time. The United States Treasury Department has adopted a gallon and a bushel, but neither is in accordance with the legal standards of Great Britain. They not only differ from the present standards of Great Britain, being respectively 17 per cent and 3 per cent smaller, but they also always differed from the discarded English standards from which they were derived.

On April 15, 1903, the Superintendent of Weights and Measures, not Congress, directed that the international metre and kilogramme should be in the future regarded as fundamental for metric and customary weights and measures. Congress, which has failed to legalize standards either of weight or of length or of capacity, has however standardized the spelling of Porto Rico and the motto "In God We Trust" on the dollar, and it is safe to say that Congress has concerned itself more with this motto than with the fact that all the thousands of millions of dollars of railroad and industrial shares sank in October, 1907, 33 per cent in value in a few weeks, and that the earning power of hundreds of thousands of men, eager to work, fell from an average of $2.00 per day to nothing.

In Germany in the polytechnic schools as late as 1875 and perhaps now, mediæval standards of proper procedure in all matters appertaining to students' duels were more definite, punctilious, important than surprisingly lacking modern standards of scientific accuracy.

These examples of American legislative and German scholastic insistence in the puerile and neglect of the all-important almost give the dignity of natural law to the statement that in standards insistence and excitement are in inverse proportion to practical every-day importance, and with such high examples as Congress and German Universities it is not surprising that in the line organization of American industrial enterprises there is more sensitiveness about prerogative than in Congress itself, more alertness to take offence at the unimportant than in the German student.

The difficulties blocking, the path of the radical improvement that would immediately result from supplementing the line with staff and standards, are the sensitiveness and apprehension of the line that, in some way it cannot explain, staff activity and application of standards will reflect on line ability, as if in the round-the-world automobile race, the benefits of good roads from Berlin to Paris and the speed made over the good roads, reflected on the capacity of the automobile drivers, who made slow yet astonishing progress through Siberia.

INTERNAL COMBUSTION FOR ROTARY PRIME MOVERS.

By Edward C. Warren.

The suggestion put forward by Mr. Warren in this article, of the possibility of producing a commercial fuel which will contain in itself the oxygen necessary for complete combustion, strikes at the root of the main difficulty encountered in the application of the internal-combustion principle to rotary prime movers—the necessity of expending a large amount of the power developed for the compression of the air required to support the combustion process. Mr. Warren is confident that the discovery of such a fuel, cheap, convenient and easily controlled, through the co-operation of the engineer and the physical chemist, is much more than an attractive possibility and in the following pages he indicates the general lines along which, he believes, success may be attained.—THE EDITORS.

THE future of power generation will be vitally affected by the application of the internal-combustion principle to rotary prime movers. The attainment of a reasonable degree of economy in the conversion of fuel into mechanical power demands the direct application of the expanding gases of combustion to the moving element of our motors, whether that be a reciprocating piston, the vaned rotor of a static-pressure rotary engine, or the multi-bladed disc of an impulse or reaction turbine.

The mooted question of the adaptability of the turbine type to use with the gases of combustion of liquid fuel as motive agent seems to have been finally settled in the affirmative, in so far as concerns the actual availability of these gases as a motive fluid, by those interested specifically in the development of this type of engine. There exist, however, by general acknowledgment of all known interested authorities, certain very serious practical difficulties in the application of the involved theories, chief among which is, by common consent, the problem of compressing the requisite supply of atmospheric air for the support of combustion. This difficulty has been clearly set forth by various investigators, notably Professor Charles E. Lucke and M. René Armengaud, whose researches and writings have so illuminated this entire field of power development.

The inspiration for the present discussion does not arise from any special interest I feel in the application of the internal-combustion principle to the operation of turbines, though to many, perhaps to nearly all, the possible readers of this article, the principal significance and interest in the ideas and suggestions advanced will lie in the fact that a solutioin of this problem is certainly indicated.

I have for many years struggled with this problem of air supply for combustion in various applications of the internal combustion principle to the production of power. I have found, as others have found, that this is by far the most troublesome and expensive feature of this method of generating power. From one-half to three-fourths of the total mechanical capacity of the "converting" mechanism is invariably engaged in the work and operations incidental to furnishing the requisite volume of air, compressed to the required degree, to permit of its introduction and incorporation with the fuel. This means an enormous power loss; but what is in many cases of more importance, it means excessive weights and bulk of machinery to produce a given power. The ordinary four-cycle oil engine, since it makes but one useful power stroke out of a possible four, produces less than one-fourth its potential mechanical capacity for power were it possible to operate on a steam-engine cycle, the piston delivering power continuously, instead of for three-fourths of its working time absorbing part of the power generated during the one power stroke.

This illustration holds good practically wherever it is attempted to burn the fuel under pressure and compress the air for combustion.

As to the remedy for this state of affairs, I propose merely to present here formulated conclusions based upon an analysis of the broad problem of internal combustion for power. When a specific problem is found to be inherently difficult, or perhaps insoluble, it may be well to inquire if there is no other path leading to our goal by which the necessity of meeting this insoluble enigma may be altogether avoided.

Upon analysis our problem has appeared to be about as follows:

We must apply the expanding gases of combustion directly to the work of impelling our "converting" mechanism, if we are to achieve reasonable economies in the converting of fuel energy into mechanical energy.

To do this involves burning the fuel under pressure.

The fuel must be supplied with oxygen, hence we must force in a supply of air against the working pressure.

Compressing air is an exceedingly troublesome and expensive operation. Supplying 235 cubic feet of atmosphere per pound of combustible at a pressure of 100 pounds or more constitutes an all but prohibitive working condition.

Examining the problem more closely: The fuel needs oxygen; the fuel consists practically of carbon, or hydrogen and carbon combined, and must have a certain proportion of oxygen supplied in order that combustion may occur. True, the fuel always contains within itself a small proportion of oxygen, but not sufficient to sustain combustion. Does not the thought naturally arise: If the percentage of oxygen were greater, less air would be required for combustion? And is it not readily observable that some forms of fuel require much less air or oxygen for combustion than others?

Here, then, we find a suggestion: If only we had a fuel that contained ***enough*** oxygen, we should have no need to furnish air to insure combustion. And this may be the key to the solution or *elimination* of this problem of air for combustion.

The available fuels are incomplete fuel substances, inasmuch as they lack an essential element of combustion, oxygen, and it is the problem of introducing the missing element that is giving us all the trouble.

The process or processes involved in obtaining a supply of oxygen and incorporating it with the incomplete fuel substance constitutes a ***manufacturing operation*** which we have been trying to carry on in conjunction with the combustion of the fuel and its utilization in a prime mover. The deduction is obvious. If the fuel is not completely manufactured and a further manufacturing process is necessary to render it combustible under the conditions imposed, the work of completing its manufacture should be performed in the manufacturing or refining plant. But, it will naturally be asked, how are we to add oxygen to a fluid or solid or powdered fuel in such a way as to render it independently combustible? It is the purpose of this article to suggest in general the manner in which this may be accomplished and a fuel provided which shall eliminate the necessity of compressing air for combustion.

The power engineer who has always been accustomed to dealing with the fuels available in the market, and who habitually regards a supply of atmospheric air as the natural and necessary concomitant of combustion, will probably regard as revolutionary a proposal to provide fuel especially prepared for power purposes and perfectly adapted to his needs. He has so long accepted unreflectingly the various hydrocarbon products of petroleum which have been thrust upon him as fuel, and has so long expended his energies wrestling with the trying problems of adapting his mechanisms to their use, that a suggestion to shift a part of his burden to the shoulders of the fuel manufacturer will doubtless strike him as a Utopian dream. However, this is exactly what it is here proposed to do.

Given a fuel containing all the elements of combustion in proper proportion, the engineer's problems will be vastly simplified. His mechanism may then be purely a power-producing mechanism and his losses will be only the inevitable losses due to conversion of energy from one form to another. At present, in calculating the efficiency of the internal-combustion motor, a heavy loss is charged to loss of power in compression, friction, and heat losses during the idle or *manufacturing* strokes, amounting on an average to probably 50 per cent of the total losses. This loss is not properly chargeable against the motor. It would be equally reasonable to charge against the motor the energy expended in refining the oil from the condition of crude petroleum.

The fuel, as finally actually applied and ignited in the motor, is a complete, fully prepared combustible. As it comes from the earth it is an imperfect and unsuitable fuel substance. When introduced into the cycle of a motor it is still an incomplete and unsuitable fuel substance, inasmuch as it requires the addition and admixture of another essential fuel element, oxygen.

Now, to the power engineer, oxygen and air appear to be regarded as synonymous terms. To obtain oxygen he must needs deal with atmospheric air. Even in technical works the volume or weight of air required for the combustion of various fuel substances is frequently set forth in manner and language inferring that the mixture atmospheric air is, as such, an essential element of combustion. Of course, on reflection, any engineer or, in fact, any layman, knows that it is the oxygen only of the atmosphere that plays any part as a supporter of combustion; that the predominant element, nitrogen, is under all ordinary conditions of combustion, an inert and troublesome factor which impedes and retards by its presence the process of combining the carbon and oxygen atoms. In fact, it is perfectly known, on reflection, that the only reason that we deal with or consider the atmosphere in this connection is that the atmosphere is an ever-present and available source of oxygen.

But, to refer to our physical chemistry, we find that "oxygen is the most abundant and widely diffused of all the elemental substances," existing in combination with other substances in all three ot the physical forms of matter. This, too, is a familiar fact, but one of the many in this domain of physical chemistry upon which we do not seem to have reflected. If oxygen is the most abundant and widely diffused of substances, and if it is available in concentrated as well as gaseous form, why do we choose to seek our supply in the atmosphere, where it is so highly expanded and associated with so large a proportion of an inert and troublesome gas? Let us boldly inquire if there may not be some other source from which we may draw the required element, some source where it may exist in concentrated form, requiring not to be condensed by wasteful compression in order to be available for admixture with our carbon. It is obvious that we cannot undertake to mix our carbonaceous fuel with air and handle, store, and utilize it in that form; but if oxygen can be obtained in concentrated, stable form, then we may hope to evolve a fuel containing this element in sufficient proportion to enable it to burn in our cylinders or combustion chambers wholly independent of air supply, and many of our most troublesome problems in power generation will be solved.

Perhaps we have now proceeded far enough with this discussion to venture to mention gunpowder and other "explosives" as illustrations of the possibility of actually producing a fuel containing all the elements of combustion. Perhaps we may also venture the suggestion that gasoline, as vaporized and mingled with air in the cylinder of an explosion engine, is quite as much an "explosive" as blasting powder, and is in fact a higher explosive than some forms of slow-burning powder. This comparison is suggested merely to show the possibility of manufacturing a complete fuel substance capable of burning and generating controllable gaseous pressure without the admixture of air. Well-known facts of course, and so are all the facts with which this discussion has dealt and will deal, and it is presumably because these facts are so well-known that they and the conclusions deducible from them have so long been slighted.

If we can make, compound, or prepare a fuel substance carrying its own oxygen, why do we undertake to employ an incomplete, volatile, and expensive substance like gasoline, and then reach out and endeavor to capture and utilize for its combustion the gaseous oxygen of the atmosphere? The reasons are probably, first, that we have not "reflected" upon this phase of the matter, and second, the oil refineries have had gasoline to sell. And as matters go in the field of power engineering, these are apparently all-sufficient reasons. The time has arrived, however, when all this should be changed.

When the power engineer undertakes to furnish motive power to meet the exacting requirements of modern scientific enterprises he is bound to consider broadly and in detail every phase of the science of harnessing natural forces. He must consider and weigh the merits of all available forms of mechanisms, materials, and fuels. It will be no longer sufficient to apply himself to devise cunning improvements upon the established and accepted forms of motors, accepting without thought or question the materials and fuels thrust upon him by interested manufacturers. He will demand that the materials entering into the construction of his mechanisms be of the composition representing the latest word and wisdom of metallurgical research, and he will also demand that the fuel substances furnished him from which to evolve the motive agent which breathes life into his mechanical creations shall have received the same intelligent scientific attention, and shall have been produced or compounded with an eye single to the fulfilling of the requisites of a fuel perfectly adapted to power uses. He will no longer be content to exercise a hard choice between several variously unsuitable casual products of the oil refinery, of varying and uncertain composition, only partially prepared for his use and owing their existence on the market to chance causes entirely unrelated to his imperative necessities. He will require that his fuel be especially prepared to meet the requirements of each of his various applications of fuel for power. He will require a special composition for his airship motors, another particularly suited to his marine-propulsion mechanisms, and still others, perhaps of less refined and exacting composition, for the use of motors for general purposes.

All this must follow as a result of the application to the important question of fuel for power of a modicum of the scientific intelligence and resources now lavished upon other fields of production and manufacture.

The foregoing reference to the fact that the so-called "explosives" employed in ordinance and blasting operations are in the nature of complete combustibles indicates the direction which this development may take. It is probably not feasible actually to employ for power purposes any of the substances referred to, though it is certainly quite possible to operate a motor with a slow-burning gunpowder, as has many times been demonstrated, just as it is quite possible to hurl a projectile through the air with the expansive energy of a charge of gasoline and air. But this is simply because those substances have been prepared with ends in view quite different from the operating of engines. If the same scientific attention had been given to the development of a "self-contained" fuel for power purposes as has been expended upon the production of fuels for the projecting of death-dealing war-missiles through space, we should have emerged long since from the present highly unscientific state characterizing this vastly more important fundamental industry of peace, the production of useful power.

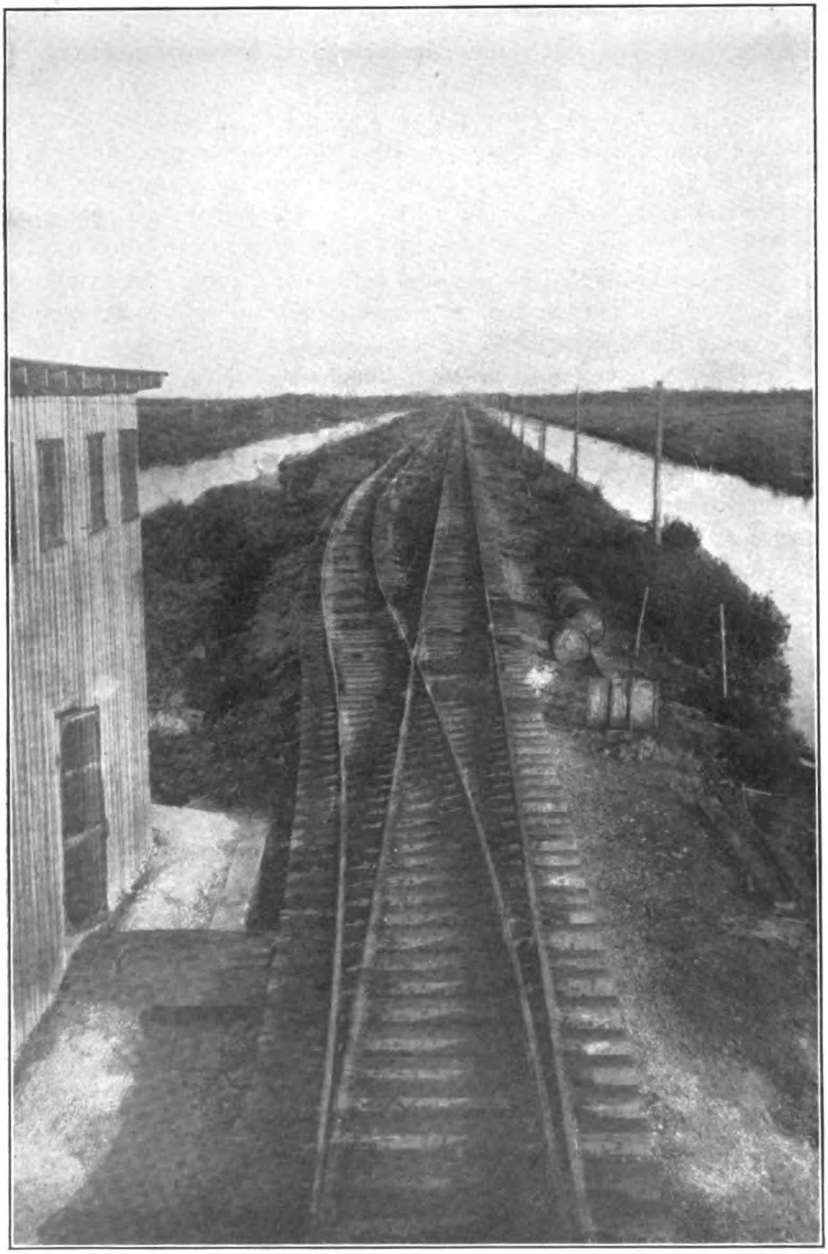
The two principal elements of a complete self-contained combustible are on every hand available, the carbon in the various grades of coal and hydrocarbon oils and the oxygen in the numberless oxides and nitrates of the earth. It only remains to bring the elements together in proper form and proportion to constitute a self-contained fuel, adapted by physical form and composition to use in our motors as a perfect fuel substance, requiring only to be ignited to produce the desired complete combustion of its elements.

The principal practical problems involved in the commercial production of such a fuel as is suggested by the foregoing are largely those arising from the questions, first, of stability or safety, since a fuel containing all the elements for complete combustion in its own volume is necessarily inherently liable to accidental combustion and, second, of cost of production.

That existing "explosive" or self-contained fuels might theoretically be employed for power in a suitably designed motor there can be no doubt. The problem is simply to modify both the fuel and the motor so as to make that which is theoretically possible practically attainable.

The fuel must be safe and the motor must be capable of utilizing it. Also the fuel must be producable at a cost comparable on a basis of dollar efficiency with existing methods of developing power.

The accomplishment of these ends is a work requiring the joint effort and intelligent co-operation of the power engineer and the physical chemist. When these two potential forces can be brought into earnest collaboration and their energies focussed upon this vitally important problem of fuel for power, then and only then can we hope to see the generation of power, that most important branch of applied science, placed upon a truly scientific and economic basis and an intelligently ordered system for the conservation of our fuel resources and the application of mechanical power to the work of the world supplant the existing "chaos of confusion and waste."



AN EMBANKMENT OF MARINE MARL.

IMPORTANCE OF THE RAILWAY TO KEY WEST.

By William Mayo Venable.

"IT is a wonderful feat of engineering, but I do not see how it can ever pay interest on the investment." This remark, referring to the "railroad across the ocean," officially, the Key West Extension of the Florida East Coast Railway, has become familiar to the ears of members of the construction organization. The opinion is shared by some of the employees of the road, as well as by many travelers who have visited the work, and by persons who have heard its more difficult features described. The recent suspension of building operations beyond Knights Key Dock, which is forty miles east of Key West, occasioned renewed speculation as to whether the road will ever be carried to its Key West terminus; and not a few believe that further extension would be a waste of money.

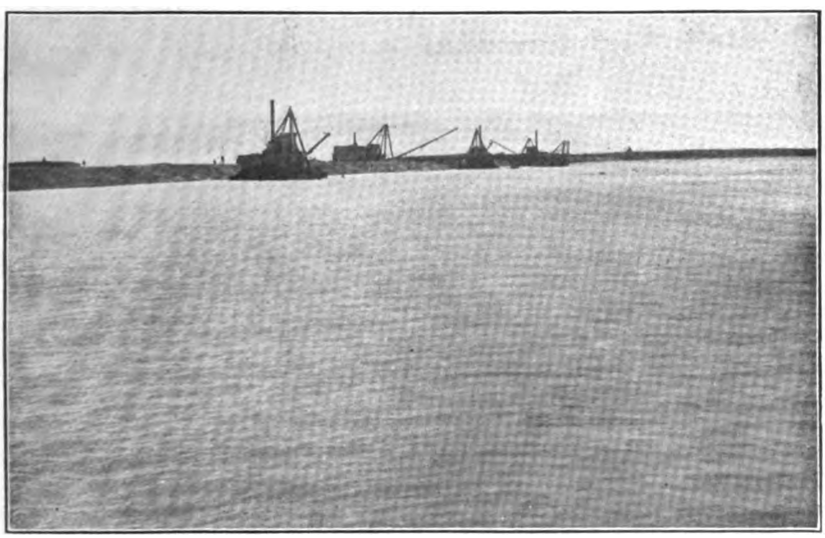
Henry M. Flagler, it is said, is building the line for the sake of fame, not utility; he desires to reach Key West merely for completeness, because that city is the southernmost point in Florida as well as in the United States; the extension is to be a monument to his memory. Undoubtedly those who direct enterprises of world-wide importance desire to impress themselves upon the world in works that will last; but a worthy fame must be connected with worthy works, and it is absurd to think that Mr. Flagler would construct this railway if he thought that it is to be known to future generations as "Flagler's Folly." To him it is an enterprise worthy of the capital required to create it. Fame of having built an expensive work for an unimportant or unproductive use could have no appeal to the mind of a man trained in the severe principles of business economics. Unless Mr. Flagler is mistaken in his appraisement of the possibilities of this enterprise; others ought to be able to see in it a utility that will justify its cost; in business terms this means a capability of returning interest upon the investment, to the owner, or, if the object sought is a national or philanthropic benefit, to his beneficiaries, within a reasonable time after the completion of the project.

The increase in traffic that may be expected to result from the line to Key West may be considered conveniently under two categories;

first, business similar to that which is already done by the railway with its present termini; and second, business of a new character, arising from the new port and terminal facilities. Before the increase in traffic is considered, the present business of the road and the manner in which it has been developed require brief review.

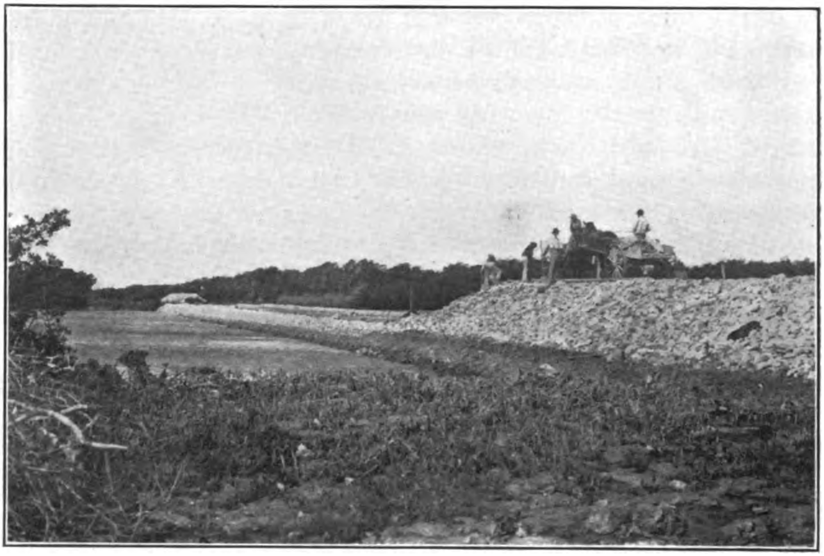
The growth of the Florida East Coast Railway from point to point southward along the Atlantic seaboard until it reached Miami was accomplished without bankrupting its owner, by means of a wise system of managing the railway in connection with other industries, so that paying traffic over each new section was established in a remarkably short time. From the beginning, the road served the purpose of affording access to the hotels of the Florida East Coast Hotel Company, whither winter visitors thronged year after year in ever increasing multitudes, as well as that of carrying freight and passengers for the communities that became established as soon as transportation was provided. In connection with the hotel company the road was a necessity, and it could be operated at a loss if necessary for a few years, on any new section, in order to make a profitable business possible at the hotels, which were owned by the same proprietor. Local freight business was developed as rapidly as possible as the road crept southward, by constantly bringing the possibilities of the country to the attention of all classes, including the tourists, and by fostering immigration. Successful methods of agriculture were stimulated by rendering limited financial assistance to a few of the most capable and progressive farmers, who were willing to adopt scientific methods, and who were so successful that their example became an object lesson which the less progressive were willing to follow. The crops raised, though requiring large expenditure per acre, brought high prices in the northern markets; and the freight rates were such as to put the road upon a self-sustaining basis long before the capacity of the country for producing freight was reached. Year after year the railway extended a branch down the coast, establishing a town at each new terminus, as a strawberry plant puts forth runners and establishes new plants, each new terminus being supported by the parent line until it was capable of drawing its own support from the soil, until Miami was reached. Here a dock was built, whence the Peninsular and Occidental Steamship Company operated steamers to Nassau, Key West, and Havana, and foreign trade began to loom over the horizon—another and a larger world to conquer. It is this step, from a road bringing the East Coast of Florida into communication with the northern parts of the United States, to a road using the Florida Peninsula as a route to carry trade originating outside of

Florida to destinations also outside of that State, that makes the Key West extension quite a different kind of project from any previous extension that was made in the course of the growth to Miami. Within the State the freight consisted of turpentine, lumber, subtropical fruits and winter vegetables, shipped north; and fertilizers, machinery, staple food articles, and manufactured products necessary for civilization, shipped south. The peculiarities of the climate and soil of the territory make the handling of a large volume of freight in proportion to the population more necessary than in a country where all the natural products required by a complex civilization are native, and the soil is highly productive without the use of commercial fertilizers. Briefly outlined, the business of the railway has expanded consecutively in the following named directions:—carrying passengers to and from winter resorts, exporting lumber, turpentine and other products of an undeveloped territory, exporting agricultural products for the northern winter markets, the necessary importing of fertilizers and equipment for carrying on the industry, as well as the larger part of the food products and all of the manufactured products required by the local population, and finally conveying passengers and freight through the State on their way to foreign lands.



DREDGES BUILDING EMBANKMENT IN SHALLOW WATER.

The character of the country on the line of the extension from Miami to Key West is quite different from that of the other portions of the road, and it may be described briefly. The distance is 150 miles. Of this the first 30 miles, starting from Miami, runs over a rocky ridge known as the Biscayne Pineland, on the northwest of which lie the Everglades, and on the southeast Biscayne Bay. This part of Florida is especially suitable for raising grape fruit, but is well adapted for the culture of other fruits and vegetables, and it is being developed rapidly, already producing enough freight to justify the extension through it. A large amount of lumber is obtained in this region. The last town on the ridge is Homestead, after leaving which the road traverses the Everglades for a distance of 30 miles of unproductive territory. Across the glades, which are usually cov-



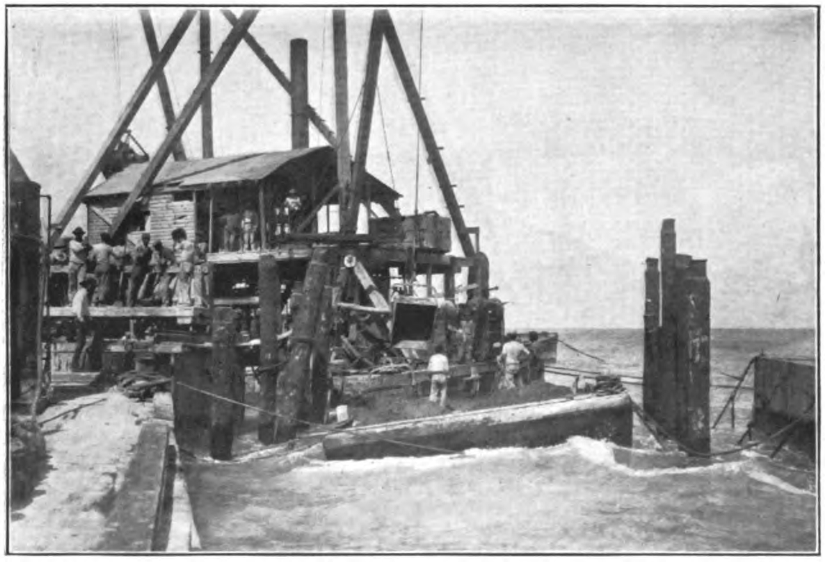
ROCK FILL AT PULL-AND-BE-DAMNED CREEK.

ered with water a few inches or a few feet in depth, the roadbed is constructed on an embankment, with a canal on each side. The view from the train extends over a broad expanse of sawgrass meadows, interspersed with small "hammocks" or islands of tropical trees and shrubs, which close the horizon on all sides. As the railroad approaches the bay the water becomes salty; mangrove trees and bushes growing in the shallow water and forming islands of verdure take the place of the meadows. Upon these islands of greenery the roadbed runs from the mainland to the solid keys of coral rock that encircle the lower end of the Floridan peninsula, entering at a point near the middle of Key Largo, the largest of the keys, having a length of 27 miles. Key Largo and the nearest keys to the southwest of it, Long Island, Windley's Island, and Upper Matecumbe, are susceptible of cultivation, producing limes, grape fruit, oranges, pineapples, bananas, guavas and other fruits. Possible shipments from them are worthy of consideration, but there is no prospect that they will produce sufficient local freight to justify the expense of the extension from Homestead. Continuing to the southwest across Lower Matecumbe, Long Key, Key Vaccas, Knight's Key, Bahia Honda, several smaller spots of land and many long stretches of water, to Big Pine Key, there is no land high enough above tidewater to be of importance agriculturally, although there are several spots where beautiful retreats for winter residents might be developed. So inhospitable is this stretch of almost 50 miles that no homes existed in it when the railway extension was commenced, but there were a few dilapidated relics of previous attempts at settlement, and a few negroes were accustomed to encamp on Key Vaccas during the winter season.

APPROACH TO THE LONG KEY VIADUCT IN PROCESS OF CONSTRUCTION.

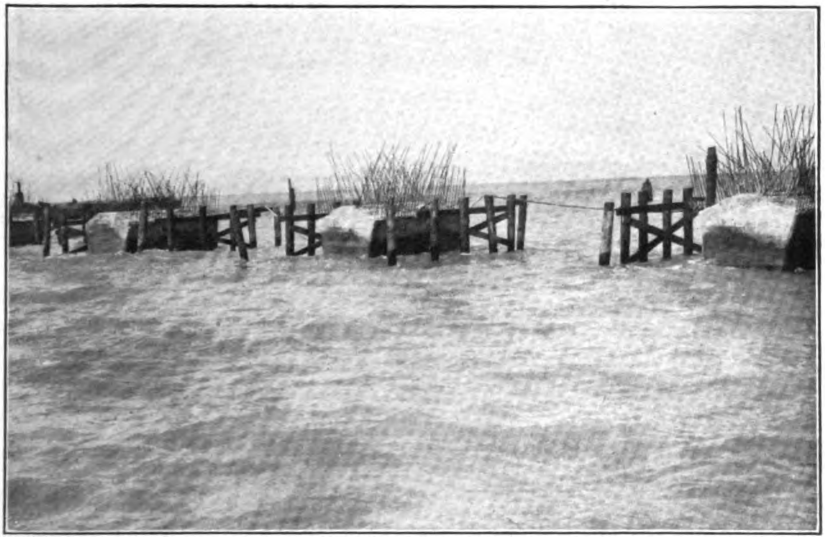
From Big Pine Key to Key West the keys afford better chances for cultivation, and there are a number of homes scattered throughout this region; but there is nothing of sufficient importance to be any inducement toward building the railway to them.

The physical difficulties and the expense of building the road from Miami to Key West are distributed very unevenly over the route. The portion from Miami to Homestead offered no special obstacles. Across the glades, dredges working on each side of the line made an embankment of half a dozen cubic yards per running foot at a very low cost, and the work was difficult only because the marine marl, which was the material handled, dried out but slowly, and the bank had to be raised by stages, instead of by a single operation of the dredges. The cross section of the embankment became greater as the exposure to wave action increased, and in many localities, especially where the line crossed from the mainland to the keys, the material to be used for the embankment was so soft that great quantities were necessary, on account of the slope it assumed when placed in the fill. Occasionally the only material available at the site was the fiber of mangrove roots, which had accumulated in the water for a depth of many feet. When dredged into a bank this dried out and became inflammable, so that it required a covering of broken stone to protect it from fire, as well as to make it steady enough for track.



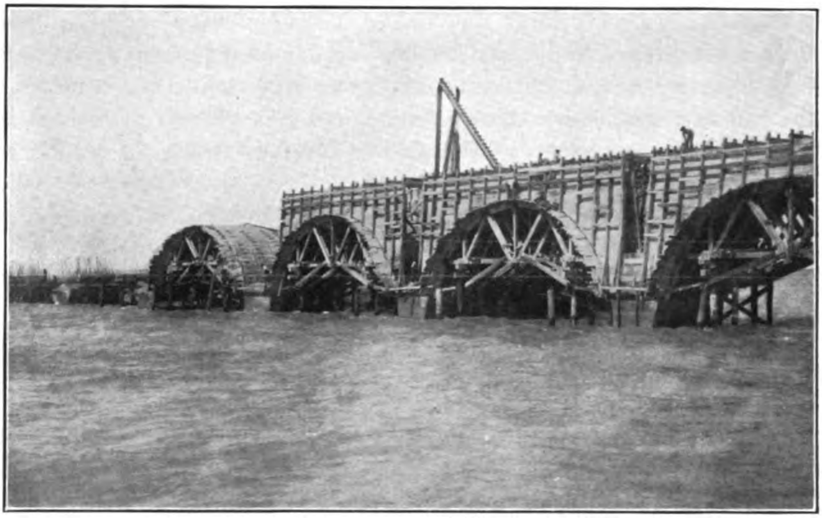
A CONCRETING BARGE AT WORK.

The grade work on the keys was done by day labor, either with wheelbarrow and shovel or with carts, as was most convenient at each station. Where the embankments were very large and the conditions favorable, excavating machines operating orange-peel buckets were employed. The material available for embankments on the keys was sometimes sand, sometimes marl, and sometimes coral rock, and whatever was at hand was used, the sides of the banks being riprapped afterwards if necessary. On the keys the top of the grade was from 6 to 10 feet above tidewater, according to the exposure. The embankments across the openings between the keys were difficult and costly, as the sections were large and the exposure to wave action and to tidal wash severe, especially during construction before the riprap was in place. At the approach to the Long Key viaduct the section of the embankment is about 2,000 square feet, and the top of the grade 24 feet above the water; at Pull-and-be-Damned Creek the section is about the same, but the grade is only 8 feet above water, the bulk of the material going to close the deep creek, in which a current due to a head of 2 feet of tide oscillated twice a day.



FINISHED PIERS OF THE LONG KEY VIADUCT.

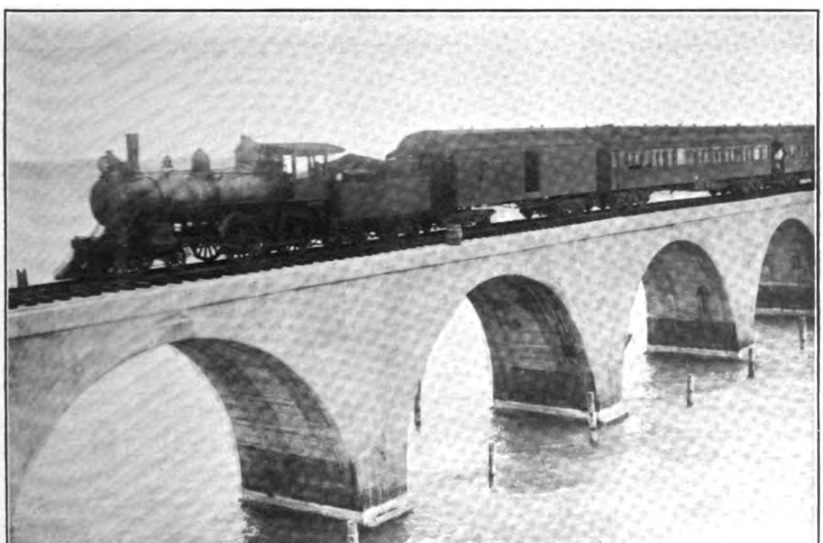
The first of the viaducts is located 90 miles from Miami, southwest of Long Key. It is 2 miles long, and carries the track 31 feet above mean low water. A series of 180 arches of reinforced concrete, built to withstand wave action as well as to bear the weight of trains, it is a substantial and expensive structure. Between the end of it and Knight's Key, about 18 miles, the road runs on embankments in shallow water protected from the ocean by interposing keys, or upon the keys themselves; but from Knight's Key to Big Pine Key, a distance of 13 miles, the most expensive and difficult portion of the work of construction is concentrated. Three viaducts with an aggregate length of 4 miles will be required on this stretch, the deepest water to be crossed being more than 30 feet, while practically all the embankments are to be subjected to severe wave action. From Big Pine Key to Key West the exposure to currents and to waves is not bad, and most of this part of the road is practically ready for track, and awaiting only the connecting link to Knight's Key.



ARCH FORM WORK ON THE LONG KEY VIADUCT.

On February 6, 1908, the road was opened for business as far as Knight's Key Dock, although a very large amount of work still remained to be done to make the embankments between the keys permanent. Before that date all construction work southwest of Knight's Key was suspended, and no steps taken that indicated a resumption of work south of that point at a definite time to come. Work on the terminal dock at Key West had been suspended a few months earlier, the occasion being a disagreement with the United States Navy Department about the right of the railway to dredge certain material in the harbor for use in reclaiming land for the railway terminal. Knight's Key dock was built in a channel near to Knight's Key for the purpose of receiving materials for the construction of the viaducts, this being the most convenient place at which gravel, broken stone, and cement brought from afar could be transferred from vessels large enough to navigate the ocean safely, to barges of shallow draught for conveying it to the sites where the bridges were to be constructed. Vessels drawing 19 feet of water can reach Knight's Key dock from the Atlantic, although Miami harbor cannot be reached by vessels drawing more than 14 or 15 feet. From Knight's Key to Havana is but a trifle greater distance than from Key West to Havana, and as soon as trains were run to Knight's Key the P. & O. Steamship Company discontinued its service of three ships a week from Miami to Havana via Key West, and substituted therefor a daily ship from Knight's Key to Havana and a separate ship between Knight's Key and Key West, so that Key West is not now on the line of travel from Miami to Havana. However bad this arrangement may be for Key West, it would seem to be as serviceable to the railway as a terminus at Key West, unless it can be shown that there are advantages in the port at Key West that will bring to the railway business that cannot be diverted to Knight's Key. It is undoubtedly true that by making Knight's Key its terminal this year, the railway was able to transact practically as much business as it was able to handle with the road in its uncompleted condition and the necessity of continuing with a certain amount of construction work. The passenger business certainly did not suffer, for the travel was little short of phenomenal. What advantages, then, can Key West offer, which will justify the expenditure of the millions of dollars necessary to reach it and to construct a terminal?

Of the larger islands of the Florida Keys, Key West is the most western and southern, although not the most western or southern of all islands in the group, which extends about twenty miles west of Key West. It is not really large, its length being four miles and its width a mile. The surrounding water is shallow, except at the northwestern corner of the key, where a deep passage known as "Man of War Harbor" comes close to the shore. This channel is easy to enter from the Strait of Florida, as the deep water between the keys and Cuba is named, Havana being less than 100 miles distant. To the



THE COMPLETED VIADUCT.

east and the northeast lie most of the Florida Keys and the Bay of Florida. Cape Sable, the most southern point on the main land, is 60 miles away, surrounded by shallow water. Tampa is about 230 miles to the north; Pensacola over 500, New Orleans more than 600, and Galveston more than 850 miles distant. Key West is on the line of ship travel between all points on the Gulf of Mexico, Yucatan, and Honduras and the eastern coast of the United States. Vessels from Europe to Mexico or to Yucatan pass within sight of it. Those from Europe to Central America have choice of passing Key West or of going to the south of Cuba.

Its convenient location at the gate of the Gulf of Mexico, and opposite to Havana, did not make it a place of great importance in early days, because of its isolation from the continent. While a place where a stop could conveniently be made, it possessed nothing to induce a ship to stop; but in spite of its isolation it has now grown to be a town of more than 17,000 inhabitants, and it is regarded by its natives as the most desirable place in the world to dwell in. When Florida became a part of the United States, Key West increased in importance for both legitimate and illegitimate industries. It had a value as a naval base and as a port of refuge for vessels not over-anxious to obey the Spanish laws. Many Cubans settled in Key West, and Spanish is still as much spoken there as English. Residing where the means of making a livelihood were limited, where agriculture could not be carried on to any great extent, the native of Key West was a good fisherman, a sponger, and a wrecker; but he was very likely to be a cigar maker also, and when times afforded such occupation, a blockade runner, a smuggler, or a revenue officer. Of late years wrecking has not given much support to the people in this part of the world, on account of the scarcity of wrecks. The lighthouse service along the coast is effective, and few vessels are lost on the reef. The most important industry of the island now is the manufacture of cigars of Cuban tobacco. The city has a coastwise and insular trade that is carried on by small sailing vessels, which usually spend the winter months fishing for Spanish mackerel, which are shipped north from Miami by express. Steamships of a number of lines stop at Key West occasionally, and some regularly during the winter, and the naval station and the army post assist in furnishing employment for the people of the city. During the past few years the construction work on the railway terminal and the grade approaching the city brought many persons to Key West and contributed to the business there; but the cessation of this work and the diverting of through travel to Havana accentuated the hard times that the town is suffering owing to the depression in the cigar industry, which has resulted from the general financial depression throughout the United States. A few years ago there was considerable opposition in Key West to the coming of the railway, many persons feeling that this innovation would destroy their isolation, in which they took real pride and comfort, and to which they even ascribed the prosperity of the town. But when the railway came to be regarded as a certainty the people began to speculate upon its results, and real estate went soaring. When doubt was again entertained as to the certainty of the railway reaching the island, and when work of construction was suspended without definite announcement that it will be resumed, the city was plunged into consternation. That the city would profit by the advent of the railroad now needs no argument to convince the most conservative citizen. But that the railway will secure at Key West sufficient business to justify completing the road to Key West is not so clear.

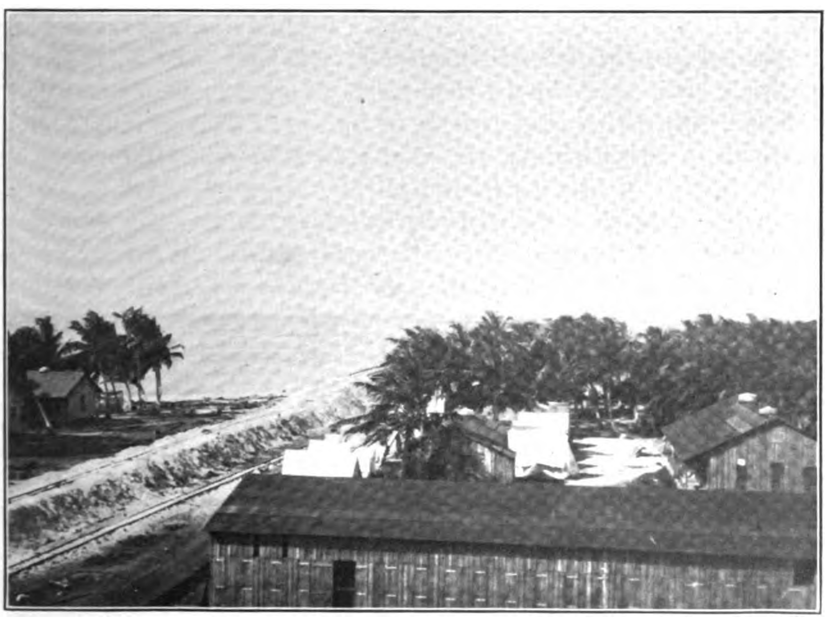
TRESTLE APPROACHING KNIGHT'S KEY DOCK.

The disadvantages of Knight's Key dock over Key West are these. Access to it can be had by ships drawing only 19 feet of water, while vessels into Key West may draw 30 feet or more. Key West has an area sufficient to permit the building of a large sized town, while Knight's Key contains less than half a square mile of land, and the dock is half a mile from the key, so that there would not be room for the establishing of any industry at the terminus, and the dock can be only a point of transfer of goods from the trains to the ships and from ships to trains. Key West is already a town of considerable population, a naval and a military base, a coaling station, and a port where vessels of many lines are accustomed to go occasionally, and it is located a few miles nearer to the gulf, and consequently to the Panama Canal. The importance of these advantages of the Key West terminus become apparent upon consideration of the nature of the business to be anticipated by the railway when it has established its terminal.

WATER-SUPPLY STATION.

That business in which the Florida East Coast Railway is expert, namely the carrying of passengers from northern States to southern winter resorts, will doubtless continue to increase for many years to come, for this is stimulated by the growing interest on the part of the American people, especially the business men, in the affairs of South America and the West Indies. The travel over the East Coast Railway during the season now closing is said to have been one third larger than during any previous season. The shorter the distance that must be travelled by water, the more readily will a great many persons undertake such journeys. The Key West terminus will afford opportunity of making connection with steamers bound for any part of the world, not merely those operated over short distances. The terminal dock at Key West is planned to receive alongside of it vessels drawing 30 feet of water.

The advantage of location at the entrance to the Gulf of Mexico is great enough to make Key West a desirable terminus for a railway communicating with the interior of the United States. But this advantage will be greatly increased when the Panama Canal is opened for international travel. The master of a vessel from Europe, desiring to discharge a small part of his cargo for delivery into the interior of the United States and to proceed with the rest through the canal to Asia or to the west coast of South America, will naturally prefer to run as little out of his course to Panama as possible. In this, Key West harbor has a great advantage. Running in to Pensacola or to New Orleans *en route* for Panama would make the sailing distance 850 miles longer than running in to Key West; and a similar diversion to Galveston would lengthen the voyage 1,300 miles. Such an additional distance with a big ship is an important matter, and it would be preferable to make a much longer haul by rail if the portion of the cargo to be discharged in the United States were small. The shorter distance from Key West to the Canal and to points in the West Indies and South America will undoubtedly lead to the concentration of several lines of fast steamers to such ports, carrying the bulk of the passengers, the mail, and the express business, on account of the faster schedule.



CAMP IN A COCOANUT GROVE.

From time to time there have been rumors, doubtless not wholly without foundation, that the Florida East Coast Railway will arrange to operate a ferry from Key West to Havana, upon which railway cars will be transferred bodily, and conveyed on Cuban railways to various points in Cuba. The distance across the strait is less than a hundred miles, and there is nothing in the proposition that is not entirely practicable from an engineering point of view. The effect of refrigerator car service both ways between Chicago and New York on the one hand and the interior of Cuba on the other at all seasons of the year can be imagined; and it would be interesting for the northern farmer to ship fresh vegetables to Cuba in the summer time, and to eat fresh vegetables from Cuba in the winter; but to depart less from the probabilities of the next few years, such car service if established now would be able to carry certain fruits and vegetables through at a profit from the south to the north, and doubtless carry beef the other way. The freight business between the interior of the United States and the interior of Cuba, of which there is a large amount, will tend to go all the way by rail as soon as such a transfer is possible. It is difficult to see how water transportation can compete with a rail haul of this kind, even for such products as sugar, when the point of destination is in the interior of the country.

After the Florida East Coast Railway has established its terminal dock at Key West, and after the Panama Canal has been opened for traffic, the quantity of freight hauled over the East Coast Railway will probably be fixed not by the competition of other means of transportation, but by the physical capacity of the road. This will most likely come about in spite of higher freight rates by rail, for on account of the high cost of construction of the road higher rates are permitted by-law over the Extension than on other lines, and the legal fare that may be charged for a passenger is fixed in the charter of the road at four cents per mile, during the first fifteen years of operation.

Far from being known as "Flagler's Folly," this road will be a monument to its builder indicative of his far-sightedness and his willingness to devote his resources to an enterprise of world-wide importance, even though he undertakes it late in a life which has, however, been devoted to the building up of industries to which this is the natural sequel. His undertaking it indicates not a lessening of intellectual vigor, or a weakening of the judgment, as some would have us believe, but the ability to sustain the burden of a great project, for the sake of having it accomplished, with the belief that the work will be justified.

SPECIAL ALLOY STEELS AND THEIR MECHANICAL APPLICATIONS.

By Léon Guillet.

In many fields of engineering, there has been a most interesting evolution of improvement in materials, design, and methods through the reciprocal effort of the constructor and the metallurgist. In no case, probably, has that advance gone further, in recent years, than in the higher grades of machinery. The combustion motor, the motor car, the aeroplane, and by no means least, the modern tool, have stimulated investigation and led to discovery of new and most useful alloys. M. Guillet is known all over the world as a foremost specialist and authority in the subject, and his summary of conclusions so far established will prove a valuable synopsis of the state of the art for all interested in the new alloy steels and their properties.—THE EDITORS.

THE utilization of special steels—that is to say, of alloys of iron with carbon and one or several other elements—may be considered from different points of view. First, we might seek to increase the safety of machine parts. To secure that we would not diminish the section of pieces calculated with the ordinary coefficients for common steel; and as these coefficients are higher in the special steels the strength would naturally be increased.

Again, it might be our purpose (and this question is particularly interesting in aviation and in automobile work) to preserve the same coefficients as we have been applying to ordinary steel, and then we should be enabled to reduce the section, or in other words, to diminish the weight, and thus to make the machinery lighter.

Finally, our search might be for steels with altogether peculiar properties, as, for example, non-fragility after hardening, as in some nickel-steel alloys, or a predetermined coefficient of expansion, as in other alloys in which the content of nickel is high.

In any study of the alloy steels the division generally adopted is based on classification according to the foreign substance added. In this short study preference is given to investigating what we may demand from the different special steels, with reference to their employment in mechanical construction. We may seek to obtain:

1.—High resistance to shock.

2.—The highest possible elastic limit.

3.—Resistance to abrasion.

4.—More generally, simultaneous fulfilment of several of these requirements.

Metal giving higher resistance to shock, according to modern theories, ought to give good results under test upon the nicked bar. Steels best fulfilling this condition are those with a high percentage of nickel and of manganese, which have a special structure and in which the iron is in the allotropic form defined as γ iron by M. Osmond. These steels will easily give 40 to 50 kilogrammetres in the test on the nicked bar. They have, however, several disadvantages; their elastic limit is relatively low if the metal is not cold-hammered (20 to 25 kilogrammes) and they are extremely hard to work; some of them indeed can not be worked except by grinding.

At the present time they have important applications. Foremost, they are employed for the construction of valves for petrol motors, the steel commonly used showing carbon 0.25 to 0.30 per cent and nickel* 32 per cent.

A steel is also used with the same carbon and nickel contents, but with 2 per cent of chromium in addition; this gives a much greater hardness. Further, the steels of γ iron are much used for parts of railway track which are subject to heavy blows, as, for example, frogs. They are no longer used, at least in France, for shafts.

Other kinds of steel may also be chosen for high shock resistance, but it is necessary above all that these alloys shall be low in carbon. Nickel steels are particularly to be recommended; they may contain up to 0.30 per cent of carbon and 5 to 6 per cent of nickel. With a higher proportion of nickel they possess of themselves the structure of tempered steels (martensite) and become extremely difficult to work.

The other elements—manganese, chromium, tungsten and molybdenum—are rather injurious. However, it might often be of interest to add chromium, especially, to nickel steel, without reducing its shock resistance.

There is, however, one element which is particularly interesting in this connection. This is vanadium. Vanadium imparts to steel two qualities which are very definite. It plays the *rôle* of an anti-crystallizer—that is to say, it forces the iron to form much finer crystallization than would occur in its absence; second, it gives to the alloy a considerable tempering quality without in any way injuring its resistance to shock—at least when the vanadium is in small quantity. Indeed, it must be remembered that this element (one of the most useful in metallurgy, according to my opinion) should be administered in homeopathic doses. Not more than 0.5 per cent of vanadium should

* Only the important elements are given. There are never more than traces of sulphur and phosphorus.

be added; 0.2 is generally sufficient and a "dose" of more than 0.7 per cent is extremely injurious. Let us look further at examples showing well the influence of this valuable element.

1.—Simple vanadium steel. Composition, carbon, 0.144; vanadium, 0.290; managenese, 0.125; silicon, 0.105. Annealed at 850 degrees it gave:

$R = 44$; $E = 30$; A per cent $= 24$; $\Sigma = 62.5$; shock $= 30$.

Quenched at 850 degrees it gave:

$R = 55$; $E = 50$; A per cent $= 23$; $\Sigma = 67$; shock $= 10$.

R signifies the breaking load in kilogrammes per square millimetre. E is the elastic limit in kilogrammes per square metre. A per cent signifies elongation after rupture, referred to 100 millimetres of initial length. Σ is reduction of area or "choke" of the test bar—that is to say, the ratio

$$S - s \times 100 \div S,$$

S being the initial section and s the reduced section after rupture. Shock signifies the number of kilogrammetres obtained on a nicked test bar of the Mesnager type. The dimensions of this bar are 60 millimetres long, 10 millimetres wide and 10 millimetres deep. The nick is 2 by 2 millimetres, rounded at the bottom. These symbols will be employed throughout the article with the same meaning. For convenience it may be remembered that the figures here given in kilogrammes per square millimetre multiplied by 1422.3 will give the equivalents in pounds per square inch.

2.—Nickel-vanadium steel. Composition, carbon, 0.261; nickel, 2.32; vanadium, 0.35; manganese, 0.45; silicon, 0.539. Annealed at 850 degrees it gave:

$R = 66.3$; $E = 55.2$; A per cent $= 21.5$; $\Sigma = 57.2$; shock $= 31$.

Quenched at 850 degrees it gave:

$R = 117.0$; $E = 97.0$; A per cent $= 8$; $\Sigma = 44.3$; shock $= 11$.

Tempering power is considerably increased by the addition of vanadium. To summarize, we may note that for parts subject to shock:

a. In special cases where a low elastic limit is not dangerous, where difficulty of working is not a serious objection, and where price does not enter as a very important factor, steels with a high nickel or manganese content may be used.

b. In more ordinary cases, steels with a small proportion of nickel are very interesting and their mechanical properties may be remarkably increased by the addition of chromium and of vanadium. We shall return to this later. Still another case at least as important as the preceding, is that in which the maximum of strength and of elastic limit are sought. At the same time it is generally desirable to avoid too great brittleness. The problem may be approached in various ways. Many shops which have little or poor equipment for hardening or heat treatment, seek a metal which in the condition in which it is delivered to them combines these resistance qualities with comparative ease of machine-tool working. Other shops, on the contrary, more modern in their equipment, seek rather the quintessence of desirable qualities in all the metallurgical products which are offered to them, and care little how complex may be the heat treatment to which the parts should be subjected. From these points of view, therefore, we may class the high-resistance steels in two categories—those used without treatment or with only very simple treatment, and those which must be treated before they are used. The applications for steels which can be used without treatment are relatively few, because the mechanical constants of these alloys are never extremely high, at least until the percentage of alloy rises so high that the structure of the mass becomes the same as that found in tempered steels (that is to say, martensitic) and we then have to deal with a material which can not be worked except with great difficulty. What limits, then, do we actually find in the present state of the industrial manufacture of special steels, so far as concerns the obtaining of determined mechanical properties in untempered metal? Let us eliminate at the outset the martensitic steels which are too difficult to work. If, then, we examine simple steels—those containing only one special element—we shall find that among nickel steels those giving the highest results are the alloys containing 5 to 6 per cent of nickel and 0.25 to 0.35 carbon. They give:

R = 70 to 80; E = 60 to 70; A per cent = 25 to 20; Σ = 60 to 70; shock = 25 to 35.

It is plainly possible to obtain nickel steels with much higher breaking strength and elastic limits; for this it is sufficient to increase the carbon and to decrease the nickel. (If the carbon be increased while the nickel content is maintained constant, a martensitic steel will be obtained). But it is well to remember that this principle applies in some degree throughout the metallurgy of special steels—that is, that when carbon is increased brittleness is also increased to such an extent that the steel rapidly loses its suitability for most of its applications. We shall see later on the important restrictions which must be noted in this regard.

A French firm has recently put out certain nickel steels high in carbon. The analyses and characteristics of two of these types are:

a. Carbon, 0.862; nickel, 0.88; chromium, 0.85; manganese, 0.23. Annealed at 750 degrees, with no tempering, it gave:

R = 97; E = 51.3; A per cent = 11; Σ = 23.8; shock = 3.

b. Carbon, 0.771; nickel, 1.13; manganese, 0.32. Under the same conditions this showed:

R = 108.3; E = 61.5; A per cent = 10; Σ = 19.3; shock = 3.

The brittleness of these steels will be clearly observed. It is to be noted that the breaking strength is determined in all cases in the direction of the lamination. It would certainly be lower still if taken transversely to lamination. It is therefore necessary when a high breaking strength, a high elastic limit, and resistance to shock are simultaneously required, that the carbon content should not be raised. My own opinion is that it ought not to exceed 0.40 per cent and that it would often be better even not to reach this limit. However, the case is quite different, as we shall see later, when the question of resistance to abrasion must be taken into account.

If we turn now to other species of simple steels, we shall find but little of interest. Those alloyed with manganese, chromium, tungsten, and molybdenum are very far from exhibiting the interest which is found in nickel steel. They are much more brittle, and the increase in the breaking strength and the elastic limit is less marked. Vanadium steels are not important, in the annealed condition, though we shall find them highly so when tempered. Silicon steels—the only remaining type—are also of interest only after hardening. Before hardening they do, indeed, show rather high tensile strength (85 kilogrammes) and a high elastic limit (45 to 55 kilogrammes); the elongation is not bad (15 per cent); but these figures are obtained from steels carrying carbon also, which are extremely brittle.

If, now, we take up the study of the complex steels containing two or three elements, we are led at once to the consideration of products almost all of which contain nickel with one or several other constituents. The compounds which are at present of industrial importance are the nickel-chrome and certain nickel-vanadium steels. There are, however, also, certain chrome-vanadium steels which are interesting. These steels are almost all employed after treatment. Let us see what should be understood by "simple treatment" and the qualities which the special steels must possess to be susceptible to it.

A simple treatment evidently should be one which does not require any complex manipulation, and one in which the temperatures need not be so accurately attained as to require instrumental measurement; in a word, it should be one which is practicable in any ordinary manufacturing plant. This treatment, designed to increase the tensile strength and elastic limit, is in fact primarily an operation of tempering. For simplicity it should not require any following drawing of the temper, nor the use of high-temperature measurements. The simplest of all these processes evidently consists simply in heating the metal followed by cooling in the air.

If we except the case of the rapid-cutting steels (a case easily explained, according to Le Chatelier and Osmond, by the difficult solubility of triple carbides of iron, chrome and tungsten in γ iron) we are led to the conclusion that the only steels which can really take a temper—that is to say, undergo transformation of their pearlite into martensite—are the pearlitic nickel steels which approach the limit of martensitic steels—for example, steels containing 0.30 per cent of carbon with 5 to 6 per cent nickel. Chromium and manganese increase further this property of air-hardening. Consider, for instance, the analysis of an air-hardening steel containing carbon 0.25, nickel 5.5, and chromium 1.0. After annealing with slow cooling this gave:

R = 70; E = 60; A per cent = 25; Σ = 70; shock = 35.

After air-hardening at 800 degrees it gave:

R = 85; E = 70; A per cent = 18; Σ = 55; shock = 25.

The disadvantage of these steels is in their cost, and further in that a very slight variation in composition often results in very large variations in their properties.

If air tempering is plainly the simplest, above all when the air-hardening temperature is not necessarily very high (as in the case of the rapid-cutting steels), hardening in a liquid may be regarded as a very easy manipulation if it does not involve subsequent reheating. Many steels may be used after hardening without reheating; others, on the contrary, must undergo reheating or, more exactly, annealing—that is to say, heating to a temperature lower than that of the point of transformation. Into this last category enter all the steels carrying high carbon—say, above the limit of 0.30 to 0.35. Below this, tempering in water is generally sufficient; above, reheating is requisite. At least this is true unless (and this point is vital) brittleness is not objectionable, or unless one uses for the cooling a liquid which reduces the activity of the operation—in other words, unless one employs a bath of such sort that the speed of cooling of the metal is reduced. Two examples may be given of modern steels which may be very simply treated:

1.—Nickel-vanadium steel, employed for shafts and also for defensive armor-plates. It showed upon analysis carbon 0.25, nickel 6.0, vanadium 0.2. Annealed at 900 degrees it gave:

R = 55 to 65; E = 40 to 45; A per cent = 25 to 20; shock = 20.

Quenched at 850 degrees in water without reheating it showed:

R = 110 to 140; E = 95 to 120; A per cent = 10 to 8; shock = 12.

2.—A steel susceptible of oil hardening without reheating and containing carbon 0.175, nickel 4.0, chromium 1.0. Annealed at 800 degrees it showed:

R = 97; E = 77; A per cent = 12; Σ = 40; shock = 3.

Quenched at 850 degrees in oil it gave:

R = 146; E = 129; A per cent = 9; Σ = 50; shock = 9.

The resistance to shock is thus sufficient for a large number of applications.

Let us now consider steels which must undergo complex treatment—that is to say, hardening followed by reheating. These necessitate special arrangements, both for the determination of temperature, and for the furnaces and heating baths. Baths of melted salts are to be recommended from every point of view, both for tempering and reheating. Steels of this class are many in number. We shall present the characteristics of the types most employed; but it should be remarked beforehand that in the analysis of the mechanical properties of metallurgical products, such as we have been making, there is another factor of which we have not yet spoken. This is the so-called endurance or Wohler test. Comparatively little attention has been given to these tests in France. In other countries, on the contrary, they have received a great deal of attention. English metallurgists have studied many types of steel from this point of view, and Ken Smith has shown that the chrome-vanadium steels are particularly interesting. Let us now take up the principal types of complex special steels employed when high breaking strength and elastic limit are required without attendant brittleness. These steels are in constant application in the French industries. Among them we find:

1.—The nickel steels whose characteristics we have already discussed.

1.—The nickel steels whose characteristics we have already dis-

We have already referred to a steel of this type containing carbon 0.25 to 0.30; nickel 5.0 to 6.0, chromium 0.5 to 1.0. Another steel of this class containing carbon 0.25 to 0.35, nickel 2.50 to 2.75, chromium 0.275 to 0.500, annealed gave:

R = 55 to 75; E = 35 to 50; A per cent = 15 to 25.

Quenched at 850 degrees in oil, and reheated at 300 degrees it gave:

R = 80 to 110; E = 60 to 100; A per cent = 8 to 12.

3.—Nickel-vanadium steels, which have been already described.

4.—Silicon steels of which the principal classes are, first, carbon 0.45 to 0.50, silicon 1.5 to 1.2, manganese 0.40 to 0.50; and, second, carbon 0.65 to 0.70, silicon 0.90 to 0.80, manganese 0.50 to 0.60. Both showed almost the same results, which in the case of the steel of the analysis first mentioned, annealed, were as follows:

R = 75 to 85; E = 46 to 50; A per cent = 18 to 15.

Quenched at 850 degrees and reheated at 500 degrees it gave:

R = 120 to 130; E = 100 to 110; A per cent = 12 to 15.

Let us now examine the case of a piece which must be exposed to abrasion or rubbing friction. This case, it should be observed, is extremely frequent; and even though the final result depends not only upon the substance which is exposed to abrasion, but equally upon the material which produces the abrasion, and the conditions under which the abrasion is produced (presence or absence of lubrication) nevertheless certain principles may be defined.

If it is desired to obtain a special steel of great hardness, using this word in its mineralogical sense, we must introduce two principal elements—carbon and chromium. But the former especially (as we have already said) causes at the same time brittleness. It must, therefore, be correctly proportioned. Further, many manufacturers prefer in a large number of cases to resort to case-hardening, which permits the production of an extreme degree of surface hardness secured by no other method, and which, if it is well done, leaves the body of the part very tough and with high resistance to shock.

Before entering upon the question of case-hardening, and exhibiting the important *rôle* which the special steels may play under this process, let us stop to consider the types which may best be employed to resist abrasion.

They must always possess a high degree of hardness; also they are employed after hardening, followed, if necessary, by reheating; but we must consider at the outset whether it is necessary further to avoid brittleness because the pieces must endure shock, or whether brittleness is non-important. Pieces which are subjected simultaneously to shock and to abrasion may be typified by automobile gears and particularly speed-change gears. They must be sufficiently hard to avoid wear; but on the other hand, the teeth must resist sudden shocks or blows, especially when a change of speed is made.

Many types of steel may be used for this result. First come the nickel steels of greater or less complexity and with varying proportions of carbon. Next comes silicon steels, and finally the chrome-vanadium compounds. The principal kinds used at present in France show the composition and the properties expressed below.

1.—Nickel steels:

a. An alloy containing carbon 0.40 and nickel 5.75, air-hardened at 750 degrees, which gives:

R = 130; E = 110; A per cent = 8; Σ = 39; shock = 70.

b. A steel with carbon 0.35 to 0.40, and nickel 6.0 giving the following results:

	R	E	A per cent.	Σ	Shock.
Annealed	80	70	20	65	30
Air hardened at 850	125	110	11	53	19
Quenched in water without reheating	140	125	10	50	17

2.—The nickel-chrome steels which are most used are:

a. Carbon 0.25 to 0.35, nickel 2.50 to 2.75, chromium 0.275 to 0.50. Of this we have already spoken.

b. Carbon 0.45, nickel 2.50, chromium 0.50.

c. Carbon 0.60, nickel 2.50, chromium 0.50. It will be seen that these three types differ only in their carbon contents. They are all employed after hardening and reheating. The following results are given by the type *b*:

	R	E	A per cent.	Σ	Shock.
Annealed at 850 degrees	87	50	14	48	6
Hardened at 800 degrees and reheated to 500 degrees	134	122	7	48	11

It is noticeable that the resistance to shock is increased after tempering. Further, it may be remarked that in France 0.2 per cent to 0.3 per cent of vanadium is frequently added to steels of the preceding types, the hardening qualities being much augmented thereby. A fourth type used after air hardening is:

d. Carbon 0.35, nickel 5.0, chromium 1.0.

This steel is slightly martensitic and consequently is difficult to machine. After air-hardening it gives:

R = 143; E = 120; A per cent = 7; Σ = 38.7; shock = 6.5.

3.—Silicon steels, already discussed.

4.—Chrome-vanadium steels which are but little used in France. A typical composition is carbon 0.2 to 0.5, chromium 1.0, vanadium 0.8.

These special steels which we have just been considering are suitable for employment for various machine parts such as shafts, gears, axles, spindles, etc., which must resist wear and possess hardness with a certain degree of toughness. There are other cases where brittleness is of little importance, and where it is necessary above all to obtain an intense surface-hardness. The best example which could be cited is that of a cage of a ball bearing. We need not fear that this part will be subjected to any more sudden blow than that to which the entire mechanism is subject. On the other hand, it must be extremely hard and the balls must not groove its surface. We need, therefore, consider but two factors—hardness which we can secure only after tempering, and the capacity for undergoing the hardening process without danger of cracks or flaws. All the special steels employed for the manufacture of balls and cages for ball bearings are chrome steels with percentages of chromium varying from 0.5 to 2.0 and carbon between 0.80 and 1.40.

We have already said that case-hardening is an operation commonly used to obtain great superficial hardness, which, without this process, we could not get even from special steels. We have remarked, also, that the new alloy steels have caused a great advance in the process of case-hardening, not perhaps in the surface produced, but at least in the final result of the operation so far as general mechanical properties are concerned. It is important to emphasize this point. When case-hardening of a piece is undertaken, the purpose is to obtain great hardness of the face with high shock-resistance or toughness of the body of the part. To this end, a steel is used containing but little carbon (less than 0.20 per cent) so that the prolonged heat of the cementation shall alter the mass composition as little as possible and that no brittleness after hardening shall result. On the other hand, it is necessary that the steel shall not contain more than 0.30 per cent of manganese, as otherwise the hardened face will be easily detached under the influence of blow or shock.

Case-hardening may be performed in two ways:

1.—The piece to be hardened may be kept in contact with the cementation material at a temperature of 850 degrees. The absorption of carbon is comparatively slow, but the interior mass, being only moderately heated, undergoes relatively little change; for, as is well-known, steel alters by heating directly in proportion as the heat is prolonged and especially as the temperature is high. The interior of the piece being but little changed, a single tempering at 750 degrees suffices to secure the surface desired.

2.—The case hardening may be prosecuted at a high temperature (1,000 degrees), but then the body of the piece is altered and its properties must be restored. To secure this result (the transformation point of extra-mild steel being about 800 to 850 degrees) it is necessary to give a first tempering at 875 degrees, this being solely for the purpose of regenerating the quality of the interior mass; the transformation point of the high-carbon surface being about 720 to 750 degrees this preliminary tempering at 875 degrees does not secure sufficient hardness; the steel is easily attacked by the file. It is therefore necessary to give a second tempering at 750 degrees, which is essentially a hardening temper. For every reason this mode of operation is much to be preferred to the preceding.

These preliminary remarks seem necessary to an understanding of the considerable advantages possessed by certain special steels.

It must be noted, first, that certain elements promote case-hardening, while others retard it considerably. Nickel, silicon, and aluminum have been shown to belong in the second category, while tungsten, molybdenum and manganese belong in the first. The most interesting points, however, are the following:

When we case-harden a steel containing less than 0.20 of carbon and less than 0.30 of manganese, with more than 1 per cent of nickel (generally 2 per cent) there is no longer any need for two tempering processes to secure a tough body mass, even after cementation at 1,000 degrees; a single operation at 750 to 775 degrees will give simultaneously surface hardness and interior toughness. It may be noted further that, taking a steel with the same analysis as to carbon and manganese, but with nickel up to 6 per cent, under similar conditions, the pieces obtained will be very strong and free from brittleness.

On the other hand, if we take a steel containing 0.20 per cent of carbon and 7 per cent of nickel we shall find the same structure as in an ordinary annealed steel (pearlite); but a steel containing 0.80 of carbon and 7 per cent of nickel possesses the structure of tempered steel (martensite); if, therefore, by cementation of a steel of the former composition, we raise the proportion of carbon in the face to 0.80 per cent, we obtain by this simple process the same results which would be secured by cementation followed by tempering, and therewith secure the great advantage of avoiding the distortions of shape which tempering always occasions.

To sum up, special steels render most remarkable service in mechanical construction for various purposes; but it may be said also that mechanical construction, by a constantly more exacting demand and by requiring materials ever more and more remarkable in their properties, has gradually stimulated perfection of that branch of metallurgy which was first created by the need for armor plates; and that to this mechanical stimulus are due many of the latest and most noteworthy developments.

OBTAINING ACTUAL KNOWLEDGE OF THE COST OF PRODUCTION.

By F. E. Webner.

VI. COST RECORDS AS A CONSTITUENT PART OF THE GENERAL ACCOUNTING PLAN.

In the preceding instalments of his series, which began in our May issue, Mr. Webner has discussed the themes "What Constitutes a Knowledge of Costs"; "When and Where a Close Knowledge is Needed"; "The Profitable Use of Cost Comparisons"; "The Use and Abuse of Mechanical Aids in Cost Finding"; and "The Organization of a Cost Department." The paper presented this month concludes the series.—The Editors.

THE logic or course of reasoning is not just clear, but the fact is patent, that a very large percentage of manufacturers who put their financial officers under heavy bonds for the faithful performance of the duties entrusted to them, and for the strict accounting for funds, will shut their eyes effectually to the oftentimes wanton waste of good material which goes on day after day within the range of the manager's vision. We may perhaps find that a manufacturing jeweler will guard his store of precious metal more closely than the manufacturer of machinery does his pig-iron pile, the reason obviously being that, to the petty thief, the intrinsic value per ounce of the former is more attractive than that of the latter. This comparison comes to my mind merely to emphasize the point that it is not the physical removal of goods through theft that is considered; that may be the least likely to cause any worry. For although a workman may overstep bounds occasionally, and with temporarily subdued conscience carry home a few nails to mend the cow shed, or studiously appropriate a little solder to mend Aunt Mary's wash boiler; or even yet, some of the younger element whose ideas of honor have not been cultivated to anything like dizzy heights, might, by cunning conniving, become able to lay thieving hands on brass in one form or another, a good watchman can detect such physical removals of stolen property, and a good watchman in a bank can detect the unlawful physical removal of money in bulk there, but in neither case is the greatest likelihood of loss; on the contrary, the loss most to be feared is that which can take place and often does take place right under the manager's supervision—losses which can be detected only by good accounting methods properly and faithfully carried out.

The cashier's accounts can be checked and any discrepancies located by means of the checking process; disinterested auditors are now widely used for such checking process. If men will not be honest on principle they frequently will as a matter of good policy. It may be surprising to some to know that in many modern plants material is almost as closely checked as cash, and one purpose of this article is to impress on the reader's mind the fact that many more plants sorely need the means of accomplishing such a check. Spoiled work is one important leak which, if not so surrounded with safeguards as to detect it and show it up on the individual's record, will run into money; it frequently is not so much the intrinsic value of the iron as the cost of the workmanship already put on it, and where a plant has not a cost system this element of cost is frequently lost sight of entirely. One large plant in my knowledge keeps spoiled work at the minimum by giving a lay-off to every one who makes mistakes up to a certain amount in cost; one mistake may bring the lay-off, or it may take the aggregate of several smaller items. Another important leak is the making of goods for stock and through lack of proper controlling records entirely overlook the fact of their existence at the time when they are wanted. When material is closely accounted for under a plan in which the factory records are embraced in the general books, such finished or semi-finished goods cannot be overlooked, as a stock account of them will stand out as clearly as will a debit balance against a customer; the proof by balance plan will serve to keep the record on the surface—it will show that a certain amount of money is wrapped up in goods in process or in stores-room stocks, and the same "going over" process that is applied to accounts receivable can be applied to stores account and old material can be used to advantage, where without the knowledge presented by the records such old material would not be thought of; for as a matter of fact physically it might be covered up with other shapes or sizes of stock.

A dollar is a dollar to a solvent manufacturer, no matter what state it be in, whether in money, accounts receivable, or goods in process. The general run of workmen do not have the same wholesome respect for twenty-dollars' worth of castings that they have for a twenty-dollar gold piece, yet one such may have himself received in money the greater part of the value of such castings for his services thereon.

All business is a conversion of assets from one state to another. The prime pre-requisite for a substantial business is cash or its equivalent; given the tangible asset, cash, and the intangible but extremely valuable asset "know how," and a business is assured. The various evolutions and comminglings, through which these combined assets are put, finally produces more of the first class of assets than originally obtained; the increment to a large extent measures the value of the second class.

In the past, as a broad rule, a sharp controlling account has been kept of the first class of assets in its original state, cash; however it has seldom been a necessity to keep individual records of nickels, of dimes, and of each of the other denominations of fractional currency—that has not been necessary from the fact that money can be changed at the bank on short notice. This however is not so with that class of accounts which constitute the last stage of the evolution, finished product to sales. The manufacturer must know not alone what is the aggregate of his accounts receivable, but he must know the amount of each separate customer's indebtedness, so that he can keep after the customers through ordinary commercial channels, and finally complete the evolution by turning the accounts into the first stage of the succeeding evolution, cash.

The interim stages between the first stage, cash, and the last stage, accounts receivable, includes raw material, goods in process, and "know how"; a fitting system of records which shows the management any results worth while will include in the balance sheet synthetical accounts covering each stage of the evolution, to wit: Cash, Raw Material, Goods in Process, Finished Product, Accounts Receivable and Profits; the sum of the parts must equal the whole, and a cost system without proof of accuracy is naught but a series of memoranda.

Formerly the accounts of the great majority of manufacturing concerns consisted of merchandise account, manufacturing expense, and general expense; into the first account were dumped promiscuously the inventories, purchases of raw material, and pay rolls, and in such account sales of product were shown on the credit side, so that the net balance of the account showed nothing whatever of value to anybody. The concerns which used such a plan were not getting the full benefit of a system of good records. The conditions are no different today where the cost records are not a constituent part of the accounting plan; for broadly speaking, any records which will not disclose the condition of the business without stopping to take a complete physical inventory are weak—very weak—and the management is not getting the benefits that would be derived from a system of good records. A going inventory is a prime prerequisite to such a system and is in itself a good asset in the way of a money-saving device; it saves money in so many ways that an article could be written on that one subject alone. That factory which can be run from the office is indeed well equipped—where foremen are not required to answer calls to the office, then return to their department to make certain investigations as to stock on hand, conditions of certain orders in process, etc., before an answer can be given to the office. That manager is indeed modern, and incidentally it is not to be spoken of as luck, because it is not; it is but the sure result of a determined and intelligent effort to have his records show him just what he wants to know—to have the data of his business presented therein both synthetically and analytically.

Along the line of running the business from the office the recollection comes to mind of a good illustration recently recited, wherein two very large corporations with a common line of product were concerned.

Each of these in turn was asked verbally by an executive officer of a concern which is a large user of the product, as to what delivery could be made on a stated quantity of goods; one concern used the long-distance telephone to a number of its plants, while the other concern consulted records within its office and was able to give a decisive reply within half an hour, and to know just what works was best able to turn out the goods, while the other concern had a number of superintendents on edge looking up data and could not give a positive reply short of two days.

Modern methods in producing goods and merchandising are essential, and modern methods in accounting must follow or the producer gradually falls behind in the race; records of facts must be substituted for the guesses of the past.

If the general records are divided into the following broad group of synthetical accounts, and the cost records are made to coincide or articulate therewith, then there will be presented data which will disclose what is the condition of the business any day, any week, or any month, as may be required, and the period of annual inventory can be done away with by verifying the accounts of goods of each class or kind, individually, while the stocks of such goods on hand are at their lowest ebb.

The controlling accounts should be:
Cash.
Bank.
Notes Receivable.
Accounts Receivable.
Accruing Manufacturing Expense.
Raw-Material Stores.
Goods in Process.
Finished Parts.
Finished Product.
Commercial Expense.
Real Estate and Buildings.
Investments.
Accounts Payable.
Sales of Product.
Capital Stock.
Surplus and Profits.

With an adequate system of time reporting, whereby time is charged against given order numbers, and with material issued only on authentic requisitions and charged to the order number upon which it is used, and (last but not least) a fair and just distribution or diffusion of manufacturing expense over goods in process, in such manner that all expense is absorbed, leaving nothing over or short—then will result facts concerning the exact condition of the business, each proving the other.

THE CONSERVATION AND USE OF WATER-POWER RESOURCES.

By H. von Schon.

II.—THE EFFECT OF WATER-POWER CONSERVATION UPON INDUSTRIAL DEVELOPMENT.

In a preceding article, Mr. von Schon proposed a definite plan for Federal, State, and corporate action in the conservation and development of water resources, and supplied some valuable data of explored water powers and their characteristics. In the present paper he examines the extent of the influence conservation might exercise on National economic conditions. A following instalment will conclude the study by presenting a typical, concrete case and furnishing a working solution for it.—The Editors.

THAT industrial growth is clearly reflected by the amount of power utilized appears from the United States Census statistics of the comparative power consumption by some leading industries for 1900 and 1905:

	Horse Power Reported. 1900.	Horse Power Reported. 1905.	Increase. Per cent.
Iron and Steel Industries	1,670,000	2,720,000	63
Paper and Pulp "	765,000	1,122,000	47
Agricultural Implements	77,000	106,000	38
Worsted Goods	97,000	130,000	34
Cotton "	811,000	1,040,000	28
Silk "	61,000	78,000	28
All Industries	10,400,000	14,640,000	40

The use of electric power in the industries is stated by the same authority to have increased from 493,000 to 1,592,000 horse power, or 222 per cent. To what extent this increase is due to the growing utilization of water power for hydro-electric product is not clearly set forth, but its effect is evident from the fact that 800,000 horse power were added from the development of some thirty hydro-electric power plants transmitting the current to various distances with a maximum of two-hundred miles, while many smaller hydro-electric plants have come into existence during this period.

And this increased use of electric power in industries has developed under the most adverse conditions as regards the hydro-power sources—that is, the existing extreme flow fluctuations on almost every water course from which power is taken. I have designed power plants on some southern rivers, within recent years, where the flood-flow volume is one hundred times the normal flow, the flood rise reaching fifty feet and more. The adaptation of hydro-electric installation to such conditions presents problems which can be met only by special and costly works and safeguards, and great loss of efficiencies of the generating equipment cannot be avoided during the periods of excessive fluctuations of flow while continuous output can be secured only by the aid of large auxiliary power installations. The waste flow over the many government dams on the Allegheny, Monongahela, Ohio, Muskingum, Kentucky, Green, Cumberland, and Tennessee rivers would develop many thousand horse power which could all be remuneratively marketed. Under the present conditions of uncontrolled flow such developments offer no attraction as a business enterprise, as they are prohibitive in cost; were it otherwise, the Government might secure a sufficient revenue from these to defray the cost of operating their navigation works, and near-by communities could enjoy the luxuries of economical electric-current service.

It needs no argument to convince that the hydro-power source is the most economical of all when the power element, water, is assured with reasonable constancy, nor can the economical character of the hydro-electric power plant and its equipment, as compared with any other type, be doubted, while economy of operation is of itself evident, as there is no fuel charge, and the costs, maintenance and depreciation are trivial when compared with these items in any other type of power plant. That the individual electric motor, as compared with the mechanical drive of shafts, pulleys and belts, is safe, clean, noiseless and economical, is also self-evident; in fact, considering that the steam-plant output must be constantly maintained at its maximum, whether the machines in the shop are operating or not, the economy of the electric power current, registering through a meter only so much energy as actually performs work, appears so great that even at high current rates it may not exceed 50 per cent of that of the most economical steam power service; in fact, the power consumer enjoys the privilege of paying for so much power only as he actually uses in the work.

The foregoing are some of the reasons why the use of electric power in the industries increases 222 per cent from 1900 to 1905, why the future increase will still be greater; hydro-electric current would soon displace steam-power current if its development were based on river-flow control.

All stream flow has its origin in so much of the precipitation as is not evaporated, this term embracing the quantity absorbed by vegetation and that which evaporates. The residue of precipitation runs off the surface immediately, or sinks into the ground whence it feeds out gradually into the stream channels. The ratio of surface run-off to ground-storage supply depends entirely upon the surface and subsurface characteristics. A bared, hard-baked surface absorbs but little water; a forested area with its deep layer of leaves, brush, and humus is a sponge which becomes saturated with the water; it is a natural storage reservoir. The rapid storm surface run-off erodes the top soil and carries it in suspension, dropping it somewhere in the lower channels; timbered slopes obstruct this surface run-off; it gathers force but slowly; it finds no loose earth or gravel to carry along; the foliage canopy of the trees breaks the force of the downpouring rain, which reaches the ground gradually; finally, the snowfall on the open hillsides melts quickly under the influence of the wind and the sun, while that in the forest remains to melt gradually and then to sink into the ground.

The Chief of United States Engineers in his report for 1885, part 2, page 947 says this of the eroding effect of the flood on the James river:

"It has been estimated that at least 275,000 cubic yards of solid matter pass Rocketts Reef in twenty-four hours when there is a freshet not higher than ten feet. No account is taken in this estimate of the heavy material rolling along the bottom. It is probably far within limits to say that in such a freshet not less than 300,000 cubic yards pass in twenty-four hours. Large quantities of the lighter particles are carried down the river, but the heavier pieces that roll along the bottom move only by a rapid current and stop as soon as the freshet subsides."

That water waste with its collateral flood destructions of life and property, the constantly increasing erosions of the fruitful top soil and the consequent impoverishing of what remains, and the sedimentation of river channels, are primarily caused by the cutting away of the forests in the headwater regions of rivers, was recognized and acted upon by some of the European peoples hundreds of years ago; little Switzerland enacted a forest-conservation statute as early as 1680, which has been enforced in a most business-like manner since; 20 per cent of the mountain republic's area is in conserved forests, some 2,000,000 acres; the cost of maintenance and supervision is $1.32 and the net revenue, $2.25 per acre annually.

Germany's forest area is 35,000,000 acres; its system of forest preservation was inaugurated one hundred and fifty years ago. France has 23,000,000 acres of forests, all under admirable preserve laws. The combined population of these two countries exceeds that of the United States about 15,000,000. They now expend annually on forest preservation some $11,000,000 and enjoy a net revenue of about

$30,000,000, while the United States forestry expenditures last year aggregates $1,400,000 and the revenue $130,000. However, the American people are fully awakening to this forestry problem and energetic steps are being taken towards its economical solution. Several States have legislated for forest preservation by creating reserves and preventing destruction by fire. The total forest area of the country aggregates 600,000,000 acres, of which about 150,000,000 acres are now under Federal and State forest-reserve protection.

But while forest preservation is the prime and durable water conserver, the re-forestation of now wholly or partially denuded watersheds is the work of many years—yes, of generations, and even the present forest area can be maintained only by the promptest and most vigorous preservation policy. The annual growth of timber is not sufficient to replenish what is consumed; it does not exceed 60 board feet per acre or 36,000,000,000 feet from the entire area, while the lumber output alone exceeded this quantity in 1906; to this is to be added some 12,000,000,000 feet for shingles, cross-ties, pulpwood, cooperage stock, mine timber, lath, veneering, poles, and for distillation. And this is only the known consumption; there is yet to be reckoned that for firewood, some 100,000,000 cords or 50,000,000,000 feet, and last but not least what is destroyed by forest fires, which has been estimated as high as 12,000,000 acres in one year. The total timber consumption therefore is nearly three times the total annual new growth, and unless this is more nearly balanced very soon, water conservation by the aid of the forests does not look very promising for the near future, that is for fifty years or more to come. In the mean time the destruction and waste goes on unchecked; the floods will occur annually and will increase in violence rather than diminish; the sometimes navigable channels will be choked up quite as regularly by the detritus washed down from the bared hill sides, and the water powers of the stream, which alone might be of sufficient earning capacity to pay for all the reasonable and economically practicable flow-control works, are hardly of any utility because of the uncertainity of the available flow.

Prompt relief can be had only from one programme, such as was generally outlined in the article appearing in the September number of this Magazine. This comprises the storing of the largest practicable flood run-off per cent, and the distribution of this quantity during the dry season; in this manner only can flow control be had within a reasonable period of time, and some abatement of flood destruction and some betterment of power conditions will be realized from each effort.

Of the many influences which direct the industrial development of a country, none are of greater importance than those of transportation, and the watercourses are Nature's highways. Water transportation represents the earliest and, under proper conditions, the most economical means of conveyance; it was so when the towpath was as much in evidence as is now the steel track, and it will be so again. But in America's rapid industrial development of the recent past, water transportation appeared too slow, too inadequate to meet the great expansion, to keep up with the rapid advance of the pioneers; railroads were demanded; and because their success, it was thought, permitted of no water-transportation competition, railroads were built and canals abandoned. Now we are returning to first and sound principles. We are realizing the error and fully appreciate the mischief done. Railroads alone, after all, cannot keep up with the enormous rapidity of the pioneer's progress, cannot handle the grain he raises when the crop is good, and when times are a little off they cannot secure the funds to meet necessary betterments. Railroads put the canals out of business, but it will fall to inland water transportation on a proper scale, together and in co-operation with the best equipped railroad system which can be developed, to meet the greater transportation requirements of the future industrial expansion. On this topic the President of the United States, in his address to the Deep Waterway Convention at Memphis, Tenn., on October 4, 1907, said:

"Facility of cheap transportation is an essential in our modern civilization, and we cannot afford any longer to neglect the great highways which Nature has provided for us. The natural highways, the waterways, cannot be monopolized by any corporation. They belong to all the people and it is in the power of no one to take them away. . . .

"The industries developed under the stimulus of the railroads are for the most part permanent industries and therefore they form the basis for future development. But the railroads have shown that they alone can meet the demand of the country for transportation, and where this is true the rivers should begin to supplement the railroads, to the benefit of both, by relieving them of some of the less profitable freight."

Inland water transportation is the now popular demand, and it will be rehabilitated before long on a scale which is commensurate to our present-day requirements.

Of the economy of water as compared with rail transportation there is no doubt; the Interstate Commerce Commission reports that the average cost of moving freight by rail in 1906 was 7.48 mills per ton mile, while the statistical report of Lake commerce for the same year shows that 51,000,000 tons passed through the Sault locks, at the outlet of Lake Superior, in a season of seven months navigation, at an average cost of 0.84 of one mill per ton mile, and the cost of moving freight on the Ohio river in 1905, under anything but favorable water transportation conditions, was 0.76 of one mill per ton mile from Pittsburgh to Louisville, and from Louisville to New Orleans 0.67 of one mill per ton mile. This shows that water transportation was one tenth as costly than that by rail, and with continuous favorable conditions guaranteed by flow control of the rivers, and with low-cost electrical power, this low water-transportation rate may still be considerably reduced.

Transmitted electric energy comes to the fore also as an important transportation factor; up and down hill, almost regardless of grades, on economically constructed and maintained road beds, speeds the interurban electric through the country, bringing the town to the door-step of the farm, and the farmer, his family, and his products to the town, disposing of the factor time and of muddy roads at one swoop. Inland waterways and electric traction are destined to become the chief transportation methods of the future, and the development of both of these are collateral consequences of the conservation of water and of the water-power resources.

As was pointed out in the first article of this series, the complete development of the water power of a river, in the majority of cases, will also render it navigable, and this complete development is possible, and will prove profitable, if the flow of the river is under reasonable control. All the electric current which can be developed could find employment in transportation by the electrification of the present steam systems, for the electric interurban lines (which in not distant future, will parallel every important highway in the United States), and in electrically propelled craft on the inland waterways; every hydro-electric plant would be a supply depot of the electric energy for transmission lines or storage batteries. This problem of inland water transportation will not be solved by the continued dredging out of the detritus brought down by the flood waters, but by the diminution, if not the prevention, of the floods, by the storing of the flood waters and its distribution during the dry season, whereby the now three- and four-feet deep navigation channels may be increased to a constant depth of eight feet or more.

Past efforts to create slack-water navigation on the rivers flowing from the Southern Appalachian mountains have cost some $30,000,000 to date, and the results obtained are anything but continuous navigation; there is either a feast or a famine of water, and then the loss of much of the work done and renewed dredging. From a late report of the United States Geological Survey on the relation of the

Southern Appalachian mountains to inland navigation, it appears that all-year navigation may be secured on the Potomac, James, Roanoke, Great Pedee, Yadkin, Santee, Wateree, Savannah, Altamaha, Oconee, Chattahoochee, Monongahela, Youghiogheney, Kanawha, Tennessee and Ohio, by storing approximately 30 per cent of the flood flow of these rivers in reservoirs which have been sufficiently examined to determine their storage capacity, flowage area, and cost of required storage works; and that the proper distribution of this per cent of the flood waters during six low-flow months annually will, in normal channel sections, maintain a navigable depth of about eight feet, while the present system of channel improvements does not claim to secure better than four feet. As of the relative cost of the two methods there can be no doubt. Channel conditions secured by aid of flow control have some permanency; those without it are changed by every flood. It has been urged against such a programme of flood storage that the initial cost would be so enormous that the country would not stand for it. I claim that the enhanced water-power capacities alone will carry such an investment—yes, that the prevention of flood destruction, or its considerable diminution, would do so likewise—and, thirdly, that the waterways thus created and their maintenance as such would equally well meet this cost by the consequential savings of the cost of the present improvement methods. Again, it has been said that the elements of danger from the possible failure of any of these storage works are so awe-inspiring that they will never be authorized. To this it might be replied that we are living in an age when great things are done, and that storage dams, in suitable locations, can be made as safe as any works created by men; that they can be made a part of the everlasting rocks and be as secure as these. It is hardly believable that American enterprise and genius will be found inadequate to create safe storage works for any purpose.

But not only may water *transportation* be thus rehabilitated, but water *powers* as well, and enormously enhanced in value. A similar recent report from the United States Geological Survey on the relation of the Southern Appalachian mountains to the water powers quotes the present power capacities of the rivers before enumerated at 2,800,000 horse power, while the storage programme as outlined would increase them to about 7,000,000 horse power. Late Census statistics quote the water power used in the southern States at 150,000 horse power—about 5 per cent of that now available and 2 per cent of what can be created by flow control. If the available water powers of the southern States could now be economically developed, the cotton-goods industries, which now utilize over 1,000,000 horse power, would soon be located in the land where the cotton grows, and the wood pulp and paper industry of New England would have to meet a formidable rival in paper manufactured in the South from rice straw and other there plentiful fibrous materials, such as are now being made into paper in Europe. With such an asset of electric energy, and the consequent low cost of it, electric heat would become available for the reduction of ores, and Pennsylvania would not long continue to hold the supremacy in the iron and steel industries. Water conservation and the complete development of the available water powers would indeed give to the industrial development a new phase, as power is a factor of great import.

And this holds good not only of the South, but of the North and the East and the West. The rivers flowing from the White mountains, the Alleghenies, and the Rockies, all are proper subjects of this conservation programme and the benefits to be realized therefrom. Whether this is to be initiated and carried out by the States or the United States is a question of powers and policies as determined wisest by the people; at any rate it is a public and in the majority of cases, a national subject. The great, the broad, the all-overlying need is to stop the waste, to do things for the conservation of this, the greatest of all natural resources, water; to sober up from our orgies of indulgence so that the generations to come may be saved from the pangs of want; to act as reasonably and wisely in regard to our natural resources, as a people, as the normally constituted American business man would act with his own.

I would suggest that this is a proper time for the serious consideration on the part of all commercial, industrial and professional bodies, of the engineering societies especially, of this question of conservation of water. This seems to be the time for the initiation of an energetic campaign, now that the general subject of conservation of our natural resources has received such important impetus on the part of the National and of several State administrations, and has been given commensurate importance among the weighty questions of the day in the plaforms of the political parties, for all proper influences to be exerted to preach and spread the gospel of conservation in every community and State, so that a united interest may become enlisted and the desired results be obtained as speedily as practicable.

This article is to be followed by a typical case of water conservation, and of its effects and results as compared with the methods and policies followed in the past.

SYSTEMATIC FOUNDRY OPERATION AND FOUNDRY COSTING.

By C. E. Knoeppel.

The thought underlying Mr. Knoeppel's work is that "action is the result of conclusions based on reasoning applied to comparisons." His purpose is to lay down practical, sensible methods by which the data essential to comparisons may be obtained. His series beginning in this issue will cover all elements entering into the problem of systematic, profitable conduct of the foundry. A brief topical outline of the discussion is given on pages 96 and 97.—The Editors.

IT is doubtful if, in the whole realm of business endeavor, any industry has received less intelligent consideration from those most interested than the foundry industry, with its millions of tons of yearly product, finding its way through our twentieth-century commercialism to all parts of the world. That this vastly important industry, as a whole, is far from measuring up to the limit of its possibilities, is a fact that will admit of little if any argument. It is about time that its old methods were done away with and new ones substituted—about time that its position should be on a plane equal to that now occupied by the machine shop—about time for it to be looked upon as something infinitely more than a "necessary evil," a "dirty hole" where almost any kind of rigging, any method was good enough—about time for it to be given as important a place in the organization of a business as any other department; and fortunately, the indications are that the foundry is coming into its own as is evidenced by the attention given to such subjects as organization, mechanical arrangement, rigging, tools, chemistry, accounting, etc., by the many associations devoted to the interests of this industry. Nor is the move for greater efficiency confined altogether to the United States, as appears in an extract from the address of President Pilkington, of the British Foundrymen's Association, at their meetings, August 6, 7 and 8, 1907:

"It appears to me, however, that although there are many excellent exceptions, there is no department in our great iron and steel trades which is so antiquated, not only in commercial methods, mechanical arrangement, in systematic organization and scientific methods as that of the ordinary foundry industry. What we want to do in this country is to 'wake up,' and it is the duty of associations such as ours to awaken our foundries by such criticism and teaching as we are capable of.

"If it requires a careful organization in foundries on special lines of work, it is therefore clear how much more so it is requisite, if the ordinary jobbing or general foundry be taken, which is on varying work of a very different character. The system has to be an extremely elaborate one, carefully thought out, to get the exact cost of each of the different jobs at different classes of castings produced, which can be the only correct system to use to form an accurate basis for sending in proper tenders for work."

It would be almost impossible to attempt to determine by what process of reasoning foundry managers have allowed their shops to stay for so long behind the machine shop, in the way of mechanical arrangement and systematic methods. We go into a machine shop; we see an excellent equipment; perhaps the machines are electrically driven; we see electric cranes, air hoists, etc.; we find the building well lighted, heated, and ventilated; we note the excellent equipment of small tools, jigs, gauges, etc; we are surprised at the systematic handling of raw and finished materials from and to the machines, as well as at the way the order, time, and cost details are handled, and we marvel at the wonderful progress made by the machine shop. Now for the other side of the picture. We enter the foundry and the first thing that is liable to greet us, if it be winter, is gas fumes from a number of coke fires; we find the ventilation to be far from what it should be, and if we are in the foundry when a heat is being taken off, it is a hard matter to see from one end of the shop to the other on account of the smoke and gas; we find a flask equipment that saw its best days quite a little time ago, some being so bad that a really good moulder would dislike to use them for making even the commonest kind of work; we see flasks piled in every conceivable place in any old order; we see a poor lighting system; pig and scrap arranged in all kinds of ways; in fact, everything seems to be disorder and confusion. We find that the melting—a matter of the utmost importance—is left to ignorant men; that little care is exercised in weighing the metals, that in throwing into the cupola, it sometimes makes little difference how or where the metals are thrown as long as they get into the cupola and out again as iron, be it good or poor. As to a systematic method of gathering pertinent data, we are likely to find this work in a very crude state; but the surprising feature is that the foundry manager wants good castings in maximum quantities and he does not want them to cost more than they should, either.

It is strange sometimes to come in contact with these men, who, considered shrewd, display such a small amount of business acumen in expecting maximum results from equipment and methods that are far from being up-to-date and efficient. A workman, whether he be a machinist or moulder, is about what his environment makes him, and the efficiency of a workman is generally limited by what he is given to work with. It is therefore safe to conclude that maximum efficiency, in the foundry, in the way of increased production and reduced costs, is in proportion to the attention paid to such matters as equipment, proper working conditions, accurate methods, etc., and it will be found that results are better as the foundry, as a plant, approaches the plane occupied by the machine shop.

If we assume that it is right and proper to give the machine shop the careful attention that it has received—and results are bearing out this assumption—then why is it not right and proper to give the foundry like attention? Is not this our starting point? Most of the raw material used by the machine shop is the finished product of the foundry, whether it be iron, brass, or steel castings—the product of a jobbing foundry or a foundry in conjunction with a machine shop. Why start half-way? If an architect designs a building, he pays particular attention to the matter of foundation; is not the foundry our foundation in so far as the machine shop and those who use its product are concerned? Should not one rule apply to all branches, instead of conducting the business in a lax and careless manner "to the machine-shop door" and then exercising extreme care "from the machine-shop door"? The work in the machine shop is, to a large degree, mechanical, while in the foundry we find brain and muscle the principal factors. This naturally increases risk, for in the machine shop a drawing is furnished, the piece to be processed is placed in the machine, and this simply requires the attention of an operator who has little to do other than to watch his work, using the necessary tools for this purpose and seeing to it that the piece or operation is completed in accordance with the drawing or sketch. Nothing but the carelessness of the machinist himself can result in the loss of the piece, unless it be inaccurate tool equipment, which as a rule is carefully guarded against. In the foundry the moulder has sand, a pattern, and a flask with which to work. His pattern may or may not be what it should be, while it is safe to assume that his flask has been used and kicked around for so long a time as to make it unfit for anything else but firewood, while his sand is likely to have the consistency of grit. Out of all this, he is expected to furnish a good casting, but he does not always do so. Comparing machine shop with foundry, the element of loss must be greater in the latter; for even though a moulder might perform his work well, in spite of what he has to work with, any one of a number of things might happen which would result in a bad casting. Carelessness is often responsible for loss, but there is no getting away from the fact that "contributory negligence" on the part of the management is much in evidence.

Again comparing machine shop with foundry, we find daily wage per man averaging more in the foundry than in the machine shop, in the majority of cases. It should be evident that the greater the risk, loss, and wages paid in any one department, the greater should be the attention given to it; if this is the case in the foundry, no logical argument can be advanced against the conclusion that the foundry is justly entitled to a *greater* degree or attention than is given to the machine shop, in equipment, mechanical arrangement, and methods.

Foundries can be divided into two classes—jobbing and specialty (in conjunction with a machine shop)—but in either case the desire is a maximum production at a minimum cost. The jobbing foundry depends upon a reasonable cost to be able to make prices which will result in orders, while the castings from the specialty foundry go to make up a machine, the cost of which must be kept within certain bounds in order to sell them at a profit.

The various items of expense make up total cost, which added to a reasonable profit gives the selling price. If this price is too high, the order is lost. It will not do to sell below cost very often, although it is sometimes necessary to take work at cost in order to keep the output up to a required amount. Of the three items just referred to, we find selling price dependent upon cost and added profit, while the percentage of profit depends to a large degree, if not entirely, on cost; so that the logical inference is that cost constitutes the basis of a sale, regardless of whether the sale involves a machine or simply castings. Now then, if we can arrange through some method or other to watch this item of cost carefully, a means is provided for enabling us to get it down to a consistent figure and keep it there.

A manufacturer with no system at all will keep some sort of a record showing him, at the end of the year, what his sales have been. He finishes a business year, we will say, with sales amounting to $100,000, but in comparing the year with the preceding one, he is surprised to find that the sales were $125,000, a decrease of $25,000. As every effect has its cause, he concludes at once that something was wrong. Upon what does the finding of this something depend? First upon a *comparison* to find the *effect,* which in this case is a reduction of $25,000 in the sales, and then upon an *analysis* to find the *cause.* It is evident that the time necessary to make this analysis depends altogether upon the facilities for the comparison of items of like nature.

His comparison showed him that something was wrong, and his conclusion may be that he was forced to make his prices higher in order to offset higher wages paid and greater material costs; which might have been responsible for the falling off in the sales—although this might not have been the reason, which remains to be found. A flood of questions come to him regarding production, costs, percentages, etc., but it is next to an impossibility for him to answer them owing to his inability to pick past performances to pieces.

Does it not stand to reason that he should have had compilations of data and information on hand, which would have enabled him to compare and then analyze? Most assuredly it does, but to *compile* he must *secure*—my reason why a system of costing is an absolute necessity in any manufacturing establishment. To sum up briefly, we first of all have effects or results of every kind and description; if these are gathered or secured in a systematic manner, compilations can be made, and by comparison for different periods, analysis will point out the way for ascertaining causes. Once a manufacturer knows the *why,* he is in a position to plan for maximum efficiency.

In the foundry business competition is not getting any easier, although it might seem that it was from the way many foundries are managed. There are many cases where one foundry will make a price of $2.50 per 100 pounds on certain work, and another will ask $2.35 for the same work, regardless of whether they can make the work for this figure or not. It seems that many either go on the assumption that "ignorance is bliss," substituting "I think" for "I know," or they look upon the matter of basing a price as so simple as to render unnecesssary any method for accurately determining what should be charged. The competition of the successful foundry is not the hardest to meet, but rather the ignorant and unintelligent competition of the concerns who know as much regarding where they stand as a child does about the Greek tongue, such concerns making a gambling proposition out of what should be up-to-date business in every acceptance of the term. Even if price is not the important consideration, the need for a proper system of costing is none the less, for the ultimate purpose of any system of accounting is a reduction in the expenses and an increase in the production, brought about, as before stated, by a careful analysis of all pertinent information. This applies to the specialty foundry as well as to the jobbing foundry, for the desire of manufacturing concerns operating their own foundry is (or should be) a foundry production costing no more than the castings can be purchased for outside.

In the specialty foundry, the discoveries of actual conditions are not made as quickly as in the jobbing foundry, because the output of the specialty foundry is usually governed by the orders received by the machine shop, while the jobbing foundry must keep constantly on the jump, to get enough business to keep the plant running full time, the result being that the specialty foundry is looked upon as a sort of "necessary evil" to facilitate the work in the machine shop, and consequently receives less intelligent consideration than it otherwise would. The result, if the truth were known, is a high cost of production; for not knowing where the leaks are, the management is in no position to stop them or cause them to be stopped, whereas if they would once put their foundry on the same basis as the machine shop, the results would be such as to cause the saving of considerable money, or the foundry would be closed down and the work sent outside when only good castings would be paid for at the market price.

How can a foundryman find out where and how he stands? From his cost system, which if properly devised and introduced will inform him regarding the cost to produce his output; what he is making; the productiveness of his men and the plant, etc., and by a segregation of all the details, then a classification and an analysis, he is in a position to pick the bad threads from the good, and instead of saying "there is something wrong *somewhere*" (anyone can say this) he is able to say *"here is the fault."*

Is foundry accounting simple. Ask some foundrymen this and they will reply that it is, and confidentially tell you that the total wages paid, added to the materials consumed, plus the expenses, will give the total cost of producing castings; dividing by the weight of castings produced will give the cost per ton of good castings; deducting this from the selling price shows the profit—if the cost is not larger than the amount received. Or they may tell you to classify product under headings of bench, loam, green-sand and dry-sand work, and divide the total cost of each group by its castings produced. The argument that might be advanced in favor of these two methods is the ease with which costs can be figured; but unless the determination is an accurate one the methods are worse than none at all, inasmuch as the results would be misleading, and no foundryman can afford to work in the dark, especially in these times. The methods outlined would be accurate in shops having a uniform class of product, where the increases or decreases in the material, wage, and expense costs are proportionate to the increase or decrease in the weight of the castings produced. Such a condition exists in but few shops, as will be evident when one considers that in the majority of foundries, a piece taking 10 hours to make might weigh 500 pounds, while another piece made in the same time might weigh 2,000 pounds, or two pieces weighing 1,000 pounds each might be made in 3 hours and 7 hours respectively; this shows that we can have the same weights and different labor, and same labor and different weights, as two extremes with numberless fluctuations between; it shows also that the relation between weights and labor are far from being proportionate; this being the case, the methods above mentioned must be discarded on account of their inaccuracy, as this will show:—

We will say that the cost determination on the entire month's output or a group output, shows it to be $2.50 per 100 pounds, made up of the following elements:—

Material	$1.00	
Labor	.75	
Expenses	.75	(100%)
Total	$2.50	

Take for instance two castings, alike in every particular, but made from different patterns, one being so constructed that when finished it weighs 2,000 pounds while the other weighs 3,000 pounds. It stands to reason that the difference in the making time will not differ materially, if at all, but in costing at our rate of $2.50, we get a cost on the 2,000-pound or "A" castings of $50, while on the 3,000-pound or "B" pieces, the cost is $75, the details being—

"A" 2000 lb.		"B" 3000 lb.
$20.00	Material	$30.00
15.00*	Labor	22.50*
15.00	Expenses	22.50
$50.00 (C)	Total	$75.00 (D)

Instead of two different items of labor as shown at (*), the labor on both pieces was either $15 each, $22.50 each, or *neither;* in fact, the labor might have been $10, $8, or $12; but on the assumption that it is $15, our table should read:—

Case No. 1

"A" 2000 lb.		"B" 3000 lb.
$20.00	Material	$30.00
15.00	Labor	15.00
15.00	Expenses	15.00
$50.00	Total	$60.00
....	Cost "D"	75.00
....	Difference	$15.00

Assuming that the cost is $22.50 each for both and we have:—

Case No. 2.

"A" 2000 lb.		"B" 3000 lb.
$20.00	.............Material	$30.00
22.50	.............Labor	22.50
22.50	.............Expenses	22.50
$65.00	.............Total	$75.00
50.00	.............Cost "C"	.....
$15.00	.............Difference	.....

It is therefore evident from case 1 that cost "D" was overestimated by $15, while case 2 shows us that cost "C" was underestimated by the same amount.

Getting down to a strict commercial basis, by which any method should be measured, we find as far as concerns this particular transaction (which is far from being an isolated case) that overestimation and underestimation are the result, the significance of which is no doubt apparent to every foundryman whether he is running a jobbing or specialty foundry. As far as the jobbing foundry is concerned, overestimation means that competitors are very likely to get the orders of which the costs have been overestimated, while underestimating carries with it the orders, at a loss in producing; neither of these results is at all desirable. The machine shop using the castings from its own foundry, will have its output when overestimation occurs costing more than it should, and less than it should when costs are underestimated. This is liable to result either in loss of orders or loss in money and the possibility of *loss both ways* is something to avoid. At any rate, it should be seen that as far as shops having a varied product are concerned, the determination of costs on a tonnage basis is most inaccurate as well as misleading and consequently of no value whatever.

What method should be used, and how may costs of production be ascertained, so as to insure not only results in the way of greater efficiency, but accuracy, comprehensiveness, and simplicity? To answer this question will be the purpose of a series of papers of which this is the first or introductory. The aim will be to show, step by step and in detail as far as possible, the work of costing, from the proper securing of the numberless details to *recording* of final analysis for reference purposes. In scope the series will consider and discuss the proper apportionment of burden; the elements entering into the burden; how they are absorbed by production; purchases, and the proper handling of materials received; charging and billing; inventories; returns and their analysis; cupola data; material adjustments; labor—direct and indirect; expenses; the accounting and compilation of cost information; focusing of pertinent details at one point; facilitating and recording analysis; standardization of costs, work, duties, and other points which affect the success or failure of the foundry enterprise. The *how* and *why* of things, with illustrations and definitions where possible, will receive special attention, so as to make the series clear to the readers. It is reliable and accurate information, carefully secured, compiled, segregated and then analyzed, which enables a manufacturer to plan for maximum efficiency in such a way as to lead him to feel that his efforts will count for something.

NOTE.—To insure against "it all looks good on paper," the author decided to use, as a basis, a system actually in operation and giving results, instead of building methods around a hypothetical case. To do this, it was necessary to find a foundry having, as a product, a varied line of light and heavy work as well as a foundry with a reasonable sized output of recognized quality. It was also necessary to find a foundry successful in a commercial sense, and in a locality where competition is keen and where there would be no question but that the methods and systems were playing a large part in the success of the enterprise.

Such a foundry was found in Erie, Pennsylvania, under the name of the Walker Foundry Company, its president and general manager, Mr. G. I. Black, kindly consenting to give the author all the information necessary regarding the details of the business, in order to make the series as strong and complete as possible. The business in question, which was started in 1893 with about 15 employees, is now operating with a capacity of 250 employees at an average daily tonnage of 30 tons; the shop is a large one, having three floors—main, side and bench—with two cupolas, one taking care of the light work, the other the heavy work, so that the methods which have assisted in making this enterprise successful, should prove of value to those interested in the foundry industry.

The systems in use today—which have been revised only when it was necessary to meet changed conditions—are the result of the combined efforts of Baker-Vawter Company, Chicago; J. C. Loughry, Elyria, Ohio, and Mr. Black, who has made a careful and consistent study of costing methods—quick to introduce any method which would tend to make his business more successful—and with the author is now at work on a campaign of standardization and betterment, the result of which will be given to the readers of this magazine, in the papers which are to follow.

THE AUTHOR.

EDITORIAL COMMENT

Mastery of the Air.

AERIAL navigation so inspires the imagination that it is easy to overestimate the successes obtained and to overstep probabilities in forecasting the future. It has been demonstrated that under given conditions a dirigible balloon carrying many passengers may be manœuvred safely for several hours, and an aeroplane carrying one or two may fly swiftly for one or several hundred miles; but the "conditions" are so rarely "given" that these solutions seem after all to apply but to single and exceptional cases and not to the general problem.

The Zeppelin and Parseval airships —just as the multitude was ready to acclaim them conquerors of the air— were destroyed by a mere fillip of the wind's finger tip. The scope of Wright's wonderful machine and the extent of the inventor's success are marred by the distressing fatal accident of September 17th; but the limit does not lie here, but in the fact that he had to wait hours, days, almost weeks, for atmospheric conditions good enough to permit him to fly at all, and could launch or land only by the aid of equipment or environment which left the feat still immeasurably far from free-ranging locomotion of the air.

For certain purposes where risk and cost of performance are wholly negligible (as in war, sport, and improbably some emergencies) the problem is solved or is very near solution. For broader employment this problem of navigating a medium subject to furious and not always foretellable disturbance, by a vessel immersed in that medium, is as far as ever from solution—is probably insoluble. It is much like attempting to build a submarine that can travel safely in the rapids of Niagara.

Resumption Enforced.

THE season approaching a presidential election is notoriously a time of partial suspense in business, and this year — with its atmosphere of uncertainty trailing after it from a preceding depression—could hardly be expected to prove an exception. The hesitation, however, seems to be in fixing the rate at which the future shall be discounted, rather than in deciding what that future is to hold for our industries.

Meantime physical conditions are rapidly reaching the point where a large increase of activity will be forced upon manufacturers in spite of all hesitation and of the acquired inertia of the past depression. Retrenchment in maintenance of equipment, makeshift and expedient in the repair and upkeep of still active machinery, inattention to the condition of machinery which must soon be started, have gone as far as they can go. Reserve and surplus stores have been drawn down to nothing; idle equipment has been "robbed" to maintain live equipment until Peter can no longer pay anything more to Paul; new purchases must be made. The slightest increase in the amount of moving machinery means now considerable increase in the purchase of fittings, auxiliaries, supplies—means considerable expenditure to bring the dismantled outfit up to condition. And just as contraction circled rapidly back upon the heads of those who began the retrenchment, so renewal and resumption will spread in circles, ever enlarging, no longer "vicious," but now beneficent.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

STEAM-ELECTRIC MARINE PROPULSION.

THE ADVANTAGES OF ELECTRIC TRANSMISSION IN SECURING HIGH EFFICIENCY OF BOTH TURBINE AND PROPELLER.

William P. Durtnall—Institute of Marine Engineers.

A PAPER read recently before the Institute of Marine Engineers by Mr. William P. Durtnall, abstracted in *The Electrical Engineer* for July 24, gives one of the most interesting discussions of the question of electrical transmission for marine propulsion that has come to our notice. The low efficiency of the direct-connected turbine system is due to the fact that the steam turbine works most efficiently at high speeds, while the propeller efficiency is higher at low speeds. Mechanical gear and compressed air have been tried as means of transmitting the power of high-speed turbines to low-speed propellers but with unsatisfactory results. As Mr. Durtnall points out, the electrical system seems to be the one in which the greatest possibilities lie, and the system he proposes, an outline of which is given below, would seem to solve the problem in a practical and efficient manner.

The turbine is in several ways an almost ideal motor. It is easy to open up and repair, and the simplicity of its working parts and ease of lubrication make it especially suitable for use with highly superheated steam; it gives a uniform torque and is, at least in some cases, highly efficient under great variations of load. Its direct application for marine propulsion has secured a very strong hold, but for this purpose it has a few but important disadvantages. It must be designed to run at low speed to permit the use of a propeller of high propulsive efficiency, and consequently its weight and diameter are increased to a very large extent. The blade clearance is also greater, involving higher consumption and leakage of steam. Added to these disadvantages are the difficulty of reversing and the increased steam consumption per horse power when working below full load and speed. Tests on the "Lusitania" have shown the steam consumption per shaft horse power per hour to increase from 14.46 to 26.53 pounds when speed was reduced from 25.4 to 15.77 knots. The ability to manœuvre is perhaps of small importance with ships making long runs, but it is very important for those making short voyages and for ships of war; it is usually secured by the installation of astern turbines of about one-third the total ahead power. This arrangement is not satisfactory, as the dead weight is considerably increased, and full power astern is not secured. The latter would be possible only with a full duplicate set of turbines, and for many vessels considerations of safety might justify such an increase in dead weight. In order, therefore, to secure the complete success of the steam turbine as used for ship propulsion, some means must be provided to allow the turbine to run at high speed and the propellers at comparatively low speed, and so secure economy in both cases, and also to provide reverse motion for all shafts.

The greatest possibilities lie in the method of electrical power transmission. This system supplies the very elements required to take advantage of high-speed turbines by utilizing them to drive electric generators, thus securing a reduction of turbine weight and high economy in steam. The current generated would be used to supply low-speed electric motors coupled to moderate-speed, large-bladed propellers of high efficiency. This method of power transmission would do away with the necessity for extra turbines, shafts and propellers for reversing. The turbo-generators would always run in the same direction as regards speed rotation while the motor could be run efficiently in either direction and at any speed, with the additional advantage that changes of direction and speed to meet the conditions of practice could be made instantaneously. Both motor and generator could also stand very severe overloads for short periods without damage.

For marine propulsion electrical power transmission can be successfully effected only by the use of polyphase alternating currents, with synchronous generators and squirrel-cage induction motors, on account of the low cost and weight per horse power, absence of commutators, and high efficiency of these machines. In generators of this type the armature is a stationary closed ring, inside which the field magnet revolves. The main current is generated in the stationary ring and taken off direct, without any of the intermediary devices necessary when collecting current from a rotating source. The field magnet receives its exciting current from a small direct-current machine mounted on the generator shaft. This current, which only amounts to about 2 per cent. of the generator output, is delivered to the revolving field through simple collecting rings. Such combinations, as converters of mechanical into electrical energy are characterized by exceptionally high efficiency, light weight, and low steam consumption. The efficiency varies from 85 per cent. in small sets, to 98 per cent. in large installations; the weight is between 35 and 22 pounds per kilowatt output continuous rating, according to speed and other circumstances; while the steam consumption in 7,500 kilowatt sizes, running at 750 revolutions per minute, with 160 pounds steam pressure at the stop valve, 150 degrees superheat, and exhausting into 27½ inches vacuum, is only 13.5 to 14 pounds per kilowatt-hour, including steam used for auxiliaries.

The powerful starting torque, light weight, simplicity, low cost of construction, mechanical strength, durability, and running characteristics of the induction motor make it especially suitable for marine work. As there is no commutator and no sparking limit the output can be carried much higher per unit weight than in other machines. These motors can be built for marine work of from 1,000 to 10,000 horse power continuous rating, weighing 35 to 20 pounds per brake horse power, with an efficiency of 93 to 97 per cent. Although polyphase motors are termed non-synchronous, they always tend towards synchronism, and with squirrel-cage rotors the variation in speed from light to full load seldom exceeds 5 per cent., even in small sizes, and would probably not exceed 1 per cent. in large sizes. The main working current passes through the stationary part of the motor only, facilitating strong and reliable construction for the conductors and rendering the machine so simple as to require no skilled and very little unskilled attention, with very low maintenance cost.

"Let us assume that we wish to know what will be the steam capacity of the boilers for a vessel fitted for electrical transmission. For four propellers, each requiring to rotate it 1,000 brake horse power at 250 revolutions per minute, the motor would be of the polyphase induction type, with squirrel-cage rotors, and with stators wound for full, half, and quarter speeds. The generators would in this case consist of two turbo-alternators and exciters capable between them of generating and supplying 3,250 kilowatts, and running at a speed of 1,500 revolutions per minute with steam at, say, 150 pounds pressure and 150 degrees F. superheat. These alternators would be, say, two-pole machines, therefore, if the motors are wound for 12 poles (for top speed), it will be equal to 6 to 1 reduction in turbine for propeller speed. For half speed the second winding would be arranged for 24 poles, 12 to 1 reduction with two sets of windings in parallel; and for quarter speed this winding would be arranged for 48 poles, 24 to 1 reduction. With these windings in series the synchronous speeds would thus be full speed 250, half speed 125, and quarter speed 62½ revolutions per minute. For the top speed the above turbo-alternators would be coupled up in parallel, and when supplying the motors with current would generate 3,250 kilowatts, and the consumption would be, say, 16 pounds per kilowatt, or 52,400 pounds of steam per hour, or 13 pounds per shaft horse-power, which compares, in my opinion, very favourably with what would be required with direct-coupled turbines working under similar speed and circumstances, and would be more in the order of 22 pounds per shaft horse-power, 88,000 pounds; therefore, difference in steam consumption 36,000 pounds per hour, representing a saving of no less than 41 per cent. in boiler capacity comparatively. Now, at half speed we will close down one of the turbo-alternators altogether, and we shall probably only require, say, 600 shaft horse power at this speed; therefore, I will estimate the efficiency of the motors at this half speed and load 60 per cent.—740 kilowatts. The turbo-generator would use, say, 24 pounds of steam per kilowatt-hour with this load, but would run at top speed, although at half vessel speed, and this is equal to 17,760 pounds, while the direct-coupled turbines would each run at half speed, and the consequent steam consumption would be not less than 47 pounds per shaft horse-power to 28,200 pounds of steam, or under these circumstances there would be a saving of no less than 11,800 pounds per hour, or equal to 37 per cent. saving in steam at half vessel speed (and I have estimated on the easy side for the direct-coupled turbine). Assuming these estimates to be approximately correct, it may be asked, what will be the relative weights between the two systems? So we will take first the four motors:

4,000 brake horse-power at 35 pounds per horse-power developed	say	62½	tons
Conductors, switchgear, etc.	"	6	"
Two turbo-generators as above	"	70	"
Condenser for above	"	19	"
Steam-piping, etc.	"	13	"
Air-pump and motor	"	6	"
Circulating pump and motor	"	7½	"
		184	tons

While the weight of the direct-coupled turbines and part of the propeller shafts, shaft tunnels, etc., including condenser, steam-pipes, etc., air and circulating pumps—which would have to be arranged to deal efficiently with the 88,000 pounds of steam—would be at least (taking the speed of the turbines at 250 revolutions per minute) 148 tons, showing that the electrical machinery would be about 25 per cent. heavier, but it is here necessary to point out that that only applies to the plant from stop valve to propeller shaft connections. We will now look into the possible saving in operating costs and weight at the other side of the stop valve, and taking the data that have been published as regards the weights of cylindrical boiler, stokehold equipments, etc., which are as follows, when taking reciprocating engined vessels into account. It has been stated that with good cylindrical boilers, including small and large mountings, firebox and funnel (boiler empty) with forced draught, pipework, including all pumps, water, steam, and exhaust pipes, gratings, platforms, etc., weight per indicated horse-power in boiler-room reaches 180 pounds. Therefore, the weight of the boiler-room equipment of a vessel in which would be installed, say, two reciprocating engines running condensing would approximately be as follows: Taking 180 pounds boiler equipment weight per indicated horse-power, then 4,700 indicated horse power, with a mechanical efficiency of 85 per cent., would equal 4,000 brake horse power = 377 tons, and in order to get at the steam consumption per ton of boiler weight we will allow, say, 16 pounds of steam used per indicated horse power, including steam required for auxiliaries and losses due to radiation, etc., therefore = 75,200 pounds of steam per hour per ton of boiler-room equipment. Under these circumstances the boiler-room equipment would weigh, for the 52,000 pounds of steam that will be required for the electrically-driven vessel, 260 tons, while for the direct-coupled turbine-driven vessel the boiler equipment would weigh not less than 440 tons. Hence, with electrical transmission there will be a saving in weight in boiler-room equipment for the same propeller horse-power of not less than 40 per cent., or 180 tons.

"Now, as regards coal consumption and comparative saving in this direction, we will take it that with hot feed, clean flues, and with good Welsh coal, it is possible to evaporate, say, 10 pounds of water per pound of coal burnt, so that we have in the direct-coupled turbine vessel a coal consumption of 8,800 pounds and in the case of the electrical vessel 5,200 pounds, or a saving of 1.6 tons per hour, which equals in a ship running for six days a net saving in favour of the electrical scheme of no less than 230 tons less dead weight, and, what is very important, running cost; and this important matter will be surveyed with somewhat close interest by cargo vessel owners, as it may be at the same time observed that the propellers are run at about the same low speed as is necessary and usual in these slow vessels. In order to secure economy at the propeller, and for the usual speed of such cargo vessels, it is possible to further reduce the speed of the propellers should it be considered necessary to suit the ever-varying conditions that will possibly be met with in practice, and this could be secured by slight increase in the weight of the motors only, the generating plant weight remaining the same. The system is very suitable for conversion of existing single-propeller vessels, while in twin-propeller ships a certain advantage is secured in economical operation by the use of one power generating plant working twin screws, with their various advantages, certain security, and ease of control."

THE CARE AND MAINTENANCE OF STORAGE BATTERIES.

A REVIEW OF OPERATING METHODS AND OF THE CAUSES AND REMEDIES OF BATTERY TROUBLES.

F. A. Warfield—The Electric Journal.

IN the following abstract of a paper by Mr. F. A. Warfield on the care and maintenance of storage batteries, published in *The Electric Journal* for August, will be found an interesting and valuable supplement to Mr. Percival Robert Moses' articles in THE ENGINEERING MAGAZINE for September and in the present number. Mr. Moses deals with the construction and application of storage batteries and their auxiliaries; Mr. Warfield with the proper methods of charging and discharging, the conditions necessary for most efficient operation, and the causes of, and remedies for, the more important and common battery troubles.

"Batteries should ordinarily be charged at the normal, or eight-hour rate, which in all cases is specified in the contract under which the batteries are sold. The voltage required to start the charge is about 2.15 volts per cell. If this voltage does not give the required ammeter reading, adjustments should be made by means of rheostats installed for the purpose. When charging a fully discharged battery, the writer has usually obtained best results by using a variable rate of charge, and the following method is suggested: Start charging at fifteen per cent. above the normal rate, maintaining this rate until the voltage reaches approximately 2.5 volts per cell. At this point the current should be reduced to the normal rate and the charge continued until the voltage stops rising.

"The general behavior of a battery on charge is as follows:—When the charging current is first applied the voltage of the battery rises immediately to about 2.15 volts per cell. During the first hour of the charge the voltage rises rapidly until it reaches about 2.25 volts per cell. As the charge progresses, a very gradual rise is observed, until at about 2.45 volts per cell, a sudden jump is taken to nearly the maximum value, at which point the voltage remains practically constant, with both positive and negative plates giving off gas freely while the solution is perfectly clear. The evolution of gas usually begins at about 2.3 volts per cell, the bubbles gradually increasing in size as the cell becomes fully charged. Under ordinary operating conditions a battery may be considered fully charged when the voltage reaches a constant value, but at least once a week this method of determining the state of charge should not be relied on.

"There are three ways of determining when a battery is fully charged:

1—By the voltage reaching a constant value.

2—By the color of the battery plates.

3—By the specific gravity reaching a maximum constant value.

"It is very important that the battery be fully charged, but it is just as important that it be not overcharged. In the same way that the voltage reaches a maximum constant value, so will the specific gravity of the electrolyte, and readings of the individual cells of the battery in use should always be taken at least once a week with a hydrometer. These readings will act as a check on the voltage and, while it is not necessary to take them every time the battery is charged, it is very important that it be done frequently.

"The time required for the charge is, of course, variable and will depend upon the condition of the battery when the charge is started. In general, it may be assumed that about 20 per cent. more charge is required than discharge obtained. At least once in every two weeks the battery should be given an overcharge. To do this, charge the battery at the normal rate until the voltage reaches a constant value. At this point drop the charging current to about one-half the normal rate and continue to charge for three or four hours. While doing this it will be noticed that the specific gravity of the electrolyte will continue to rise for an hour, or even longer, after the voltage has become practically steady. This overcharge should be continued until the specific gravity becomes stationary.

"If, in case of an emergency, it becomes necessary to charge more quickly than usual, the charge may be started at about twice the normal rate and continued until the battery commences to gas and the voltage reaches 2.6 volts per cell. At this point the electrolyte will have a milky appearance and the battery will be gassing very freely. The charge should then be lowered to about 1.5 times the normal rate and the charge continued until the voltage again rises to 2.6 volts per cell, when the charging current should again be lowered. This proportionate reduction should be made every time the voltage reaches 2.6 per cell until the normal rate is reached, when the charge can be continued to the end in the usual manner. Great care must be taken not to overcharge excessively at a high rate, as this causes rapid shedding of the active material. At least once a week is often enough for an overcharge, provided the battery is in constant use. If the battery is only used spasmodically, or is kept floating on the line for an emergency, it is a good plan to discharge the battery at least once every two weeks, and then overcharge.

"The temperature of the battery must never be allowed to exceed 100 degrees F., the cells near the middle of the battery being used as a guide. If the temperature is found to be rising too close to the limit, the charge should be lowered or stopped. Experience has shown that the best results, both when charging and discharging, are obtained when the temperature is between 70 and 90 degrees F. A considerably lower temperature will materially reduce the available capacity, this reduction being regained with the return to normal temperature. If the battery gives its full rated capacity at 70 degrees F., at 30 degrees it will give about 76 per cent. of its capacity, while at 90 degrees it will give about 112 per cent. Low temperature never injures a battery but, on the contrary, if the temperature be maintained for any length of time above the normal, the wear on the plates is excessive.

"The level of the surface of the electrolyte should be at least one inch above the top of the plates in the cell. When fully charged, the specific gravity of the acid in the majority of the lead batteries is from 1.200 to 1.225. Whenever a battery is given an overcharge, the specific gravity should be tested and adjusted. In making this adjustment, it should always be remembered that it is to be done towards the end of the charge and while the charging current is on. Should the specific gravity in some of the cells be lower than the majority, it is a better plan to charge these cells separately by cutting them clear from the battery and charging them separately at a low rate. When the cells are large and connected up permanently in series and it becomes necessary to charge a single cell to bring it up to condition, two wires may be run to the terminals of this cell from a separate source of current and the cell charged independently. If the gravity of a cell increases, it is a sign that this particular cell has, for some reason or other, been run down lower than its fellows and needs additional charging. If, however, the gravity does not come up and the temperature does not increase with charge, extra acid should be added. It is seldom necessary to add acid to a cell to bring up gravity (that is, gravity 30 or 40 degrees below normal). Never add acid until the cause of lowness is determined. With a battery in normal condition, the acid will usually be found to be high in gravity and water should be added to make up for the electrolyte lost by evaporation and gassing. This water should always be introduced into the cell at the bottom by a hose, or lead pipe, as the water will, if poured in, float on top and mix very slowly, since water is lighter than the acid."

The principal causes of trouble in a battery are loss of capacity, fracture and buckling of plates, sulphation of plates, reversal of cells, and impurities in the electrolyte. Loss of capacity is due to internal short circuits and the latter are usually caused by a bridging of the active material between adjacent plates or a filling of the bottom of the jar with sediment sufficient to reach the bottom of the plates. Their presence is indicated by the failure of the voltage to come up on charge, non-appearance of gas at the end of the charge, muddy solution, and a temperature above normal. Bridging between the plates can be removed readily by passing a strip of wood or glass between them. The removal of a deposit of sediment is more difficult. The best method is to separate the cells after the battery has been fully charged at a low rate, remove and wash thoroughly the elements, decant carefully the acid for use again, and flush the sediment out of the jars with pure water. In case the elements are too large to be removed readily, the sediment should be stirred up, the contents of the jars pumped out, and the jars then flushed with water. The sediment can be allowed to settle in another vessel and the acid decanted and used again. After cleaning, the battery should be charged for about 12 hours at normal rate until the voltage is at a maximum and then discharged to see that the voltage of all the cells is the same. Low cells should be charged separately until brought up to the voltage of the others.

Fracture and buckling are due to overdischarge, too rapid discharge, or defective plates. Shedding of the active material usually accompanies fracture and buckling. The remedies for the first two causes of this condition mentioned are obvious; for the third there is no remedy. Charging should seldom be done above 2.5 volts per cell and discharging never above 1.8 volts per cell.

Sulphation of plates, caused by overdischarge or excessive discharge rates, is usually indicated by a whitish appearance of the plates and a low specific gravity of the solution. The sulphate is gradually reduced by charging at about half the normal rate for from 40 to 90 hours, but several cycles of charge and discharge are necessary to bring the battery up to its full capacity. The battery plates should be carefully watched for sulphating and if they begin to turn lighter than normal, the sulphated cells should be given a good overcharge. Discharged cells should not stand idle for any length of time on account of their tendency to sulphating.

Reversal of a cell seldom happens except when a cell has lost some of its capacity through accident or defect and then only when discharge has been carried so low that it is completely discharged before the other cells of the battery. The remedy is to remove the cause of loss of capacity, which may be due to bridging of the active material or to sediment, and then charge the cell separately up to normal condition.

Impurities in the electrolyte are indicated by disintegration of the plates, low voltage and decreased capacity, and are usually due to the presence of iron or chlorine. The presence of these elements in the electrolyte can be detected by the ordinary chemical tests. Nothing but a thorough cleaning will remedy the trouble.

"If the battery is to be put out of commission for two or three months, it should not be allowed to stand in the electrolyte unless a small charge and discharge can be given at least once a week. It should be slowly charged until full, then discharged at the normal rate for two hours. After this the electrolyte should be drawn off and pure water immediately put in the tanks. Continue the discharge at about one-half the normal rate until the voltage reaches about 0.5 of a volt. To do this it will probably be necessary to short-circuit the individual cells. The plates should then be washed thoroughly by using a hose on each element, then soaked in running water for 24 hours and allowed to dry. When put in commission again, pour in the electrolyte and give a long over-charge."

BENZOL AS AN AUTOMOBILE FUEL.

RESULTS OF A LARGE NUMBER OF TESTS ON A PANHARD-LEVASSOR MOTOR.

A. Grebel—Société des Ingenieurs Civils de France.

THE utility of benzol as a fuel for automobiles has recently been made the subject of two papers by M. A. Grebel, the first a discussion of the relative merits of benzol and gasoline, published in *Le Génie Civil* for June 13, and the second a very comprehensive paper covering thoroughly the whole subject, read before the Société des Ingenieurs Civils de France and published in the *Mémoires* for May. The following notes are taken from these papers.

Almost all benzol is produced as a by-product in the manufacture of coke, the process of extraction from the waste gases consisting of dissolving the crude benzol in heavy oils and later recovering it from the solution by distillation. It is then rectified by the removal of carbon bisulphide, tar, naphtaline, and other impurities and a final purification is obtained by washing with acids, soda, and other reagents. If the benzol is intended for use in automobile motors, this purification must be very carefully performed. If it is improperly carried out tarry products are left which interfere with the proper working of the carbureter and give rise to obnoxious and corrosive fumes. About 5 kilograms of rectified benzol are recovered per ton of coal coked. In the present state of the industry, France, Germany, England and Belgium produce large quantities of benzol annually but the amount could be largely increased in all countries so that the present price of from 25 to 28 francs per hectolitre (about 20 cents per gallon) could be maintained even though the demand were to increase to very large proportions.

The comparative physical properties of benzol and gasoline are as follows:

	Benzol.	Gasoline.
Density	.885	.700
	Calories per kilogram.	
Calorific power	10,033	11,464
	Calories per litre.	
	8,879	8,025
	Degrees C.	
Freezing point	—6 to —8	—100
Quantities of fuel added to 1 litre of air at 0° C. and 760 mm. for theoretically complete combustion	Grams.	
	.09615	.08434
	Cubic centimetres.	
	.10864	.1205
Vapor tension at 20° C.	122	296
	Degrees C.	
Temperature of boiling	81	50

The close similarity between benzol and gasoline has been the cause of many disappointments and vexations. It has led to the belief that benzol could be simply substituted for gasoline without any difficulty, and it must be admitted that by accident certain motors have worked well for a time within certain narrow limits of speed. In cases where bad results have been obtained, however, they have been hastily and erroneously attributed to the fuel itself. Benzol indeed presents many points of similarity to gasoline but it is distinguished from it by various characteristics of which account must be taken in the design of carbureters, the regulation of ignition, etc.

The principal charge made against benzol is that it causes fouling, but the black smoke, the odor of burned gases and the fouling are due entirely to imperfect combustion. M. Grebel has made upwards of 200 tests on a Panhard-Levassor motor and has never encountered any fouling except when testing a benzol only 50 per cent. pure. It is an easy matter to prevent fouling because, in order that a deposit of soot may be formed, it is necessary that the proportion of benzol in the fuel should be raised to double that theoretically necessary for complete combustion. Many carbureters, however, make an explosive mixture imperfect to a degree that would be believed impossible without the striking evidence of analysis of the waste gases. The influence of the mixture on the efficiency of the benzol motor cannot be too strongly emphasized. Even when the exhaust gases are colorless and odorless and the motor seems to be working perfectly, the combustion and consequently the efficiency may be relatively poor.

M. Grebel's investigations have shown that the minimum specific consumption corresponds to a percentage of carbon dioxide in the exhaust gases of 14 in the case of gasoline, and 17 in the case of benzol, without excess of oxygen and without carbon monoxide. These are the highest percentages attainable in practice, though the theoretical percentages for complete combustion are 14.4 and 17.4 respectively.

The maximum of power is found at about the point of maximum explosibility which corresponds to the highest explosive pressure. This is given by a mixture slightly richer in benzol than the mixture for theoretically complete combustion. With the mixture giving maximum power, about 1½ per cent. of carbon monoxide is found in the burned gases.

In M. Grebel's tests the minimum of consumption has always been found to be attained when the air actually introduced bears to the air theoretically necessary the proportion of 1 to 1.1. This differs considerably from the proportion of 1.3 to 1.7 recommended some years ago by Sorel and adhered to by many builders through fear of a shortage of air under certain conditions.

A NEW METHOD OF TESTING HARDNESS.

A DISCUSSION OF THE THEORY AND APPLICATIONS OF THE SHORE SCLEROSCOPE.

J. F. Springer—The Iron Age.

UNTIL recently the only available means of measuring the hardness of metals with any degree of accuracy have been the Brinell ball test and determination of the magnetic capacity. A method has now been developed which measures hardness by determining the recuperative power of a metal subjected to an instantaneous blow which strains it beyond the elastic limit. The instrument used and the theory on which it is based are discussed by Mr. J. F. Springer in *The Iron Age* for August 27, from which we take the following extracts.

"The question what is to be understood by hardness is by no means an easy one. We say that brass is hard and lead is soft. The file gives us reliable information as to this. But when we turn to manganese self-hardening steel and pure carbon tool steel, we may find that a specimen of the alloy steel offers the same resistance to the file as the pure carbon steel, but that the alloy is really softer. Some other quality of the alloy steel is furnishing resistance to the file in addition to hardness. This appears to be the toughness. It would seem that particles of the alloy yield somewhat to the file at first, but resist actual separation, producing a total resistance to the file equal to that afforded by the pure steel. It appears thus as if time were a factor, the particles of the alloy suffering a slight displacement which occupies time, but in the end resisting determinedly any further displacement. This is the case also with tar asphaltum. A sharp, quick blow will shatter a block instantly into fragments, whereas it will yield under the mere weight of the hammer if time be allowed. Sealing wax also is comparatively hard for instantaneous impacts of tools, but soft for slow ones.

"Let us provisionally define hardness, then, as the resistance set up to instantaneous displacements. If displacements can be effected with an instantaneous effort which would fail if slowly operating, it would appear in the latter case that a second quality is assisting, namely, toughness. Perhaps we may say that the degree of hardness varies with the recuperative power of a substance subjected to instantaneous and permanent deformation.

"About a century ago a method of testing for hardness by means of the diamond was proposed in Germany. This process of scratching with a diamond point was improved in England and proved of value, especially, it would seem, where toughness did not enter. With tough substances, however, the diamond, like the file, seems to have failed. A more modern method is that developed under the name of the Brinell test. This consists essentially in pressing a steel ball into the specimen and then measuring the depth or diameter of the permanent displacement effected. This is, no doubt, a practical improvement over the file and the diamond point. The deeper the depression, other things being kept equal, the softer the metal is judged to be. As the pressure is applied slowly, it would seem doubtful, however, that this process would be successful in eliminating the element of toughness.

"Recently an invention by Albert F. Shore has been put upon the market. If the provisional definitions heretofore given be accepted, this new instrument would seem to supply the means of effecting accurate and scientifically correct measurements of hardness, for with it an instantaneous blow is struck, and the recuperative power of the specimen is then measured by determining the extent of the rebound of the striking hammer, the elastic limit of the metal being tested having been exceeded."

The instrument consists essentially of a glass tube, open at the bottom, on the back of which is a graduated scale running from 0 to 140. The tube serves to guide the falling hammer which is the most important element of the instrument. The hammer is sucked up to the top of the tube by compressing a rubber bulb and a suitable device is provided for holding it there until it is desired to strike the blow. Release is obtained by pressing another rubber bulb. The hammer, a small piece of steel fitting smoothly in the bore of the tube, falls perfectly freely. On striking the specimen under test it rebounds, and the amount of the rebound as read upon the scale is considered a numerical statement of the degree of hardness. The body of the hammer is cylindrical but the striking end tapers to a sharp point. The blow compared with the area of impact is very large, being calculated to be no less than 75,000 pounds per square inch. Tests are always made, of course, with the hammer falling vertically in the tube, and levelling screws and plumb rods are provided for the purposes of adjustment.

"Now, if the definition of hardness as the recuperative energy instantaneously available upon permanent deformation be correct, then the scleroscope would appear to afford a reliable measure. For if the recuperative energy is nil the rebound is zero and is so indicated on the scale. If the recuperative energy in one case is double that in another, then the amount of work accomplished in the former case will be double that in the latter. But a rebound through double the space means double the work accomplished. So that when the scleroscope records a rebound of 90 graduations in one case and 45 in another, these indicate recuperative energies in the same ratio of 2 to 1. Now this seems to contrast with the Brinell indentations. For even granting that the latter vary inversely with the hardness, it can scarcely be contended that an indentation of double the concave area means double the hardness. In fact, much more than double the energy is required to produce double the area. Where is the guarantee that the rate is proportional to the decrease in hardness?"

The instrument is applicable to any and all metals. Among other important applications, it offers an easy and convenient means of determining the relative hardness of machine parts in frictional contact, and also of determining variations in hardness at different points of the surface of a specimen. It may also be applied to testing hardened steels for crystalline structure and from the results already obtained it is expected that by its use metal cutting will be put on a much more scientific basis. A further use is for testing and inspecting product before shipment. Comparative tests by the Brinell and scleroscope methods show fairly close agreement in results.

THE JAPANESE MERCHANT MARINE.

A STATISTICAL REVIEW OF THE DEVELOPMENT OF SHIPOWNING IN JAPAN.

Engineering.

WITHIN the last few months a statement by no less an authority than Mr. James J. Hill, to the effect that the American and Canadian steamship lines engaged in the Pacific carrying trade are being gradually driven out of business owing to their inability to meet the competition of the Japanese subsidized lines, has drawn attention to the remarkable development of Japan's mercantile marine. The rapidity of this development is well shown in a statistical review in *Engineering* for August 14, from which we take the following notes. In a future issue we shall present an abstract of a similar review of the development of the shipbuilding industry, which *Enginering* promises in the article here abstracted.

"Shipowning in Japan, on a scale comparable with the shipping work of Western lands, is necessarily a matter of very modern development. Whatever the country may have done or attempted to do in its earlier history, the year 1639 marked a complete cessation of foreign trade; the size of home-built ships was, about that time, limited by law in order to prevent them from venturing too far from their own shores; and amongst the other countries of the world, China, Korea, and Holland were alone permitted to trade with Japan by sending their ships to Japanese ports. The prohibition of foreign trade thus enacted extended over a period of fully 220 years; the reopening of the country in 1853 necessitated an entire change of policy, which, keenly desired, was not so readily effected; the need, however, was emphatically declared by the Shogun's Government in 1861, when permission was first given for the engagement of Japanese ships in foreign trade. This permission was so far taken advantage of that, in 1868, just after the commencement in 1867 of the present era of Meiji, there existed forty-six merchant vessels, of 17,000 tons, and of 'foreign' construction; some of these vessels were steamers, the others sailing vessels; some were built in Japan, and the rest purchased from abroad.

"In the early days of Meiji an intimation was repeatedly made by the Government that such 'foreign' vessels were allowed, and that protection would be afforded by the Government to Japanese shipping enterprises with foreign countries. In 1870 the first large steamship company was established, under the name of the Kwaiso Kwaisha (the

Transport Company); this company, under Government auspices, underwent various changes, its name in time becoming Nihonkoku Yubin Jokisen Kwaisha (Japan Mail Steamship Company). In 1871 a rival company appeared on the scene, organised by the late Baron Yataro Iwasaki, under the name of Mitsu Bishi Kwaisha (Three Diamonds Company, so called from the crest and flag adopted by the new organisation). This company did such excellent work for the Government during the military expedition to Formosa in 1873-4 that it was deemed advisable by the authorities to lean largely upon it for support, wind up the affairs of the officially directed company, and close the keen competition that had sprung up between the two; the ships of the Nihonkoku Yubin Jokisen Kwaisha were, therefore, in 1876, transferred to the Mitsu Bishi Kwaisha, and the latter company strengthened in other ways. The combined fleet of this company then consisted of forty-two ships, six of them sailing vessels, and the remainder steamers of various sizes, twelve exceeding 1000 in gross tonnage. In 1882 the company further strengthened itself and added steamers capable of performing the functions of both transports and cruisers, a stipulation being made by the Government, in return for privileges conceded, that it was to have the use of the ships, in case of need, on the payment of some 5 yen* per ton per month. In 1882 the gross tonnage owned by the Mitsu Bishi Kwaisha was 22,000. In the same year, with the object of increasing the mercantile marine, Government support was afforded to a new company, the Kyodo Unyu Kwaisha (Union Transportation Company), so that two companies, rivals along certain lines, were again in the field, both obtaining assistance from the State funds. This lasted until 1885, when an amalgamation was made, and the now powerful Nippon Yusen Kabushiki Kwaisha (Japan Mail Steamship Company) formed by the combination of the two.

"To the newly-formed Nippon Yusen Company a dividend of 8 per cent. was guaranteed by the State; but this was commuted, in 1887, to an annual subsidy of 800,000 yen. In the years previous to the war with China this enterprising company made steady progress, doing most of the coastwise trade, and also the trade with the nearer foreign ports; in 1892 it established a line to Bombay, and performed, moreover, frequent service to Australia in the one direction, and to Hawaii in the other. In the Chinese war of 1894 the large steamers of the company were all requisitioned by the Government, and many more were purchased by the company both for Government needs and to maintain its own trade; the services were very efficiently rendered and the company became correspondingly stronger. On the conclusion of the war, and encouraged by the new bounties, to which reference will be made in a subsequent article, the Nippon Yusen Kaisha resolved on a large expansion of its work and influence; it raised its capital to 22,000,000 yen, and established regular services to America, Europe, and Australia, in addition to the existing line to Bombay. Large steamers, twelve of them exceeding 6000 tons, were ordered, mostly from the Clyde, though with the reserve of a sufficient number for Japanese construction to develop and advance the art of shipbuilding at home. Since that date the company has frequently added to its fleet, its new ships being, in recent years, all built at home—*i. e.*, in Japan—although these have been supplemented by the ships purchased during the war with Russia and the captured ships taken over from the Government after the termination of the war. Among those recently built in Japan, the Hitachi Maru (second of the name), 6715 gross tons, for the European service; the Nikko Maru, 5539 tons, for the Australian service; the Tango Maru, 7463 tons, for the American service; and the six ships of the Kamo class, each of 8770 tons, now completing, and to be employed as general traders, may be specially mentioned."

When the latter are completed, the company's fleet will consist of 85 vessels of a total tonnage of 313,627. The

* Yen = 2s. 0.582d., or 49.8 cents.

capital of the company is 22 million yen.

"In 1884 the Osaka Shosen Kabushiki Kwaisha (Osaka Mercantile Steamship Company) was established, and received from the first some measure of Government support. Many coasting services have been, and are, performed by this company, whose operations are extended also to Formosa and the costal trade of that island, to Korea and to Hong Kong, and to various Chinese ports." The capitalization is 16½ million yen. The company now owns 107 vessels of a total tonnage of 107,013, but it "is on the eve of development in the direction of the establishment of a regular freight service with America, for which purpose six steamers (each of 6000 gross tons) are at present under construction in Japanese shipyards.

"The Toyo Kisen Kabushiki Kwaisha (Oriental Steamship Company) was established in 1896. Its first three steamers were built in England, and created a Japanese service with San Francisco, making occasional runs to Mexico and other ports." It now owns 8 vessels of 53,065 gross tonnage. Recent developments have necessitated an increase of capital to 13 million yen. "The two great strides this company is making at the present time are, on the one hand, the construction of the Tenyo Maru (now running), the Chiyo Maru, and another steamer, all of 13,500 gross tons, and furnished with Parsons turbines, to give a speed of 19 knots; and, on the other hand, the use of oil fuel, both in the large vessels just mentioned, and in the other branches of the company's work. In this connection, the company has recently purchased three tank steamers of Tyne build, and is building two more (of 9320 gross tons each) at Nagasaki. The three turbine steamers are for the Hong Kong, Yokohama, and San Francisco run.

"The three large companies thus far referred to have a certain importance from another circumstance not yet mentioned—viz., that they receive each year definite subsidies for prescribed services which they undertake. Until last year there were three other small companies doing regular services round the coasts of Japan, to, from, and in China, and to and from Korea, which were the beneficiaries of similar subsidies. These companies were the Konan Kisen K. K., the Daito Kisen K. K,. and the Oya Shosen Goshi Kwaisha. Last year the two former of these companies passed into a new combination, together with some vessels hitherto belonging to the Osaka Shosen K. K. and the Nippon Yusen Kwaisha.

"This new company is styled the Nisshin Kisen K. K., and possesses fourteen steamers in all, with an aggregate gross tonnage of 29,347 tons. The Oya Shosen K. K. has five steamers, of 8415 tons. The other most important shipowners of the country, whether companies or individuals, are the following:

Mitsu Bishi Goshi Kwaisha, with 13 steamers, of 13,292 aggregate gross tons.

Mitsui Bussan Gomei Kwaisha, with 29 steamers, of 28,627 aggregate gross tons.

Ojiro Goshi Kwaisha, with 5 steamers, of 12,498 aggregate gross tons.

Tatsuura Shokwai, with 9 steamers, of 17,289 gross tons.

Ukon Gonyemon, with 7 steamers, of 16,108 gross tons.

Oaki Kikusaburo, with 14 steamers, of 22,257 gross tons.

Hiromi Nisaburo, with 10 steamers, of 24,545 gross tons.

"A summary of the total registered and unregistered ships and tonnage of the country built in 'foreign' style, as held at various dates, is as follows:—

	Steamers.		Sailing Vessels.		Steamers and Sailing Vessels.	
Date.	No.	Net Tons.	No.	Net Tons.	No.	Net Tons.
1868	....	....	....	......	46	17,000
1875	149	42,304	44	8,834	193	51,138
1880	210	41,215	329	48,094	539	89,309
1885	461	59,613	509	52,643	970	112,256
1890	586	93,812	865	51,880	1451	145,692
		Gross Tons.		Gross Tons.		Gross Tons.
1895	827	341,369	702	44,794	1529	386,163
1900	1329	543,365	3850	320,572	5179	763,937
1905	1988	939,749	4132	336,571	6120	1,276,320
1906	2051	1,041,311	4497	353,434	6578	1,394,745

Excluding all vessels below 100 tons, the figures for some years past become:—

	Steamers.		Sailing Vessels.		Steamers and Sailing Vessels.	
Date.	No.	Gross Tons.	No.	Gross Tons.	No.	Gross Tons.
1890	112	26,815	81	19,853	193	46,658
1895	274	194,234	71	19,095	345	213,329
1900	510	516,292	1108	154,663	1618	661,955
1905	740	901,225	1219	168,338	1959	1,069,563
1906	799	993,302	1255	172,279	2054	1,165,581
1907	848	1,066,432	1296	178,112	2144	1,244,544

This list neglects junks, of which there were in 1906 21,920, of a gross tonnage of 261,000.

THE RUSSIAN PLATINUM INDUSTRY.

A PROPOSAL TO MAKE THE RUSSIAN PLATINUM INDUSTRY A NATIONAL MONOPOLY UNDER THE DIRECTION OF THE IMPERIAL BANK.

The Mining Journal.

THE issue of *The Mining Journal* for July 25 contains an abstract translation of a report recently submitted to the Russian Minister of Finance, in which the nationalization of the platinum industry is strongly advocated by Mr. P. M. Utyakoff, one of the Ural producers. Russia, as is well known, produces 95 per cent. of the world's supply of platinum and it might be expected that the platinum industry would be ruled from that country. On the contrary, however, the Russian business is almost wholly in the hands of foreign capitalists and this works to the disadvantage of the native producers in a variety of ways. Notwithstanding the facts that no satisfactory substitute has been found for platinum, that its use is increasing annually, and that no deposits have been found to compete with the Ural fields which are rapidly becoming exhausted, the price of the metal is subject to very wide fluctuations, due not to variations in the demand but entirely to speculation in foreign markets. The producers, under these conditions, are unable properly to organize their production, to institute a detailed system of prospecting, to install and organize proper extraction and manufacturing plants, or intelligently and economically to take advantage of the ground of the Urals. The platinum treating industry is similarly affected by the unsettled conditions. The three small treating plants in Russia manufacture only 7 per cent. of the world's supply of refined platinum, not enough for the needs of the country. Hence the agitation for a Government monopoly along the lines outlined below.

"Platinum ore, as is known, besides its platinum content, contains associated precious metals such as osmium, iridium, rhodium, rutinium, and palladium; on the average, there is about 3 per cent. of these metals in the ore. At the present time these metals are exported for nothing. The crude platinum is sold per percentage of content of pure platinum metal, without taking into account the associated precious metals contained in it. Although the quantity of metallic associates of platinum (which are worth even more than the platinum itself) is not great, nevertheless, if we take into account that the Russian refining factories work up now no more than 10 poods of platinum, and that the country produces 400 poods in the year, one can grasp the loss that the national platinum industry suffers in this respect alone. Besides this, the difference between the price of the crude platinum and the manufactures therefrom is very great, and is entirely lost to the country. It is gained by the foreigner.

"Resulting from the foregoing, the author suggests the measures to be taken as follows: the Government, through the Imperial Bank, should buy the platinum at a minimum established price, but not below a level that would pay for working poor deposits. With modern technical and economic conditions the price, according to the estimate of Mr. Utyakoff, could be fixed at 29,000 roubles per 100 per cent. metallic platinum. Direct sales abroad should be prohibited, and all the platinum produced in Russia, both refined and crude, should be accepted by the Imperial Bank. By taking delivery of the crude platinum only the quantity of pure platinum content of the ore could be calculated, without reference to the associated precious metals. The bank would sell the metal in a refined form with the object of keeping the associated precious metals in the country. Every half-year auctions would be held at the prices existing in 1906—namely, 42,000 roubles per pood of refined metal. Half or the difference between the purchase and sale price would go to the bank and the other half to the industry. In this way the bank would make not less than 2,500,000 roubles from the annual production of platinum. By fixing the price and not letting it go under 42,000 roubles per pood, the desired level would be reached. It may be urged that the foreign platinum syndicate, possessing reserves, would not abdicate its position without a struggle, and would put its platinum on the market in such quantities and at such prices that the platinum belonging to the bank would be unsaleable. That is a groundless fear. The stocks of metal held by the foreigners cannot be great, and in the course of the first half-year they might put 200 poods on the market in order to obviate a platinum famine. Being convinced that the bank was determined to continue the purchase and sale of platinum, the syndicate would not continue to sell at a low price goods that it could not replace. It would not be difficult for the bank to regulate the price of platinum by limiting the deliveries. The amount of working capital would hardly exceed the annual production of platinum—*i. e.*, about 10,000,000 roubles. The cost would be insignificant in comparison with the profits which it yields.

"If the monopolization of the platinum industry were recognised as impracticable on the basis named, the author still thinks that the Government could get the benefit of the industry bv undertaking the regulation of the price of the metal, which could be easily done as follows: During a fall in price, let us suppose under eight roubles per solotnik, the bank would accept platinum at the current price, and hold it in stock, and when the price reaches eight roubles it could cease buying and put what it has on the market. A price limit could be fixed every year conformably with the state of the market, and the difference between the buying and the selling price the bank would (just as in the case of the actual monopoly supposed above) divide between the Treasury and the industry.

"As to refining the metal, that presents no technical difficulties, even on a large scale. But for this, in any case, there is no need to build Treasury refineries, as some have suggested. The existing refineries in Russia can deal with it quite easily, not only as to the production, refining, separation of the associated precious metals, but also in respect to the manufacture of all kinds of platinum goods."

THE DIRECT PRODUCTION OF COPPER TUBES, SHEETS AND WIRE.

AN OUTLINE OF THE CENTRIFUGAL PROCESS FOR DIRECT ELECTRO-DEPOSITION FROM IMPURE COPPER.

Sherard O. Cowper-Cowles—Institution of Mechanical Engineers.

SINCE Elkington applied Faraday's law of electrolysis to the refining of copper in 1865, electro-metallurgists have been striving to devise a satisfactory commercial process which would do away with the smelting and mechanical treatment of copper after electrolytic refining and permit the direct production, by electro-deposition from impure copper, of sheets, tubes and wire having the physical properties of wrought copper. It was early discovered that the current density, or the rate at which copper is deposited, could be increased by circulating the electrolyte, or by moving the electrodes. In 1875 Wilde patented a process, based on this discovery, for depositing copper on iron rolls for textile printing purposes, in which an even deposit of copper was obtained by rotating the cathode, an iron cylinder, in the electrolyte which was itself agitated by means of a propeller. He failed, however to obtain a higher current density than 20 amperes per square foot. Later Elmore developed a process which consists of depositing sheets or tubes on horizontal mandrels, while agate burnishers travel continuously over the copper to consolidate it. Large works near Leeds, England, are engaged in the production of large tubes and cylinders by this process, but the current density cannot be increased beyond 30 amperes per square foot and the mechanical difficulties introduced by the burnishers are considerable. For the agate burnishers in the Elmore process, Dumoulin substituted sheepskin, and it was claimed that a current density of 40 amperes per square foot could be obtained, but the process was not commercially successful. Other processes, proposed by Swan, Elmore and others, have attempted to increase the rate of deposit by impinging jets of the electrolyte against the cathode surface, but with little success. The latest development, the centrifugal process, invented some four years ago by Mr. Sherard O. Cowper-Coles differs in many respects from its predecessors and, according to a paper read by the inventor at the July meeting of the Institution of Mechanical Engineers, has proved much more successful than any of them. We present below an outline of the methods and results of the process as given in this paper.

"The author, when carrying out some experiments on the production of copper tubes and sheets by electro-deposition on rotating cathodes, observed that when the speed was greatly increased entirely new results were obtained, and that a current density of 200 amperes or more per square foot could be employed, the copper remaining smooth and having a tensile strength equal to the best rolled or drawn copper, and in some cases a tensile strength some 50 per cent. higher than that obtained by the ordinary process of casting and rolling, the tensile strength increasing with the rate of rotation of the mandrel. The result of revolving a mandrel at a comparatively high speed is that every molecule, as it is deposited, is burnished or rubbed down so as to produce a tough fibrous copper, the usual order of things being reversed, the present practice being to put the mechanical work into a mass of copper by rolling or drawing instead of treating each molecule separately. This observation led to further experiments, which resulted in evolving the process now known as the centrifugal copper process for the manufacture of sheets, tubes, and wire.

"After a long series of experiments had been made to determine the best composition for the electrolyte and the most economical current density to employ, the critical speed was accurately determined by means of revolving cathodes in the form of cones. By observing the point at which the copper remains smooth, and by measuring the circumference of the cone at that point and multiplying it by the number of rotations per minute, the critical speed is readily determined; 200 amperes per square foot is found to be the most economical current density, although a current density up to 500 amperes per square foot can be employed by increasing the rate of rotation, but the increased cost due to increased voltage renders such a current impracticable for ordinary commercial work.

"One of the chief difficulties inherent in any electrolytic or wet process for the production of copper tubes and sheets is having any working parts, such as bearings, in an acid copper sulphate solution, and this was one of the first troubles encountered when working the centrifugal process on a commercial scale. This difficulty was eventually overcome by constructing vats in the form of an annular ring. By such an arrangement all working parts are outside the vat and do not come into contact with the electrolyte, so that the bearings can be lubricated in the ordinary way; only the actual face of the mandrel on which the copper is to be deposited is immersed in the electrolyte. The cathode consists of a steel or cast-iron cylinder closed at one end, to which is attached on the inside a steel rod projecting below the edge of the mandrel to guide it into position; the cylinder can be 5 or 6 feet in diameter or even larger so as to produce a copper sheet of say 20 feet long by 4 or 5 feet broad. Anodes composed of crude copper are placed around the mandrel with intervening spaces and are fed forward by suitable mechanical means as the copper dissolves away so as to keep the voltage constant.

"One great advantage of the centrifugal process is that a very low voltage is required even when employing a very high current density; for instance, only 0.8 of a volt is required at the terminals of the vat when working at a current density of 200 amperes per square foot of cathode surface. The effect of revolving the cathode is five-fold; firstly, it keeps the electrolyte agitated, so that there is always a fresh supply of copper ions in proximity to the cathode; secondly, each molecule of copper as it is deposited on the cathode is burnished or rubbed down by means of the skin friction between the revolving cathode and the electrolyte; thirdly, the rotation prevents any foreign matter that may be in suspension in the electrolyte settling on the cathode and becoming entangled by further copper being deposited around or over it; fourthly, it brushes away any air bubbles on the cathode, which are the cause of nodules forming; and fifthly, the rotation of the cathode ensures the thickness of the copper being uniform even when a mandrel of say 8 feet in length is employed.

"The method of making tubes by the centrifugal process is as follows:—A mandrel somewhat smaller than the finished internal diameter of the tube is prepared by coating it with an adhesive coating of copper by first depositing copper upon the surface from an alkaline solution and then thickening it up in an acid solution, the surface being highly burnished and treated chemically to ensure the easy removal of the deposited tube. The mandrel thus prepared is then placed in a vat designed according to the diameter of the tube and its length. When the desired thickness has been obtained the mandrel is removed and placed in a horizontal or vertical lathe, and a round-faced roller run over the surface so as slightly to expand the deposited copper, which can then be readily drawn off.

"Copper sheets are prepared in a similar manner, the only difference being that the mandrels are of much larger diameter, and a narrow insulating strip is fitted down one side so that the sheet can be easily removed by inserting a tool under one of the edges of the deposited copper. It is no more costly by the centrifugal process to make thin sheets than thick ones; copper foil can be made in five minutes direct from crude copper.

"Copper tubes produced by this process without any drawing have given a maximum stress of 17 tons, and tubes after drawing have withstood a pressure of 3,000 pounds per square inch without showing any signs of distress. Sheets made without any rolling have given a maximum stress of 28 to 30 tons and more per square inch according to the peripheral speed at which the mandrels were revolved.

"The formation of copper trees and nodules was another difficulty that had to be overcome, but which has been reduced to a minimum in the centrifugal process, for the reason that impurities held in suspension in the electrolyte have no opportunity of settling on the cathode, and all gas bubbles are swept from the surface on which the copper is being deposited.

"The percentage of free acid employed in the centrifugal process is high, amounting to 12 or 13 per cent. The electrolyte, the usual composition of which is 12.5 per cent. of copper-sulphate and 13 per cent. of sulphuric acid at a temperature of 40 degrees C., is kept in the cupric state and the impurities in suspension separated by means of a centrifugal filter provided with arc lights and an atomizer for breaking the solution up into a fine spray. It has been found that by subjecting the solution to a strong light the impurities are more easily precipitated, and the solution is kept in the cupric state.

"The production of copper wire by electrolytic means is a more difficult problem than the production of copper tubes and sheets. . . . . A mandrel similar to that used for making copper sheets is employed, around which a spiral scratch is made, the pitch being determined by the size of wire required. The effect of the spiral scratch (which need only be very light but must be angular), is to cause the crystalline structure of the copper to form a cleavage plane. The copper divides exactly at the apex of the scratch, that is, the copper deposited in the scratch is equally divided and forms a small V-shaped fin on two sides of the copper strip. If the scratch is not angular, but rounded at the base, the copper will not divide, as the crystals are radial. After the desired thickness has been obtained, approximating the pitch of the spiral scratch, the mandrel is removed from the depositing cell and placed in a vertical position on a lathe, and the copper strip is unwound at an angle of about 45 degrees to the face of the mandrel. During the process of unwinding, the small fin or burr is removed by passing the wire through a suitable die and then through a wire-drawing machine provided with three or more draw-plates to reduce the strip to the desired diameter. By employing a mandrel of 6 or 7 feet in diameter, lengths of wire 4 or 5 miles long can be made in one operation.

"The advantages of an electrolytic process as compared to a smelting process are many, and the day is not far distant when copper will no doubt be leached direct from the ore and electrolyzed with insoluble anodes, to produce finished copper sheets and tubes in one operation direct from the ore without the intermediate process of smelting and refining.

"The centrifugal process is a step in this direction, as it is capable of depositing copper from its solutions by using insoluble anodes in the form of finished tubes or sheets in one operation. The centrifugal process is at least ten times faster than any existing electrolytic process, and a high current density can be employed without deteriorating the quality of the copper. There is no risk of lamination, as no burnishers are employed. The plant is simple and free from mechanical complications, and the amount of copper locked up for a given output is small compared to other processes. The process is of interest to mechanical engineers as it conclusively proves that to get a high tensile strength in metals combined with ductility, it is not essential to put a large amount of work into the metals as hitherto has been considered necessary, by the processes of swaging, rolling, or drawing, but that a very small amount of energy will suffice when applied in the manner described."

With blister copper at £65 per ton, a ton of copper sheets can be produced by the centrifugal process at a total cost of £70, as against £72 10s. by the ordinary process of refining, casting and rolling. At the same price for blister copper, wire can be produced at a total cost of £70 per ton, as against £77 by the ordinary methods. The copper produced is ordinarily about 99.976 per cent. pure. A plant to produce 10,000 tons of sheets, tubes and wire per year, is estimated to cost £104,000, and it is estimated that in such an installation, finished material could be produced at £2 16s. 6d. per ton.

THE EFFECT OF HUMIDITY ON MINE EXPLOSIONS.

THE INFLUENCE OF THE HYGROMETRIC CONDITION OF THE AIR CURRENTS ON THE FORMATION AND IGNITION OF DUST AND GAS.

Carl Scholz—American Institute of Mining Engineers.

In recent numbers of The Engineering Magazine we have reviewed in these columns three papers on the important subject of the causes and prevention of colliery explosions, dealing, respectively, with their relation to seismic disturbances, the effects of dust, and the dangers attending the use of explosives. We present in abstract below another highly interesting contribution to this discussion, from a paper to be read by Mr. Carl Scholz at the Autumn meeting of the American Institute of Mining Engineers in progress as this issue appears, and published in the *Bulletin* for July. From observations extending over several years Mr. Scholz has been led to believe that altitude and climatic conditions exert a much more important influence on mine explosions than is generally supposed. In his paper he outlines the data on which his theory is based and suggests practical means of minimizing by artificial means the dangerous conditions caused by lack of moisture in the air.

"The striking features developed by these investigations are:

1. Explosions occur more frequently in the colder months of the year; the colder the winter the more frequent the explosions. If a certain district has extremely cold weather and other sections of the country are comparatively warm, the latter sections are freer from explosions.

2. Mining fields located in higher altitudes are more productive of explosions than those at lower elevations.

3. The hygrometric condition of the atmosphere has the greatest effect upon the cause of explosions. . . . . .

"The mines of Oklahoma offer special facilities for the observation of the effect of climatic and hygrometric conditions upon explosions, because the coal is high in hydrocarbon and low in moisture; the outside temperature ranges from 90 degrees F. in the summer to 10 degrees F. in the winter, and the hygrometric condition has a wide range, because of the excessive rain in the summer, which is followed by a prolonged dry period in the fall and winter. The observations inside the mines are facilitated by the noticeable effect which humidity has upon the roof during the wet season and the number of explosions which usually occur during the cold, dry season. I therefore selected the mines in this field for a series of observations which were carried on during the past 18 months.

"The first purpose of these investigations was to stop the slacking of the roof, which occurs during the 'sweaty' season, beginning about May 1 and lasting until the middle of July. During this period a heavy deposit of moisture on the roof causes the slate to slack, especially on the in-take air-ways and near the place of in-take. On account of the high cost of timber, this condition considerably increases the production-cost. From August to November the mines became very dry, and are very dusty for the next three or four months, during which time explosions occur. One fortunate condition in this field is the fact that the veins are pitching, and the water usually runs along the entries, although the beneficial effect of this condition is not generally understood or appreciated.

"Observations indicate that when the outside temperature ranges from 75 degrees to 90 degrees F., the inside temperature fluctuates from 72 degrees to 76 degrees F. In the winter, when the outside temperature ranges from 30 degrees to 55 degrees F., the inside temperature ranges from 60 degrees to 64 degrees F. In the summer, when the warm-air current enters the mine, the temperature falls upon coming in contact with the cold ribs along the entries, and the excess vapor is deposited as sweat on the roof and the roadways, so that no dust exists. The mine, of course, becomes drier nearer the up-cast, since a part of the humidity is absorbed by the freshly-mined coal. In the winter, when the inside temperature is higher than that of the air outside, the cold ventilating current, upon warming and expanding, absorbs all the moisture available. If there is no water available, the relative humidity in the air-current is very low. For the purpose of illustrating this more clearly, the following data, representing actual readings, will be of interest:

"With an outside temperature of 80 degrees F. and relative humidity of 75 per cent., at a barometric pressure of 29.2 inches, a ventilating-current of 75,000 cubic feet per minute carries into the mine, invisibly suspended in the air, during a period of 24 hours, 15,200 gallons of water. Upon cooling to a temperature of 75 degrees F, not only would the mine-current be completely saturated, but there would be deposited in the mine nearly 1,000 gallons of water per day. In the winter, however, with a temperature of 32 degrees F. and a relative humidity of 95 per cent., upon entering the mine and warming to 62 degrees F., the relative humidity of the ventilating-current is diminished to 33 per cent., unless an opportunity is given for the air-current to absorb more moisture from running water or other sources. In order to saturate completely this warmed air-current of 75,000 cubic feet per minute, about 9,000 gallons of water per day is required. This is the reason why dust is generated in the winter in the better-ventilated mines, and the assumption is well borne out by the accident at the Monongah mines, which had a ventilating efficiency of the highest order. The more cold air forced through a mine in the winter, the drier will that mine become; the more air forced into a mine in the summer, the more moisture will be deposited along the in-take entries, and where the roof is slate, the more difficulty will be experienced in keeping up the top. It is also well known that humidity in the air has an effect upon the ignition of gases, because the fine particles of water invisibly suspended in the atmosphere absorb much of the heat in combustion. For comparison, it may be said that an air-current of a temperature of 62 degrees F., fully saturated with moisture, requires approximately 7 per cent. more heat-units (British thermal units) than dry air to reach a temperature of 1,213 degrees F., which is the point of ignition of fire-damp.

"A water-spraying system, consisting of a number of small sprays distributed over the first half of the distance which the air-current traverses, will have the effect of preventing the formation of dust and moistening the gaseous mixture. The sprays should be placed near the roof, and discharge the water in the direction of the air-current. This arrangement will have an additional beneficial effect in mines generating much fire-damp, the descending water-spray serving to break up any stratification of gases that may exist in the entries. The proper quantity of water to be vaporized will depend upon altitude, climatic conditions and character of the coal. The only danger to be guarded against is the use of an excessive amount of water, which would result in cutting a slate roof; if coal or sand-rock prevails, no limit need be established, because, with the lower temperature in the mines in this country, the danger which was pointed out by the British Colliery Commission, that excessive humidity injuriously affects the health of the miner, does not exist, the temperature of the English mines being from 90 to 95 degrees F. . . . . .

"The advantage of a spray is that the vapor will break up stratification and mix the gases over the entire cross-section of the entry. This action can be repeated as often as necessary by the spacing of the sprays, and the requirements can easily be determined by hygrometer-readings and gas-tests. There would be no advantage in or necessity of operating these sprays during the summer, unless indicated by hygrometer-readings in very dry mines. . . . . . The principal benefit derived from sprinkling water by means of water-boxes or hose-lines, as now generally practiced and recommended, is that moisture is provided for absorption by the dry mine-air. As far as the settling of dust is concerned, unless the sprinkling is very thorough and often repeated, the results are not satisfactory, because a deposit of coal-dust is impervious to water unless thoroughly mixed with it; a thin moist coat will form on the surface, beneath which the dust is as dry as ever. The cost of labor in this method of sprinkling is very high and the service performed is spasmodic, and unless constantly looked after by foremen or superintendents it is likely to be neglected. The advantage of a spraying-system is that, in addition to preventing the formation of dust, the sprays can be utilized to prevent stratification of gases at night or on idle days, and this advantage can be obtained at a cost of installation but little greater than that of the hose system, as it involves only the addition of spray-boxes at a cost of $2 each. There is no expense connected with this, because most mines employ pumpers on idle days and at nights, and the shaft pressure can be used in the sprays; or if this is not convenient, in most places some outside supply can be connected which will insure continuous operation. It is believed that the operation of such a spraying-system, by reason of the continuous and automatic protection which it furnishes to the mines, is the most economical, and at the same time the most important step which operators can take to safeguard their mines."

THE USE OF SUPERHEATED STEAM IN LOCOMOTIVES.

A DISCUSSION OF THE ECONOMIES AND ADVANTAGES SECURED BY THE USE OF HIGH DEGREES OF SUPERHEAT.

Dr. Wilhelm Schmidt—Railroad Age Gazette.

IN a series of three articles in the *Railroad Age Gazette* for July 17, 24 and 31, Dr. Wilhelm Schmidt discusses in a very simple and interesting manner the economies and advantages of the use of superheated steam in locomotives and the rules governing the design of an efficient and economical superheater. It may be noted that Dr. Schmidt was practically the pioneer in this field, and that a great many of the more important developments since a high degree of superheat was first tried in 1892 have been the result of his investigations. Below is given an outline of the more important points dealt with in his paper.

"Saturated steam of a given pressure has a certain known temperature. If heat be added to the steam while it is still in contact with water (for instance, in the boiler), more water will be evaporated, and the quantity of steam will be thus increased, but the saturation temperature remains the same as long as the pressure is kept constant. On the other hand, if heat be taken from it by cooling or by the performance of useful work during expansion, a part of the steam is condensed, and this part loses its capacity as a working fluid. This is the chief source of the losses due to cylinder condensation.

"If, however, heat be added to the steam when it is no longer in contact with water (*i. e.,* in the superheater), its temperature will be raised above that due to its pressure; in other words, it will be superheated. Such steam may be cooled in the cylinder by the same amount that it has been superheated in the boiler, without condensation taking place. It is, therefore, only necessary to superheat the steam sufficiently high, and all losses by condensation in the cylinder will be avoided. The volume per pound of steam at the given pressure increases with the temperature in a practically proportional ratio. The higher the degree of superheat, the more the steam adopts the properties of a proper gas, especially as regards low conductivity of heat.

"The volume in cubic feet of 1 pound of superheated steam is always greater than that of saturated steam of the same pressure. The higher the temperature to which steam is superheated, the larger is the volume of the steam which can be produced from each pound of water." In an ideal engine the water economy due to this increase in volume would be about 21 per cent., using steam at 170 pounds pressure superheated to 650 degrees F. Losses of heat in the cylinder, however, reduce the saving in practice to about 10 per cent. . . . .

"In the saturated steam locomotive the weight of the steam calculated from the indicator diagram is from 30 to 50 per cent. less than the weight of steam actually passed into the cylinders. The missing quantity is caused by losses due to cooling and leaking in the steam chests and cylinders." In ordinary saturated steam locomotives, condensation losses amount to over 30 per cent. Leakage losses in modern engines are not so considerable, rarely amounting to more than 10 per cent. of the losses due to cooling, and they are not increased, but rather decreased, by superheating. The condensation losses are entirely avoided by superheating, and the total water economy obtained by superheating steam at 170 pounds pressure to 650 degrees F. will be approximately 40 per cent., including the saving mentioned above as due to the increased volume.

In actual practice the water economy varies betwen 25 and 50 per cent. "This great variation in steam economy has its reasons in the different services and the varying cut-offs and speeds at which the engines are worked; on long continuous runs, where high degrees of superheat can be steadily maintained, the best results are secured. The more the superheater locomotive is forced, the higher is the degree of superheat obtained and the more economically the engine works. This is one of the principal differences between the superheated steam and the saturated steam locomotive; the more the latter is pressed, the wetter the steam becomes, and the greater, consequently, is the quantity of water carried over into the cylinders and the less economically the engine works."

"The economy in coal is generally smaller than the water economy, because a certain coal expenditure is required to superheat the steam, or, to state the case differently, the calorific value of superheated steam is higher than that of saturated steam. . . . . The generation of 1 pound of superheated steam at 650 degrees F. consumes 12.2 per cent. more coal than the generation of 1 pound of dry saturated steam at the same pressure." If it is assumed that 5 per cent. of water is suspended in the steam, the superheating to 650 degrees requires 16.3 per cent. of the total heat required for the generation of 1 pound of wet steam. It was shown above that 60 pounds of steam superheated to 650 degrees F. will do the work of 100 pounds of saturated steam, but since the coal required to produce this degree of superheat is 16 per cent. more than that required to produce wet steam, the actual coal consumption in the case of superheated steam will be 70 per cent. of that required for saturated steam; the coal economy will therefore amount to only 30 per cent. "In practice such coal economy is not generally obtained, owing to the losses that occur during stoppages and while drifting, which are the same for both types of engines, and also on account of the varying demands made on the boiler and superheater, as these conditions influence the degree of superheat. But as a safe figure, obtained in comparative service of simple locomotives with and without the Schmidt superheater, 25 per cent. coal economy can be relied on as an average."

This saving in coal increases the boiler capacity 33 per cent.; in other words, for equal quantities of coal consumed in each engine, the superheater locomotive produces 33 per cent. more indicated horse power than the saturated steam locomotive. At the ordinary speeds of express trains only about 60 per cent. of the power of the locomotive is transmitted to the draw-bar; hence an increase of 33 per cent. in indicated horse power may represent at high speeds a gain in draw-bar horse power of 50 per cent. or more. "Superheating thus forms an efficient means for meeting in a very economical way the steadily increasing demands for more powerful locomotives, without having recourse to abnormally heavy and complicated engines. The application to new or existing locomotives of an efficient superheater, capable of producing and maintaining a high degree of superheat, is tantamount not merely to a considerable increase in boiler capacity, but also to a substantial augmentation in the haulage capacity of the engines."

The low thermal conductivity of superheated steam, a property of so much value in reducing condensation after the steam has reached the cylinders, is a great disadvantage in the production of superheat, as it impedes the free transmission of heat from the waste gases to the steam. In superheater design the great desiderata are to facilitate the transference of heat and to secure an efficient use of waste gases. The steam must be divided into as many streams as possible and it must be subjected to repeated reversals to secure thorough mixing of the moist and superheated particles. The gases must be kept in close contact with the superheater tubes and they must have a very high temperature (about 1,500 degrees F.). Ordinary waste gases can produce no material degree of superheat.

Greater efficiency is secured when the steam travels at a high velocity and this must be taken into account in superheater design. Further, it is essential to provide for the protection of the superheater parts against overheating, especially when the engine is standing or floating. Suitable dampers must be arranged for the purpose of shutting off the flow of the gases to the superheater under these conditions.

The firebox type of superheater is the most efficient, on account of the high temperature of the heating gases acting upon it. It is impracticable, however, because of the difficulty of providing protection for the apparatus against the high temperature. The boiler-barrel superheater is small in weight and simple but it has shown very serious defects in practice. Smoke-box superheaters, relying entirely on the heat of the waste gases, are practically useless. Special types of smoke-box superheaters employing double tubes have proved very efficient in practice, but on account of their high cost of construction and maintenance, they have been superseded by the smoke-tube apparatus. In this type, the superheating surface is disposed within enlarged smoke-tubes in the boiler. The superheating tubes are usually U-bent return tubes and four are usually arranged in each of the enlarged smoke-tubes. The smoke-tube superheater using circular return tubes is at present the most efficient and practicable superheater for locomotives. By the use of a properly proportioned smoke-tube superheater, the steaming capacity and efficiency of the boiler are materially increased, the increase in efficiency amounting in some cases to 65 per cent.

"The principal advantages of the compound arrangement in saturated steam locomotives lie in the fact that it allows the use of higher boiler pressures than in simple engines, and that it reduces the losses due to condensation in the cylinders. Both advantages are the less pronounced the higher the speed of the engine, and they practically disappear for very high speeds and early cut-offs.

"Superheated steam can be applied to compound locomotives in three different ways: by 'initially' superheating the high-pressure steam; by the use of a 'two-stage' superheater; or by the use of an 'intermediate' superheater. The first is the most advantageous form. Approximately 50 degrees F. less superheat than that required in the case of a simple engine is sufficient to avoid all losses by condensation in the compound locomotive. Compared with the highly superheated steam simple locomotive, a small saving in coal, and a somewhat increased boiler capacity can be maintained in the compound locomotive.

"It is still an open question, however, and it depends very largely on the service to be done, whether the above-mentioned advantages of superheated steam compound locomotives are not more than counterbalanced by the practical difficulties inherent to the compound working, especially as regards high boiler pressures and lack of adaptability of the engine. In the author's opinion, the express engine of the future will be of the four-cylinder simple type, using highly superheated steam, and working with a moderate boiler pressure."

THE VENTILATION OF THE NEW YORK SUBWAY.

A PLAN FOR SECURING PISTON VENTILATION BY THE CONSTRUCTION OF A CENTRE WALL.

Bion J. Arnold—Report to the Public Service Commission.

At the time of its construction, the New York subway was, in regard to magnitude of traffic, the largest work of its kind ever attempted, and, as is to be expected in all pioneer work, the importance of many problems was inadequately estimated by the designing engineers. One of the most important of these was that of ventilation. In the original design adequate provision was made to secure hygienic conditions in the subway, but not for taking care of the heating effect of the enormous train service. Several attempts have been made since the opening to improve conditions, but all have proved inadequate to the requirements. A suggestion is now made in a report by Mr. Bion J. Arnold to the Public Service Commission that a solution may lie in securing piston ventilation by building a wall between the express tracks. We give below the part of Mr. Arnold's report in which this proposal is discussed.

Except at very infrequent periods, the temperature of the subway air is at all times higher than that of the street air, a condition of advantage in the winter, but of decided inconvenience in the summer. Although the air carries a large amount of dust, it is practically as pure as the street air, and, in fact, carries fewer bacteria than the latter. The oily odors, while annoying, are not harmful, and the relative humidity is lower than that of the street air. The present arrangements for ventilation, installed in 1906, consist of grated openings at stations, 25 exhaust fans in conjunction with 14 ventilating chambers with automatic louvres, 17 roof ventilating openings with automatic louvres between Ninety-sixth Street and Fifty-ninth Street, and an experimental air-cooling plant at the Brooklyn Bridge station. It was estimated that these extra openings, louvres and fans would cause a change of air once every 10 minutes in the section below Fifty-ninth Street, and once every 33 minutes above. They have caused some improvement, but their effect in cooling the subway air has been much less than was expected. During the summer, only about one-fifth of the heat, produced in part by radiation from the passengers, but principally from electrical losses, friction, etc., in the motors and cars, is carried by the air through the openings to the street. The remainder tends to escape through the sides and bottom of the subway, but only in a few short sections are the walls capable of carrying off large quantities of heat.

Refrigeration, either by the rapid expansion of compressed air or by the evaporation of volatile liquids, would be an effective means of cooling the air, but the cost of the installations necessary to produce a cooling effect of more than a few degrees would be prohibitive. There are objectionable features also in plans for cooling the air by water, either by forcing the air by fans over pipes in which cool water is circulated by pumps, or by drawing the air through fine sprays of cool water.

"The automatic louvres connected with the 14 ventilating chambers bordering the subway between Fifty-ninth Street and City Hall are so constructed as to prevent any street air passing through them into the subway. They open upon sufficient air pressure being created by an approaching train and then only to allow the heated air to be discharged. This plan of operation was intended to draw the cooler street air into the subway at stations and to discharge the heated air from the subway through these louvred openings between stations. On account, however, of the conflicting air currents set up by the opposite train movements and the slow speed of the trains in approaching some of these louvres, there often results an absence of the necessary air pressure to open them. As a consequence these louvres are open only about 25 per cent. of the time. Mechanical devices should be arranged to keep these louvres open during the day and to allow them to operate at night so that the exhaust fans could be used to remove some of the heated air. This should be done. By this arrangement these openings would add an area for free passage of air equal to one-half the area of the present effective station openings, and would allow large quantities of the cooler street air to be drawn into the subway, thus making these openings much more effective than at present.

"The keeping of the louvres open and thereby producing 'cold spots' in the vicinity of the louvres would not noticeably change the present ventilating system, for the small quantities of air now passing through the louvres do not cause any noticeable influx of air at the stations to take the place of this discharged air. If, on the other hand, these louvres were blocked open there would be an appreciable effect of cooler air upon the passengers when passing these free openings, thus relieving the depressing effect due to the constant temperature now existing between the stations. Every effort should be made to get as many openings as practicable from the subway to the street surface wherever such openings can be protected from street traffic.

"The more often fresh, cool air is drawn into the subway and heated air discharged, the lower will be the temperature therein. The subway air averages about 6 degrees hotter during the summer than the street air, although there are some times during the summer when the subway is from 12 to 15 degrees hotter than the outside air. While there is a difference in temperature between the street air and the subway air, the openings along the route of the subway are practically on the same level as the roof of the subway, so that the quantity of heated air rising and replaced by the cooler entering air (an action similar to the ordinary fireplace ventilation in dwellings) is practically negligible. This air can be made to travel in the same direction as the trains by constructing a division wall between the tracks upon which trains travel in opposite directions. This division wall would enable each train to push out a large quantity of air as it approaches a free opening and to draw in considerable air as it passes the opening, thus producing what might be termed 'piston ventilation.' This system operating in the subway would make a change of air therein at least six times per hour during the day, instead of two times per hour as at present, thus noticeably increasing the present ventilation, as well as relieving, to a considerable extent, the heated conditions prevalent during the summer, making the subway more responsive to the outdoor temperature changes and decreasing the power necessary to overcome the air pressure which now exists against the front of the trains, due to the counter currents caused by the rapidly moving trains in opposite directions.

"Moreover, the present system of ventilation would be made much more effective. The openings at the stations which now have a slow, uncertain and changeable velocity of air passing through them, would pass greater quantities of air in long extended draughts, making the passengers feel the air movements. The 25 exhaust fans, which now can just about take care of the heat given off by the trains during the night operation, could remove some of the stored heat for which they are well adapted All of these increased operations would combine to draw cool air into the subway in quantities at least three times as great as at present.

"The continuous air movements which are obtained by trains running in tubes or where they travel in the same direction in one space can be shown to exist in the Brooklyn tubes of the subway under the East River; in the section between the Grand Central station and Thirty-third Street station; in the Hudson tunnel and sections under Sixth Avenue and in the London tubes. All tubes now being installed under the rivers to Manhattan Island will have this piston ventilation.

"To decrease the heated conditions of the subway and increase its ventilation, the following recommendations are made:

(1) Block the present louvres open during the day and allow them to operate at night when the fans are being run.

(2) Construct as many protected openings as practicable between the subway and the street.

(3) At the Fourteenth Street and Grand Central stations install large disk fans located in such a way as to draw air from the street through the kiosks and force this air in large volumes down upon and among the persons waiting for trains upon the platforms.

(4) Construct a solid continuous division wall between the downtown and uptown express tracks extending from the north end of Ninety-sixth Street station to and including Brooklyn Bridge station.

"For the purpose of demonstrating the feasibility of such a wall, it is suggested that the section extending south from the center wall now at Thirty-third Street station be constructed first far enough south as to include the Fourteenth Street station. At stations the upper half of the wall to have vertically sliding counterweighted windows between columns."

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Blackwell's Island.

Anchorages for Blackwell's Island Bridge Cantilever Spans. Illustrated detailed description. 2500 w. Eng Rec—Aug. 8, 1908. No. 94230.

Draw Bridges.

Swing Bridge at Littlehampton. Drawings and description of structure over the river Arun. 700 w. Engr, Lond—Aug. 14, 1908. No. 94481 A.

Manhattan.

The Suspended Falsework for the Manhattan Bridge. Illustrated description of the method of constructing the cables and the temporary construction footbridges. 2200 w. Eng Rec—Aug. 8, 1908. No. 94227.

Erecting the Construction Footways of the Manhattan Bridge. Illustrated description of the method of erecting these footways for the stringing of the cables. 800 w. Sci Am—Aug. 1, 1908. No. 94119.

Piers.

Cost of Piers of the Chattahoochee River Viaduct. John W. Ash. Describes the work and gives costs. Ills. 2000 w. Eng Rec—Aug. 29, 1908. No. 94689.

We supply copies of these articles. See page 159.

The Sinking of the Piers for the Grand Trunk Pacific Bridge at Fort William, Ontario, Canada. H. L. Wiley. Outlines the construction methods used in sinking the piers for the bridge crossing the Kaministiquia River. Ills. 2000 w. Pro Am Soc of Civ Engrs—Aug., 1908. No. 94670 E.

Quebec.

The Design of the Quebec Bridge: Report of C. C. Schneider, with Theodore Cooper's Specifications. Gives the specifications to govern the design and execution, and an abstract of C. C. Schneider's report. Also editorial. 5800 w. Eng News—Aug. 6, 1908. No. 94224.

Reinforced Concrete.

Three-Hinged Reinforced Concrete Bridge at Santa Cruz, California. James K. James. Illustrates and describes interesting features of design, and methods of construction. 1500 w. Cal Jour of Tech—Aug., 1908. No. 94605.

Reinforced-Concrete Bridges for Track Elevation on the Illinois Central R. R.: Failure Tests of Very Large Concrete Slabs. Illustrates and describes bridges of the slab or beam construction, describing the tests of these large reinforced-concrete beams. 4500 w. Eng News—Aug. 6, 1908. No. 94223.

See also Viaducts, under BRIDGES; and Reinforced Concrete, under CONSTRUCTION.

Steel

The McKees Rocks Bridge. Details of floor construction and guard rails for this unusually heavy structure are illustrated and described. 900 w. Eng Rec—Aug. 29, 1908. No. 94695.

Walney Island Bridge. Drawings and detailed description of this new bridge connecting Walney Island and Barrow-in-Furness. 1500 w. Engr, Lond—July 24, 1908. Serial, 1st part. No. 94166 A.

Atchafalaya River Bridge of the Southern Pacific. Describes a railroad bridge of interest because of its size and the unusual conditions of its construction. Ills. 1200 w. R R Age Gaz—Aug. 7, 1908. No. 94215.

The Passy Bridge Over the Seine for the Metropolitan of Paris (Viaduc de Passy, sur la Seine pour le Chemin de Fer Métropolitain de Paris). L. Biette. Illustrated description of this arch bridge. Serial, 1st part. 3500 w. Génie Civil—July 25, 1908. No. 94534 D.

Viaducts.

Street Viaducts Over the New York Central Terminal Yards at New York. Illustrates and describes the plate girder construction used. 1800 w. Eng Rec—Aug. 1, 1908. No. 94065.

Construction of the Substructure for the Mulberry Street Viaduct, Harrisburg, Pa. Illustrated detailed description of the methods of construction for this reinforced-concrete viaduct. 2500 w. Eng Rec—Aug. 29, 1908. No. 94686.

The Mulberry Street Viaduct, Harrisburg, Pa. A reinforced-concrete structure, to replace a steel bridge, is illustrated and described in detail, and the methods of construction explained. 2500 w. Eng Rec—Aug. 15, 1908. No. 94343.

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Beams.

See Reinforced Concrete, under CONSTRUCTION.

Bins.

Method of Building a Concrete Coal Bin, etc. Ernest McCullough. Gives formulæ for calculating the pressure of coal, and also compression and tension stresses, etc. 2200 w. Min Wld—Aug. 1, 1908. No. 94096.

Reinforced Concrete Bins for Fine Materials (Silos di Cemento Armato per Materiali in Polvere). An illustrated, mathematical discussion of their design. 3500 w. Il Cemento—June, 1908. No. 94539 D.

See also Tanks, under WATER SUPPLY.

Caissons.

Pneumatic Caissons. T. Kennard Thomson. Illustrated detailed description of caisson work, especially in New York City and vicinity, with reference also to work in other places. 6000 w. R R Age Gaz—Aug. 7, 1908. Serial, 1st part. No. 94218.

Campanile.

The Rebuilding of the Venice Campanile. A detailed account of the reconstruction. The present number deals with the foundations. 2200 w. Builder—Aug. 15, 1908. Serial, 1st part. No. 94411 A.

The Reconstruction of the Campanile of St. Mark, in Venice (Reconstruction du Campanile de Saint-Marc, à Venise). P. Raulin. A review of plans and the work already accomplished. Ills. 4000 w. Génie Civil—July 4, 1908. No. 94-529 D.

Coal Pockets.

A Large Reinforced-Concrete Coal Pocket at Charlestown, Mass. George P. Carver. Illustrations, with descriptions of methods of construction. 1500 w. Eng News—Aug. 27, 1908. No. 94637.

Concrete.

See Manholes, under WATER SUPPLY.

Concrete Blocks.

Hollow Tile and Concrete Block Construction. Warren H. Miller. Suggestions for building with this material. 2500 w. Eng Rec—Aug. 22, 1908. No. 94493.

The Development of the Cement and Artificial Stone Industry (Lo Sviluppo dell' Industria dei Lavori in Cemento e delle Pietre artificiali). Illustrates and describes machines and methods for producing cement blocks. 2200 w. Il Cemento—June, 1908. No. 94540 D.

See also Stacks, under CONSTRUCTION.

Excavation.

The Cost of Digging Wet Holes, with Some Comments on Furnishing Special Clothing for Workmen. 1200 w. Engng-Con—July 29, 1908. No. 94111.

A New Method of Wet Excavating. C. M. Ripley. Brief illustrated description of methods used at Gary, Ind., in overcoming the difficulties of quicksand. 1200 w. Ir Age—Aug. 6, 1908. No. 94181.

Methods and Cost of Earth and Rock Excavation with a Steam Shovel and the Cost of Repairing a Wrecked Steam Shovel. Describes the work and methods, giving itemized costs. 3000 w. Engng-Con—Aug. 5, 1908. No. 94204.

Floors.

The Design of Reinforced-Concrete Floors (Metodo di Calcolo per Impalcature in Ferro-Cemento). Mathematical. Ills. 2500 w. Ing Ferro—July 31, 1908. No. 94546 D.

Foundations.

Foundations, with Special Reference to Modern Methods and Plant. Percival M. Fraser. Considers the principles involved, best methods in special cases, etc. 10000 w. Jour Inst of San Engrs—April, 1908. No. 94312 C.

Gymnasium.

The Syracuse University Gymnasium. Illustrated description of a steel-skeleton frame, with stone, brick, and terra-cotta walls, and with reinforced-concrete and tile floor construction. 2000 w. Eng Rec—Aug. 22, 1908. No. 94492.

Reinforced Concrete.

Some Problems in Reinforced Concrete Engineering. H. Alexis d'O. Saurbrey. A study of stresses in beams with straight reinforcement, and beams with bent-up bars. Ills. 5500 w. Eng Rec—Aug. 22, 1908. No. 94490.

Economy in Ferro-Concrete Design. Oscar Faber. Considers the question of economy in design, giving tabulated statements of strength and cost. 3500 w. Engng—Aug. 7, 1908. Serial, 1st part. No. 94370 A.

Formulæ for Reinforced Concrete in Flexure in the Light of Experimental Data. William Fry Scott. Read before the Am. Soc. for Test. Materials. Discusses whether a plane section before bending remains a plane section after bending. 1800 w. Can Engr—Aug. 7, 1908. No. 94240.

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The New Plant of the Wheatena Co., Rahway, N. J. Illustrated description of a reinforced-concrete structure having features of interest. 3000 w. Eng Rec—Aug. 29, 1908. No. 94694.

The Color Plant of the G. Siegle Company. Illustrated description of the reinforced-concrete buildings erected at Rosebank, Staten Island, N. Y., and their equipment. 2000 w. Eng Rec—Aug. 1, 1908. No. 94066.

Canal Roof with Market Hall and Highway Bridges in Mülhausen (Kanalüberdeckung mit Markthalle und Strassenbrücke in Mülhausen i. E.). W. Custer. Illustrated description of extensive reinforced-concrete construction. Serial, 1st part. 1800 w. Schweiz Bau—July 4, 1908. No. 94565 D.

See also Bins, Coal Pockets, and Floors, under CONSTRUCTION; Testing Materals, under MEASUREMENT; Aqueducts, and Pipe Making, under WATER SUPPLY; Docks, under WATERWAYS AND HARBORS; and Car Barns, under STREET AND ELECTRIC RAILWAYS.

Stacks.

Power Plant Chimney with Concealed Exhaust Pipe. Illustrates and describes an unusual construction at the new Union Terminal Station at Washington, D. C. 1000 w. Eng Rec—Aug. 29, 1908. No. 94699.

A Chimney of Concrete Blocks Built Without the Use of Scaffolding. Illustrated description of a novel construction invented by M. Dumas, of Brussels. 600 w. Eng News—Aug. 20, 1908. No. 94428.

Steel Buildings.

A Steel Frame Hay Barn. A structure of unusual interest at Dryden, N. Y., is illustrated and described. 1600 w. Eng Rec—Aug. 15, 1908. No. 94346.

Conservatory Buildings of Steel Construction in Garfield Park, Chicago. Interesting feaures of structural steel work are illustrated and described. 1200 w. Eng News—Aug. 27, 1908. No. 94635.

See also Gymnasium, under CONSTRUCTION.

Theatres.

Optics and Acoustics in Theatre Design (L'Optique et l'Acoustique au Théatre). Alfred Lacour. Notes on auditorium design and lighting. Ills. 10000

w. Bul Soc d'Encour—July, 1908. No. 94516 G.

Tunnels.

The Lötschberg Tunnel. Editorial on the work of constructing this tunnel under the Bernese Alps. 1000 w. Engng—July 31, 1908. No. 94272 A.

Construction of the Lötschberg Railway (Der Bau der Lötschbergbahn). A. Zollinger. Describes the tunneling operations. 2200 w. Schweiz Bau—July 25, 1908. No. 94567 D.

MATERIALS OF CONSTRUCTION.

Brick.

Silica-Lime Brick (El Ladrillo Sílico-Calcáreo). Description of a large plant in Brazil and notes on the properties of the product. Ills. 8500 w. Ingenieria—July 15, 1908. No. 94547 D.

Cement.

Portland Cement Mortars and Their Constituent Materials. Richard L. Humphrey and William Jordan, Jr. A review by Henry S. Spackman of Bul. 331, U. S. Geol. Survey, which gives results of tests made of different cements and sands, screenings, etc. 2500 w. Cement Age—Aug., 1908. No. 94384.

Concrete.

Tests on Bonding New Concrete to Old. Raymond B. Perry. A report of experimental investigations and the results. 1200 w. Eng News—Aug. 13, 1908. No. 94319.

Cement—Its Use and Abuse. Robert W. Lesley. Discusses the use of Portland cement concrete as a structural and decorative material. 3000 w. Jour Fr Inst—Aug., 1908. No. 94295 D.

Chemical Tests on the Alteration of Concrete in Railway Overbridges (Chemische Untersuchungen über die Veränderung des Betons der Monier-Ueberfahrten in den Stationen Mödling und Guntramsdorf der k. k. priv. Südbahn-Gesellschaft). Josef Klaudy. Investigations to determine the effects of locomotive gases on concrete construction. Serial, 1st part. 5000 w. Zeitschr d Oest Ing u Arch Ver—July 24, 1908. No. 94585 D.

See also Pavements, under MUNICIPAL.

Masonry.

The Effect of Temperature Changes on Masonry. Discussion of paper by Charles S. Gowen. Ills. 6500 w. Pro Am Soc of Civ Engrs—Aug., 1908. No. 94672 E.

Mortars.

Hydrated Lime and Cement Mortars. E. W. Lazell. Read before the Am. Soc. for Testing Materials. A report of experiments made to learn the amount of hydrated lime that could be advantageously added to cement mortars. 1200 w. Eng Rec—Aug. 29, 1908. No. 94698.

Reinforced Concrete.

The Resistance to Slipping of Reinforcement (Der Gleitwiderstand bei den Verbundkörpern). C. Doucas. Mathematical discussion and report of tests. Ills. 7000 w. Beton u Eisen—July 2, 1908. No. 94586 F.

A Test of Large Reinforced Concrete Beams. Arthur N. Talbot. Describes the testing apparatus and method of making test of very large beams, representing actual conditions of construction, and gives a comparison of the efficacy of two methods of reinforcement. Ills. 3500 w. Eng Rec—Aug. 1, 1908. No. 94069.

Steel Inspection.

The Inspection of Structural Steel. P. S. Hildreth. Remarks on the necessity and value of this work, discussing the details of good inspection of this material. 3500 w. Cal Jour of Tech—Aug., 1908. No. 94604.

Timber Preservation.

Wood Preservation. W. F. Sherfesee. Abstract from Circ. of U. S. Dept. of Agri. Explains the meaning of decay and how it may be checked. 5000 w. Sci Am Sup—Aug. 1, 1908. No. 94117.

The Preservative Treatment of Loblolly Pine Cross-Arms. W. F. Sherfesee. An illustrated study of the seasoning, treating, grading, etc., with record of tests. 8000 w. U S Dept of Agri, Circ 151—July 31, 1908. No. 94619 N.

MEASUREMENT.

Hydrographic Surveying.

Soundings in Niagara Gorge and Under the Falls. Dr. J. W. Spencer. Describes the methods used, and the facts determined. 1600 w. Sci Am—Aug. 1, 1908. No. 94120.

Standardizing.

Testing Steel Tapes at the National Bureau of Standards. Herbert T. Wade. Describes the methods of testing used by the Bureau of Standards. 2200 w. Eng News—Aug. 13, 1908. No. 94323.

Surveying.

See Geological Surveys, under MINING AND METALLURGY, MINING; and Surveying, under RAILWAY ENGINEERING, NEW PROJECTS.

Surveying Tapes.

See Standardizing, under MEASUREMENT.

Testing Materials.

A Method of Detecting the Bending of Columns: Including a Description of the Sphingometer. C. A. M. Smith. Illustrates and describes this instrument and its use. 3000 w. Inst of Mech Engrs—July 28, 1908. No. 94263 N.

Standards and Specifications for the Testing and Acceptance of Iron (Norme e Condizioni per le Prove e l'Accettazione dei Materiali ferrosi). Refers particularly to the testing of steel for concrete reinforcement. Ills. 3500 w. Il Cemento—June, 1908. No. 94541 D.

MUNICIPAL.

Bridlington.

Some Municipal Works Carried Out by the Bridlington Corporation During the Past Ten Years. Ernest R. Matthews. Read before the San. Inspectors' Assn. Describes sewage disposal, electricity works, street widenings and other improvements. Ills. 5500 w. Surveyor—Aug. 14, 1908. No. 94454 A.

Burgess Hill.

Burgess Hill and Its Local Government. E. Brown. An account of the highways, sewage disposal, water supply, etc. 3000 w. Surveyor—Aug. 14, 1908. No. 94455 A.

City Planning.

I. Town Planning. William Harpur. II. Town and Street Planning. Raymond Unwin. III. Street and City Planning. Henry M. Whitley. Three papers read before the Roy. San. Inst. Congress, and discussed together. 6500 w. Surveyor—Aug. 14, 1908. No. 94453 A.

Garbage Disposal.

Recent Practice in Garbage Disposal (Neuere Erfahrungen auf dem Gebiete der Müllbeseitigung). Dr. Thiesing. Discusses the importance of the problem and outlines methods employed in Charlottenburg, Germany. Ills. 8800 w. Gesundheits-Ing—July 25, 1908. No. 94580 D.

See also Fuels, under MECHANICAL ENGINEERING, Steam Engineering.

Pavements.

Concrete Paving for Streets. Considers the use of concrete as a paving material, giving experience in various cities. Ills. 4500 w. Eng News—Aug. 20, 1908. No. 94425.

Modern Street Work in the West. Walter C. Howe. Briefly considers macadam, asphalt, wood-block, bitumen, vitrified brick, and asphalt-macadam pavements as experienced in the city of Oakland, Cal. 1700 w. Cal Jour of Tech—Aug., 1908. No. 94606.

Roads.

The New Marine Drive, Scarborough. Illustrations and information in regard to this recently opened drive in England. 1200 w. Engr, Lond—Aug. 7, 1908. No. 94375 A.

The Maintenance of Macadam and Other Roads. Informal discussion at annual convention. Ills. 9000 w. Pro Am Soc of Civ Engrs—Aug., 1908. No. 94-674 E.

The Construction of Macadam Roads. Austin B. Fletcher. Abstract of Bul. U. S. Dept. of Agri. How rural highways may be improved. Ills. 4000 w. Sci Am Sup—Aug. 1, 1908. Serial, 1st part. No. 94116.

Sewage Disposal.

State Control of Sewage Disposal Works. Editorial on the progress made in establishing State control in Europe and America, the difficulties, etc. 1400 w. Eng News—Aug. 13, 1908. No. 94324.

Some Minor Points in Sewage Disposal and the Hampton Doctrine. R. Aglio Dibdin. States and answers doubts expressed in regard to systems of sewage disposal. 2000 w. Surveyor—July 24, 1908. No. 94144 A.

Sewage Disposal Without Sewers at Haworth, N. J. Illustrated detailed description of individual sewage disposal plants requiring no sewer system. The Ashley system. 3000 w. Met Work—Aug. 22, 1908. No. 94431.

The Broad Irrigation Sewage Farm at Fresno, California. Illustrated description of the sewage disposal system for a population of 30,000. 1500 w. Eng Rec—Aug. 22, 1908. No. 94488.

Investigations of the Distribution of Sewage Upon Trickling Filters. Stephen DeM. Gage. A report of investigations made at the Lawrence Experiment Station of the Mass. Board of Health. Ills. 9000 w. Eng News—Aug. 20, 1908. No. 94427.

See also Bridlington and Burgess Hill, under Municipal; and Pumping Plants, under MECHANICAL ENGINEERING, Hydraulic Machinery.

Sewers.

New Sewerage System of Washington. Plan and description. 3500 w. Eng Rec—Aug. 1, 1908. No. 94068.

Cost of a Large Brick Sewer at Gary, Ind. E. M. Schaflow. Gives details of cost of building a large sewer in a water-soaked sandy soil. 1500 w. Eng Rec—Aug. 29, 1908. No. 94693.

The Pumping Station Conduits and Outfall Sewer of the Washington Sewerage System. Illustrated detailed description of the features named and their construction. 4000 w. Eng Rec—Aug. 29, 1908. No. 94691.

Replacing a Sewer Outlet by a Wood-Stave Sewer, New York City. Describes work at West 42nd St., New York City, explaining conditions. Ills. 900 w. Eng Rec—Aug. 15, 1908. No. 94345.

Sewer Trenches.

Method of Excavating a Sewer Trench in Water Soaked Sand, Using the Bleeding Method of Unwatering the Soil, with Some Estimates of Costs. Illustrated description of the successful application of bleeding the sand by means of well points.

2500 w. Engng-Con—Aug. 5, 1908. No. 94205.

WATER SUPPLY.

Aqueducts.

Some Methods Employed in Constructing the 7⅓-Mile Reinforced-Concrete Aqueduct for the Water Supply of Salt Lake City. Illustrates and describes the construction of one of the largest reinforced-concrete aqueducts ever built. 1200 w. Engng-Con—Aug. 5, 1908. No. 94203.

Basingstoke, Eng.

The Water Supply of Basingstoke. F. R. Phipps. Reviews the history of the public water supply. Discussion. Ills. 8000 w. Surveyor—July 31, 1908. No. 94249 A.

California.

Rain and Run-Off Near San Francisco, California. Discussion of paper by C. E. Grunsky. 5000 w. Pro Am Soc of Civ Engrs—Aug., 1908. No. 94673 E.

Conduits.

See Manholes, under Water Supply.

Dams.

The Damming of the Murrumbidgee River, Australia. C. O. Burge. A description of this irrigation scheme. 2200 w. Eng Rec—Aug. 8, 1908. No. 94232.

A Formula for Calculating Flashboards for Dams. Richard Muller. Gives an analysis of the bending conditions of pins from actual tests, and develops a formula for calculating the maximum head of water over the crest of the dam. 700 w. Eng Rec—Aug. 22, 1908. No. 94489.

See also Hydro-Electric, under ELECTRICAL ENGINEERING, Generating Stations.

Evaporation.

Evaporation from the Salton Sea. C. E. Grunsky. Describes the conditions and gives information concerning the evaporation records made, and the special studies about to be made in the Salton Basin. 4000 w. Eng News—Aug. 13, 1908. No. 94317.

Filtration.

The Water Softening and Filtration Plant at McKeesport, Pa. Illustrated description of a 10,000,000-gal. plant for the treatment of river water. 4500 w. Eng Rec—Aug. 1, 1908. No. 94064.

The Bamford Filters of the Derwent Valley Water Board. Andrew Williamson. Illustrated description of this scheme which will supply 36-million gallons per day. 3500 w. Engng—July 24, 1908. No 94158 A.

Ground Waters.

The Underground Water Supply of Indiana. F. G. Clapp. A study of this district, giving a classification of underground supplies. 5000 w. Eng Rec—Aug. 8, 1908. No. 94228.

Indiana.

See Ground Waters, under Water Supply.

Irrigation.

Irrigation. Informal discussion on irrigation problems at the annual convention. 6500 w. Pro Am Soc of Civ Engrs—Aug., 1908. No. 94675 E.

Irrigation of the Yuma Valley. Day Allen Willey. Illustrates and describes the construction of the extensive mileage of levees in connection with the Yuma project. 1500 w. Sci Am—Aug. 1, 1908. No. 94118.

Italy.

The New Apulia Water Supply (Die neue apulische Wasserleitung). Herr Beraneck. Description of the new water supply for the three provinces of Lecce, Bari, and Foggia in Southern Italy, the conduits, etc. Ills. Serial, 1st part. 1600 w. Zeitschr d Oest Ing u Arch Ver—July 3, 1908. No. 94583 D.

Manholes.

Methods and Labor Cost of Constructing Over 200 Concrete Vaults for Underground Conduit. Records of work done in a middle Western State, through suburban towns and country. Ills. 500 w. Engng-Con—Aug. 12, 1908. No. 94339.

Pipe Flow.

The Flow of Water in Spiral Riveted and Other Pipes. E. W. Schoder and H. A. Gehring. Gives results of recent studies. 1000 w. Eng Rec—Aug. 29, 1908. No. 94692.

Pipe Laying.

Lowering a 24-in. Water Pipe in Street Grade Changes at Detroit, Mich. Illustrates and describes methods of work. 800 w. Eng News—Aug. 13, 1908. No. 94320.

Pipe Lines.

A 160-Mile Pipe-Line Water Distribution System on the El Paso & Southwestern Ry. A system in New Mexico including 160 miles of wood-pipe, a storage reservoir, and pumping stations, is illustrated and described. 5000 w. Eng News—Aug. 27, 1908. No. 94636.

Pipe Making.

Ferro-Concrete Pipe-Weaving Machine. An account of a steel and concrete weaving machine for making poles, pipes, piles, etc. A Swiss invention. 900 w. Eng—July 31, 1908. No. 94273 A.

Pollution.

Experiences with Salt Water and Oil in a Public Water Supply. Quince Walling. Read before the Indiana Conference. An account of a supply at Muncie, Ind., ruined by the discovery of oil in the region, and the way out of the difficulty. 2000 w. Munic Engng—Aug., 1908. No. 94284 C.

Purification.

Ozone Water-Purification System. G. M. Dyott. Illustrated description. 1000 w. Elec Wld—Aug. 29, 1908. No. 94634.

Rates.

Water Rates and Rentals. Charles Carroll Brown. Read before the Indiana Conference. A discussion of the principles upon which water rates and rentals should be based. 2000 w. Munic Engng —Aug., 1908. No. 94283 C.

Storage Reservoirs.

Storage Reservoirs (Die Stauweiher). Dr. P. Kresnik. A mathematical discussion of their design with reference to rainfall, run-off, etc. 3800 w. Oest Zeitschr f d Oeffent Baudienst—July 25, 1908. No. 94582 D.

Tanks.

Design of the Walls of Cylindrical Reservoirs (Berechnung der Wandungen zylindrischen Reservoire). Th. Bielakoff. Mathematical. 2200 w. Beton u Eisen—July 2, 1908. No. 94587 F.

Water Works.

History and Description of Cape Town Water-Works. R. O. Wynne-Roberts. Presented before the Assn. of Water Engrs. Ills. 5000 w. Surveyor—July 24, 1908. Serial, 1st part. No. 94143 A.

WATERWAYS AND HARBORS.

Bombay.

Port and Harbor Improvements at Bombay. Plan and description of the scheme. 2000 w. Engr, Lond—Aug. 14, 1908. No. 94478 A.

Canals.

Accident to Cornwall Canal Embankment. Illustrated account of the accident on June 23rd, on the Cornwall Canal, which runs parallel with the St. Lawrence River, causing the wreckage of a draw-span. 500 w. Engr, Lond—July 24, 1908. No. 94168 A.

See also Seepage Prevention, under WATERWAYS AND HARBORS.

Docks.

Reinforced Concrete Work in Maritime Situations. Brysson Cunningham. Gives illustrated descriptions of modern concrete constructions in dock and harbor work. 3000 w. Cassier's Mag—Aug., 1908. No. 94175 B.

Dredging.

The Operation of the Hydraulic Dredge, "General C. B. Comstock"; Galveston Harbor, Tex. Emile Low. A short description of this dredge and report of its work in Galveston harbor. 2200 w. Eng News—Aug. 20, 1908. No. 94430.

English Channel.

The Means of Communication Across the English Channel and the Question of Ferry Boats (Les Moyens de Communication à Travers le Pas-de-Calais et la Question des Ferry-boats). J. Legrand. Presents the advantages of a train ferry. Ills. 9000 w. Mem Soc Ing Civ de France—June, 1908. No. 94509 G.

English Rivers.

English Rivers: Their Uses and Control. Frank Rayner. Read before the Inst. of Munic. & Co. Engrs. A criticism of the administration of English rivers, and matters relating to their improvement. Discussion. 3500 w. Surveyor—July 24, 1908. No. 94142 A.

Harbors.

The Jetty and Port Works of Rio Grande do Sul, Brazil. From an article by E. L. Corthell. Describes the conditions and the projected improvements to cost $10,125,000. 1800 w. Eng Rec—Aug. 15, 1908. No. 94344.

See also Bombay, under WATERWAYS AND HARBORS.

Levees.

See Irrigation, under WATER SUPPLY.

Mechanical Locks.

Reconstruction of the Anderton Boat Lift. An illustrated article giving the chief points in the history of the old lift and a description of the reconstruction work. Hydraulic power has been superseded by electricity. 5500 w. Engr, Lond—July 24, 1908. No. 94164 A.

Panama Canal.

See Shops, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

River Regulation.

The Regulation Works in Progress on the More Important Rivers of Hungary (Die an den bedeutenderen Flüssen Ungarns durchzuführenden Regulierungsarbeiten). Armin Just. Describes the works and the results expected. 11500 w. Oest Wochenschr f d Oeffent Baudienst —July 11, 1908. No. 94581 D.

Sea Walls.

Two Types of Sea Wall for Land Filling, New York City. Short description of work at North Brother Island and Riker's Island in the East River. Ills. 1500 w. Eng Rec—Aug. 22, 1908. No. 94491.

Seepage Prevention.

The Prevention of Seepage from Ditches and Canals. From a report by B. A. Etcheverry of investigations made in California. 3500 w. Eng Rec—Aug. 29, 1908. No. 94688.

U. S. Waterways.

"A Wheel in the Middle of a Wheel." Lewis M. Haupt. A discussion of the proposed systematic improvement of U. S. waterways, and the attitude of Congress toward this work. 5500 w. Jour Fr Inst —Aug., 1908. No. 94296 D.

Water Powers.

The Use and Conservation of Water-Power Resources. H. von Schon. Examines the economic aspects of water-power conservation, giving a plan for federal, state, and corporate co-operation. 4500 w. Engineering Magazine—Sept., 1908. No. 94676 B.

MISCELLANY.

Forest Survey.

Forest Survey Methods. A. H. D. Ross. States the points included, and the methods used in complete surveys. 5600 w. Can Engr—Aug. 7, 1908. No. 94241.

Natural Resources.

Conservation of Power Resources. H. St. Clair Putnam. Reviews the phases of development of power resources, discussing the use of steam, water-power, and electric power, possible economies, etc. 2500 w. Pro Am Inst of Elec Engrs—Aug., 1908. No. 94298 D.

ELECTRICAL ENGINEERING

COMMUNICATION.

Radio-Telegraphy.

A Tantalum Wave-Detector, and Its Application in Wireless Telegraphy and Telephony. L. H. Walter. Read before the Royal Soc. Describes this form of detector, and reports results obtained. 2500 w. Elect'n, Lond—Aug. 14, 1908. No. 94463 A.

Radio-Telephony.

Recent Improvements in Radio-Telephonic Methods and Apparatus. L. H. Walter. Reviews recent patents relating to wireless telephony. 2200 w. Elec Engng—Aug. 13, 1908. No. 94462 A.

Submarine Cables.

The Atlantic Cable of 1858. William Maver, Jr. A review of the early history of cable making and laying, especially discussing the cable named. 3500 w. Elec Wld—Aug. 22, 1908. No. 94419.

Telephotography.

Telephotography (La Phototélégraphie). G. Cerbeland. A review of the various systems for the electrical transmission of pictures. Ills. 5200 w. Mem Soc Ing Civ de France—June, 1908. No. 94507 G.

DISTRIBUTION.

Controllers.

A No-Segment Graphite-Resistance Controller. Illustrates and decribes a controller on the principle of the carbon microphone. 1000 w. Sci Am—Aug. 15, 1908. No. 94337.

Fire Hazard.

Insulation Resistance and Other Tests in Completed Electrical Installations. Hugh T. Wreaks. An account of tests recently made and comments on their value. 2200 w. Elec Wld—Aug. 8, 1908. No. 94211.

Fuses.

See Protective Devices, under TRANSMISSION.

DYNAMOS AND MOTORS.

A. C. Motors.

Alternating Current Commutator Motors. Dr. Rudolph Goldschmidt. Discussion of the theory of the single-phase commutator motor. 3500 w. Elect'n, Lond—July 31, 1908. Serial. 1st part. No. 94254 A.

The Shape of the Current Curves in Three-Phase Motors and the Separation of the Losses. Dr. K. Simons and K. Vollmer. Abstract trans. from *Elektrotechnische Zeit.* A study, by means of the oscillograph, of losses in 3-phase motors. 1500 w. Elect'n, Lond—July 24, 1908. No. 94153 A.

High Speed Three-Phase Motors (Drehstrommotoren für hohe Umlaufszahlen). Georg Lewinnek. Describes recent developments in horizontal and vertical motors with forced lubrication. Ills. 2000 w. Elektrotech Zeitschr—July 2, 1908. No. 94654 D.

A System of Operation for Electric Railways and Hoisting Installations Using A. C. Motor with Two Moveable Parts (Betriebssystem für Elektrische Bahnen und Förderanlagen mit Benützung eines Wechselstrommotors mit zwei beweglichen Teilen). Dr. Johann Sahulka Ills. 2500 w. Elektrotech u Maschinenbau—July 26, 1908. No. 94594 D.

Commutation.

Theory of the Commutation of D. C. Machines Without Angular Displacement (Théorie de la Commutation des Machines à Courant continu sans Décalage). R. Voisin. Ills.. 2500 w. L'Elecn—July 25, 1908. No. 94524 D.

D. C. Dynamos.

Unipolar and Commutator Direct-Current Machines (Unipolarmaschinen und Kommutator-Gleichstrommaschinen). Otto Schulz. Discusses mathematically the characteristics of unipolar machines for use with steam turbines. Ills. 4000 w. Elektrotech u Maschinenbau—July 19, 1908. No. 94593 D.

Armature Reaction in D. C. Dynamos (Sur la Réaction d'Induit dans les Dynamos à Courant Continu). M. Swyngedauw. A mathematical and theoretical paper on both longitudinal and transverse reaction. Ills. 14000 w. Bul Soc Int d'Elecns—July, 1908. No. 94511 F.

D. C. Motors.

Design for a 1-H.P. Shunt-Wound Motor. F. C. Mason. Working drawings and description. 1600 w. Elec Wld—Aug. 1, 1908. No. 94109.

D. C. Turbo-Generators.

European Practice in Direct Current Turbo-Generators. J. S. S. Cooper. Illustrates and describes some of the methods adopted by European manufacturers to produce a thoroughly satisfactory commercial machine. 3000 w. Elec Jour—Aug., 1908. No. 94291.

Induction Motors.

New Methods for the Regulation of Asynchronous Motors and Their Application for Various Purposes (Neue Methoden zur Regelung von Asynchronmotoren und ihre Anwendung für verschiedene Zwecke). Ch. Krämer. Illustrated description. 4000 w. Elektrotech Zeitschr—July 30, 1908. No. 94659 D.

Synchronous Motors.

The Synchronous Motor in Systems Operating at Low Power Factor. F. C. Helms. Discusses the advantages attending the use of a synchronous condenser for improving the power factor of a transmission system. 3500 w. Elec Wld—Aug. 22, 1908. Serial. 1st part. No. 94420.

The Circle-Diagram of the Synchronous Motor. F. Creedy. Describes a diagram which is analogous to the circle-diagram so well known in the case of the induction motor, single-phase series motor, etc. 1400 w. Elec Engr, Lond—July 31, 1908. Serial. 1st part. No. 94251 A.

ELECTRO-CHEMISTRY.

Corrosion.

The Rusting of Iron. J. Newton Friend. Reviews previous researches and account of investigations and conclusions. 8000 w. Jour Ir & St Inst—No. II, 1908. No. 94610 N.

Electro-Metallurgy.

Electric Furnace Reactions Under High Gaseous Pressures. R. S. Hutton and J. E. Petavel. Abstract from *Phil. Trans. of the Royal Soc.* Discusses results obtained, in research work. 2500 w. Elect'n, Lond—July 31, 1908. No. 94255 A.

See also Nickel, and Tin, under MINING AND METALLURGY, MINOR MINERALS.

Sea Water.

Artificial Sea Water. An illustrated account of the manufacture of sea water by the Hermite process, for use as a disinfectant in London slums. 2000 w. Sci Am—Aug. 8, 1908. No. 94225.

ELECTRO-PHYSICS.

Roentgen Tubes.

The Operation of Röntgen Tubes with Purely Unidirectional Induced Currents. Ernst Ruhmer. Lecture before the Deutsche Roentgen Gesellschaft. Describes the unidirectional arrangement, explaining its advantages. Ills. 1400 w. Elect'n, Lond—Aug. 7, 1908. No. 94366 A.

GENERATING STATIONS.

Accumulators.

The Care and Maintenance of Storage Batteries. F. A. Warfield. A discussion of their action, their troubles and the remedies. 2500 w. Elec Jour—Aug., 1908. No. 94293.

Storage Batteries, Their Construction and Uses. Percival Robert Moses. Discusses the utility of storage batteries in isolated plants, describing the structural and installation features of leading types. Ills. 3000 w. Engineering Magazine—Sept., 1908. Serial. 1st part. No. 94678 B.

Berlin.

The Berlin Electrical Works from 1902 to 1908 (Die Berliner Elektrizitäts-Werke von 1902 bis 1908). Herr Datterer. Describes recent extensions and improvements to the municipal stations. Ills. Serial. 1st part. 4500 w. Zeitschr d Ver Deutscher Ing—July 11, 1908. No. 94597 D.

Central Stations.

Generating End of Power Sations. A. D. Le Pan. A detailed discussion of present day practice. 4500 w. Can Engr—Aug. 7, 1908. No. 94242.

A Modern Steam Power Central Station on the Pacific Coast. Illustrated description of the plant at Redondo, Cal., where reciprocating engines are used in preference to turbines. 7800 w. Ind Wld—Aug. 24, 1908. No. 94485.

The Power System of the Georgia Railway & Electric Company. Illustrates and describes a power system at Atlanta, Ga., using steam, gas, and water power in the generation of electricity. 2500 w. Elec Ry Jour—Aug. 8, 1908. No. 94199.

The Yatesboro Power Plant of the Cowanshannock Coal & Coke Co. C. M. Means. Illustrated description of plants equipped with turbogenerators and motors using high voltage current. 3000 w. Mines & Min—Aug., 1908. No. 94073 C.

Electrical Generating System of the Newton Gas & Electric Company of Newton, N. J. Brief illustrated description of a station equipped with producer-gas engines belted to three-phase alternators. 1000 w. Elec Wld—Aug. 29, 1908. No. 94632.

Non-Synchronous Generator Stations of the Rheinbinnencanal, Switzerland. M. Yazidjian. Illustrated description of an interesting installation, with an outline of the results obtained during the two years it has been in operation. 3000 w. Elec Wld—Aug. 15, 1908. No. 94327.

See also Interurban, under STREET AND ELECTRIC RAILWAYS.

Design.

The Operation of Electrical Machinery. Norman G. Meade. Gives suggestions to be followed when installing a new plant. 1200 w. Power—Aug. 18, 1908. No. 94378.

Hydro-Electric.

The Hydro-Electric Plant and Mill of the Superior Portland Cement Co., Superior, Wash. George H. Moore. Illustrated description. 1800 w. Eng Rec—Aug. 22, 1908. No. 94487.

Electric Power Development on Stanislaus River. Brief illustrated description of this project for generating electricity to be sold along the California coast. 1200 w. Cal Jour of Tech—Aug., 1908. No. 94607.

The Municipal Hydro-Electric Plant at Spooner, Wis. Illustrated description of a plant of special interest to small cities and towns because of its splendid financial showing. 1600 w. Eng Rec—Aug. 29, 1908. No. 94697.

Great Northern Power Company's Plant. Claude Aikens. Illustrated description of the great dam and waterways and some of the operating features of this hydraulic turbine installation. 4000 w. Power—Aug. 11, 1908. No. 94275.

The Hydro-Electric Development and Transmission Lines of the Canadian Niagara Power Company. A. H. Van Cleve. Remarks in regard to the history and general scope of the development, illustrating and describing the more important features of the plant. 11000 w. Pro Am Soc of Civ Engrs—Aug., 1908. No. 94671 E.

The Brusio Hydro-Electric Plant and its 50,000-Volt Swiss-Italian Transmission System. Frank Koester. Illustrated detailed description of a system showing modern European practice. 2500 w. Elec Rev, N Y—Aug. 8, 1908. Serial. 1st part. No. 94238.

Hydro-Electric Plant on the Tusciano, Italy (L'Usine Hydraulic-Electrique du Tusciano, Italie). M. de Kermond. Illustrated description. Serial. 1st part. 2200 w. L'Elecn—July 18, 1908. No. 94523 D.

An Electric Plant on the Avisio (Una Centrale Elettrica sull' Avisio). Description of a project involving the turning the waters of one river into another by means of a tunnel. Ills. 4500 w. Elettricita—July 30, 1908. No. 94538 D.

Location.

Pertinent Considerations on Power House Locations. E. D. Dreyfus. Gives a résumé of important considerations bearing on this subject. 2000 w. Elec Wld—Aug. 22, 1908. No. 94422.

Rates.

Diversity Factors. F. Fernie. Discusses the fixing of charges for electrical energy. 2000 w. Elect'n, Lond—July 24, 1908. No. 94152 A.

Switchboards.

A New Type of Switchboard: For the Salt River Project, U. S. Reclamation Service. Illustrated description. 1600 w. Eng News—Aug. 27, 1908. No. 94638.

Switch Gear.

Extra-High-Pressure Ironclad Switchgear. Illustrated description of a gear specially developed in conjunction with the Merz-Price system for feeder and transformer protection, although any other system may be used. 5000 w. Elec Rev, Lond—July 24, 1908. No. 94150 A.

Troubles of Central Station Switching Apparatus and Methods of Handling Them. C. F. Conrad. Considers troubles due to short circuits, troubles from overheated contacts, to breakdowns, etc. 4000 w. Elec Wld—Aug. 1, 1908. No. 94106.

LIGHTING.

Aluminium Cells.

A New Source of Illumination. G. A. Johnstone. A short description of phenomenon observed while experimenting with the aluminum alkaline electrolytic cell, and an application that has been made. 1800 w. Elec Wld—Aug. 15, 1908. No. 94328.

Hand Lamps.

Dangerous Electric Hand Lamps. Observations on some dangerous types in use. Ills. 1500 w. Mech Engr—July 31, 1908. No. 94250 A.

Helium Gas.

The Luminous Properties of Electrically Conducting Helium Gas. P. G. Nutting. An account of investigations made to determine the constancy and reproducibility of such a source of light. 2500 w. Bul Bureau of Stand—May, 1908. No. 94305 N.

Illumination.

See Theatres, under CIVIL ENGINEERING, CONSTRUCTION.

Incandescent Lamps.

Selective Radiation from the Nernst Glower. W. W. Coblentz. Gives methods and results of an investigation. 4000 w. Bul Bureau of Stand—May, 1908. No. 94307 N.

Conclusive Evidence of the "Overshooting" of Tungsten Lamps and Other Interesting Phenomena. J. Stuart Freeman. An illustrated account of investigations made. 1200 w. Elec Wld—Aug. 15, 1908. No. 94326.

Recent Achievements in Electric Lighting (Neuere Errungenschaften in der elektrischen Beleuchtung). W. Wedding. Gives a full account of a large number of tests on graphitized-carbon, tantalum and tungsten lamps. Ills. 4500 w. Elektrotech Zeitschr—July 30, 1908. No. 94658 D.

MEASUREMENT.

Dynamo E. M. F.

Determining the Electromotive Force of a Dynamo Without Running It. W. M. Hollis. Directions. 900 w. Elec Wld—Aug. 1, 1908. No. 94110.

Electrometers.

Function of a Periodic Variable Given by the Steady Reading of an Instrument; with a Note on the Use of the Capillary Electrometer with Alternating Voltages. Morton G. Lloyd. 1200 w. Bul Bureau of Stand—May, 1908. No. 94306 N.

Frequency.

See Power Factor, under MEASUREMENT.

Instruments.

The Electrical Testing Instruments of Messrs. Siemens Bros. & Co. Illustrated descriptions. 2000 w. Elect'n, Lond—July 24, 1908. Serial. 1st part. No. 94154 A.

Laboratories.

The Work and Equipment of a Testing and Standardizing Department. H. A. Ratcliff. Notes on various features of interest in connection with the testing department of electrical works. Ills. 2500 w. Elec Engr, Lond—July 24, 1908. Serial. 1st part. No. 94148 A.

Magnetic Flux.

An Apparatus for Determining the Form of a Wave of Magnetic Flux. M. G. Lloyd and J. V. S. Fisher. Illustrates and describes the apparatus and gives examples of its use. 2000 w. Bul Bureau of Stand—May, 1908. No. 94303 N.

Magnetization Curves.

Determination of the Magnetization Curves with Alternating Currents (Bestimmung des Magnetisierungsstromes bei Wechselstrom). O. S. Braystad and J. Liska. Mathematical discussion. Ills. 2500 w. Elektrotech Zeitschr—July 23, 1908. No. 94657 D.

Meter Testing.

The Test-Meter Method of Testing Service Meters. Joseph B. Baker. An explanation of this method of testing, discussing its merits and defects. 1000 w. Elec Rev, N Y—Aug. 8, 1908. Serial. 1st part. No. 94237.

Power Factor.

The Measurement of Power Factor and Frequency in Single-Phase Alternating-Current Circuits. Dr. W. Lulofs. Explains methods. Mathematical. 1500 w. Elect'n, Lond—Aug. 14, 1908. No. 94465 A.

Three-Phase Power Factor by Single-Phase Wattmeter. Nicholas Stahl. Gives three methods that are recommended for determining three-phase power-factors. 1800 w. Elec Wld—Aug. 29, 1908. No. 94633.

Resistance.

Resistance and Impedance. W. B. Kouwenhoven. An explanation of resistance and its measurement. 1800 w. Ry & Loc Engng—Aug., 1908. No. 94102 C.

Standardization.

Standardization Apparatus for Measuring Volts, Amperes and Watts. E. F. Northrup. Discusses the present status of standardization apparatus used in the measurement of volts, amperes, and watts. Ills. 8500 w. Jour Fr Inst—Aug., 1908. No. 94294 D.

TRANSMISSION.

Alternating Currents.

Amperes in Alternating-Current Circuits. A. D. Williams, Jr. Presents tables giving the amperes per lead wire per kilowatt for single-phase and three-phase balanced loads, with notes. 1500 w. Elec Wld—Aug. 8, 1908. No. 94210.

Cables.

Localizing High-Resistance Breaks in Cables. J. Rymer-Jones. Describes a method revised and simplified from an earlier method devised by the writer. 2200 w. Elec Rev., Lond—July 24, 1908. Serial. 1st part. No. 94149 A.

High-Tension Cables and High-Tension Power Transmission. R. Apt. Abstract of paper read before the Elektrotechinischer Verein. Discusses insulating materials, losses in the lead, deducing formula for the same, etc. 2500 w. Elect'n, Lond—Aug. 14, 1908. No. 94466 A.

Excess Voltages.

Excess Voltage Analogies (Praktische Ueberspannungsanalogien). Iwan Döry. Compares excess voltages produced in transmission lines at the moment of switching, etc., with excessive pressures in hydraulic systems following sudden changes in the turbine load. Mathematical. Ills. 4500 w. Elektrotech Zeitschr—July 16, 1908. No. 94655 D.

Insulation.

Disruptive Strength and Temperature (Durchschlagsspannung und Temperatur). A. Grau. A discussion of the relation between them based on tests. Ills. 3200 w. Elektrotech u Maschinenbau—July 5, 1908. No. 94592 D.

Lightning.

Lightning Phenomena. E. E. F. Creighton. A general review of important results of the study of lightning phenomena is given in the present article. 2200 w. Elec Wld—Aug. 8, 1908. Serial. 1st part. No. 94207.

Lightning Arresters.

The Resistance of Lightning Arrester Earth Connections. E. E. F. Creighton. Reports a series of tests made and their results. 2500 w. Elec Wld—Aug. 22, 1908. No. 94421.

Losses.

See Cables, under TRANSMISSION.

Oscillations.

Free Oscillations in Long Transmission Lines (Freie Schwingungen in langen Leitungen). Karl Willy Wagner. Mathematical paper on the oscillations following sudden changes in voltage. Ills. 4500 w. Elektrotech Zeitschr—July 23, 1908. No. 94656 D.

Protective Devices.

Protective Devices. H. B. Gear and P. F. Williams. Discusses this problem in connection with the development of power stations in very large capacity, and the great increase in voltage. Ills. 5000 w. Elec Age—Aug., 1908. No. 94289.

Substations.

Large Typical Substation of the Chicago City Railway. Illustrated detailed description of a large rotary converter substation. 2500 w. Elec Ry Jour—Aug. 15, 1908. No. 94325.

Transformer.

A Convenient Experimental Transformer. George T. Hanchett. Gives a simple plan of making a transformer of variable voltage out of material at hand. 800 w. Elec Wld—Aug. 1, 1908. No. 94108.

Effect of Wave Form Upon the Iron Losses in Transformers. Morton G. Lloyd. Considers the problem from the theoretical standpoint, gives results of experimental investigations, and conclusions. 6000 w. Bul Bureau of Stand—May, 1908. No. 94304 N.

Voltage Regulation.

Alternating-Current Potential Regulators. George R. Metcalfe. Describes the induction type regulator, and the step-by-step regulator, and their operation. Ills. 3500 w. Elec Jour—Aug., 1908. No. 94292.

MISCELLANY.

Agriculture.

Electricity in Agriculture. Sir Oliver Lodge. Gives a report of experiments made on a commercial scale. Ills. 3800 w. Elec Engr, Lond—July 24, 1908. No. 94146 A.

Development.

The Industrial Evolution of Electricity (L'Evoluzione industriale dell' Elettrotecnica). G. Bartoli. A general review. Ills. Serial. 1st part. 8000 w. Riv Marit—July-Aug., 1908. No. 94537 E + F.

Electric Target.

The Rose Recording Target. Describes a target for range firing which dispenses with markers. Ills. 1200 w. Elec Engr, Lond—July 31, 1908. No. 94252 A.

Resistances.

A Satisfactory Form of High Resistance. G. W. Stewart. An account of experiments made with lampblack mixed with lacquer known as "Zapon L." 1100 w. Elect'n, Lond—Aug. 14, 1908. No. 94464 A.

Groups of Incandescent Lamps Used as Constant Resistors. A. C. Stevens. Reports results of tests made with incandescent lamps with metallic filaments. 900 w. Elec Wld—Aug. 1, 1908. No. 94107.

Synchronous Devices.

Synchronous Devices and Their Uses (Appareils de Synchronisme et leurs Utilisations). M. Conrade. Describes the principles of synchronism and shows its application to devices for controling phonographs, cinematographs, and other uses. Ills. 6500 w. Mem Soc Ing Civ de France—June, 1908. No. 94508 G.

INDUSTRIAL ECONOMY

Apprenticeship.

The Crisis of Apprenticeship (La Crise de l'Apprentissage). M. de Ribes-Christofle. Outlines the causes and effects of the decline of apprenticeship in France. 2500 w. Bul Soc d'Encour—June, 1908. No. 94515 G.

Cost Systems.

Obtaining Actual Knowledge of the Cost of Production. F. E. Webner. This fifth article considers the organization of a cost department. 2500 w. Engineering Magazine—Sept., 1908. No. 94677 B.

A Uniform Foundry Cost System. Ellsworth M. Taylor. Read before Am. Found. Assn. A memorandum on foundry costs prepared by the Cost Committee of the American Foundry Assn. 2500 w. Foundry—Aug., 1908. No. 94188.

The Proper Use of Cost-Keeping Systems. Sterling H. Bunnell. Explains the value of such systems when properly used, and the causes of their proving unsatisfactory in certain cases. 2200 w. Cassier's Mag—Aug., 1908. No. 94173 B.

Education.

Technical Education in Scotland at the Franco-British Exhibition. John G. Kerr. Describes the Scotch exhibit. 2000 w. Engng—Aug. 14, 1908. No. 94471 A.

The Technical Schools' Exhibits at the Franco-British Exhibition. Joseph Horner. Describes the exhibits of the British technical schools, and outlines the work of the various schools. Ills. 4000 w. Engng —July 31, 1908. Serial. 1st part. No. 94264 A.

Secondary Mining Education. H. H. Stoek. An account of what has been accomplished in the United States and Canada. Discussion. 8000 w. Qr Bul of Can Min Inst—July, 1908. No. 94396 N.

Instruction in Economics and Sociology in Technical Schools (L'Enseignement économique et social dans les Ecoles techniques). Maurice Bellom. Demonstrates its necessity and reviews courses in French and foreign schools. Serial. 1st part. 2200 w. Génie Civil—July 4, 1908. No. 94531 D.

Engineering.

The Evolution of Engineering. Henry Gordon Stott. Presidential address. 2000 w. Pro Am Inst of Elec Engrs—Aug., 1908. No. 94297 D.

Filing Systems.

The Filing System of the New York Board of Water Supply. J. Leo Murphy. Considers the requisites of a good filing system and describes the system used by the N. Y. Board of Water Supply. 7500 w. Eng News—Aug. 6, 1908. No. 94221.

Germany.

Industrial Economy in Germany (Les Procédés de l'Industrie Allemande). Victor Cambon. Outlines the great development of Germany's trade and the influence on it of technical education, railways, ports, financial system, government regulation, etc. Ills. 1400 w. Mem Soc Ing Civ de France—April, 1908. No. 94502 G.

Industrial Villages.

The Industrial Village at Roebling, N. J. A description of the lay out of the village, the buildings, etc., with illustrations. 4500 w. Ir Age—Aug. 6, 1908. No. 94178.

A Model Colliery Village. Illustrated description of the Brodsworth Main Colliery Co.'s housing scheme. 1500 w. Col Guard—Aug. 14, 1908. No. 94470 A.

Japan.

Machinery Building in Japan. A. Gwaikokuijin. Information concerning the exports and works. 1000 w. Am Mach—Vol. 31. No. 35. No. 94628.

Labor.

A Superintendent's Views of American Shop and Labor Conditions. John George Niederer. An estimate of educational and union tendencies. 1200 w. Engineering Magazine—Sept., 1908. No. 94684 B.

Cost of Living of the Working Classes in Germany. Information from a recent volume issued by the Board of Trade reporting results of investigations of the cost of housing, prices of commodities, with rates of wages, and general industrial conditions. 3000 w. Ir & Coal Trds Rev—July 24, 1908. No. 94171 A.

Management.

Manufacturing from Stock. Clarence Hoyt Stilson. Discusses principles and methods of the stock-limit system and its advantages. 1400 w. Engineering Magazine—Sept., 1908. No. 94680 B.

Efficiency as a Basis for Operation and Wages. Harrington Emerson. This third article of a series discusses the strength and weakness of existing systems of organization. 5500 w. Engineering Magazine—Sept., 1908. No. 94685 B.

Accounting for Labor and Material. Oscar E. Perrigo. Eleventh of a series of articles on cost-keeping and shop management. Ills. 3500 w. Ir Trd Rev—Aug. 13, 1908. No. 94333.

Notes on Industrial Management (Einzelfragen aus der Organisation technischer Betriebe). F. A. Neuhaus. Discusses the keeping of records, cost accounting, etc. Ills. Serial. 1st part. 3800 w. Zeitschr d Ver Deutscher Ing—July 18, 1908. No. 94599 D.

See also Purchasing, under INDUSTRIAL ECONOMY.

Patents.

The Working Requirement in Patent Law. John D. Morgan. Discusses the advisability of the United States enacting such a requirement. 3500 w. Ir Age—Aug. 20, 1908. No. 94403.

The Mission of the Patent Attorney (De la Mission de l'Agent de Brevets). G. van der Haeghen. Serial. 1st part. 3000 w. All Indus—July, 1908. No. 94526 D.

Purchasing.

The Engineer as a Purchasing Agent. James M. Cremer. Shows the advantages of engineering experience in the purchasing of supplies. 6500 w. Cassier's Mag—Aug., 1908. No. 94174 B.

Wages.

The Payment of Wages. Forrest E. Cardullo. Reply to Harrington Emerson's criticism of the writer's article on this subject. 3500 w. Ir Trd Rev—Aug. 20, 1908. No. 94414.

A Remarkable Piece Work Document. Information supplied by the mechanical superintendent of a large railroad, showing the advantages of the system. 3000 w. R R Age Gaz—Aug. 14, 1908. No. 94352.

The Taylor and Barth Slide-Rules for the Application of the Taylor System of Management (Les Regles et Circles à Calcul de Fred W. Taylor et Carl G. Barth pour l'Application du Système Taylor dans l'Atelier de Mécanique). L. Descroix. Describes the calculating rules and their use. Ills. 6500 w. Rev de Métal—July, 1908. No. 94513 E + F.

MARINE AND NAVAL ENGINEERING

Battleships.

French Warship Construction. Editorial review of a paper by C. Ferrand on the importance of the time occupied in the construction of ships. 2500 w. Engng—July 24, 1908. No. 94162 A.

The New Brazilian Battleships and Their Armor. Particulars of the vessels, with details of the armor-plate trials, showing the reliability of the material. 1200 w. Engng—Aug. 14, 1908. No. 94476 A.

The Race for Naval Power. Archibald S. Hurd. A survey of the naval activity of the world, discussing the shipbuilding programmes of the great naval powers. Ills. 3500 w. Cassier's Mag—Aug., 1908. No. 94176 B.

Cables.

The Disappearance of Manila Lines on Board Ships. Robert Sanford Riley. An illustrated account of the machinery used in connection with steel wire cables, which have largely superseded ropes. 1500 w. Int Marine Engng—Sept., 1908. No. 94662 C.

Compasses.

The General Theory of Corbara's Quadrantal Compensation, with Notes on a More Suitable Compass for War Vessels (Sulla Teoria generale della Compensazione quadrantale del Corbara con alcune Considerazioni sui Tipi di Bussola piu Convenienti alle Navi da Guerra). Luigi Tonta. Ills. 12000 w. Riv Marit—July-Aug., 1908. No. 94536 E + F.

Cruisers.

Trial Performance of Three United States Scout Cruisers. An account of trials of vessels having totally different modes of propulsion; one having reciprocating engine; a second Parsons turbines; and the third Curtis turbines. Ills. 2200 w. Int Marine Engng—Sept., 1908. No. 94661 C.

Electric Power.

The Generation and Electrical Transmission of Power for Main Marine Propulsion and Speed Regulation. William P. Durtnall. Abstract of paper before the Inst. of Marine Engrs., Franco-British Ex. Considers the possibilities and advantages of the steam-electric system of power generation and transmission for marine propulsion. Ills. 4000 w. Elec Engr, Lond—July 24, 1908. No. 94147 A.

Ferry Boats.

The Elevating Ferry-Steamer "Finnieston," for Glasgow Harbor. Illustrated description. 700 w. Engng—Aug. 14, 1908. No. 94477 A.

See also English Channel, under CIVIL ENGINEERING, WATERWAYS AND HARBORS.

Hospital Ships

The Boston Floating Hospital. Robert Charles Monteagle. Plans and illustrated description of the new vessel launched in 1906. 3000 w. Int Marine Engng—Aug., 1908. No. 94089 C.

Japan.

Progress of Ship-Owning in Japan. Reviews the history of Japanese shipping. 2000 w. Engng—Aug. 14, 1908. No. 94472 A.

Launching.

Launching a Great Lakes Freighter. Ralph E. Flanders. Illustrates and describes the method of supporting the hull on land and of launching it. 2200 w. Mach, N Y—Aug., 1908. No. 94112 C.

Ship Design.

The Most Successful Dimensions of Steamships in Relation to Economy. Otto Alt. An examination in detail of this problem. 2500 w. Int Marine Engng—Aug., 1908. Serial. 1st part. No. 94090 C.

The Interrelation of Theory and Practice of Shipbuilding. J. J. O'Neill. Read before the Inst. of Engrs. & Shipbldrs. in Scotland. Examines only the speed-power aspect of the question. 4000 w. Engr, Lond—July 24, 1908. No. 94169 A.

The Shape of Ships' Bottoms (La Forme des Carènes). Ch. Weyher. Criticises the practice of making the stem more slender than the stern. Ills. 3600 w. Rev Gen des Sci—July 30, 1908. No. 94517 D.

Steamers.

The Lake Passenger Steamer City of Cleveland. Illustrated detailed description of the vessel and its equipment. 2200 w. Int Marine Engng—Sept., 1908. No. 94660 C.

Steamships.

Editorial Correspondence from Abroad. Angus Sinclair. Notes containing reference to engineering features of the "Columbia." 2200 w. Ry & Loc Engng—Aug., 1908. No. 94104 C.

The Isle of Man Turbine Steamer "Ben-my-Chree." Illustration, drawings, and description of what has proved the fastest Channel steamer afloat. 1500 w. Engng—Aug. 14, 1908. No. 94473 A.

Steam Turbines.

The A. E. G. Curtis Turbine with Special Reference to the Marine Type (Die A. E. G.-Curtis-Turbine, unter besonderer Berücksichtigung der Schiffsturbine).

Carl Züblin. Describes this type of turbine and its applications. Ills. 3000 w. Die Turbine—July 20, 1908. No. 94568 D.

See also Steamships, under MARINE AND NAVAL ENGINEERING.

Torpedo Boats.

Torpedo-Boat for the Bulgarian Government. Explains the difficulties in the scheme for defending their coast on the Black Sea, the final construction of the boats in France, the putting down of a re-erecting yard at Varna, including a launching and hauling-up slip, etc. 1200 w. Engng—July 31, 1908. No. 94269 A.

MECHANICAL ENGINEERING

AUTOMOBILES.

Apperson.

Apperson Small Car, 1909. Illustrated description of "Model O," a new car of the medium-powered type, to sell at a low price. 500 w. Automobile—Aug. 13, 1908. No. 94336.

Ariel.

The 20-H.P. Ariel Touring Car or Town Carriage. Illustrated detailed description. 2000 w. Auto Jour—Aug. 15, 1908. No. 94446 A.

Benz.

The 1908 Benz Petrol Cars. Illustrated detailed description of a 28-h.p. live-axle car. 1200 w. Auto Jour—Aug. 1, 1908. Serial. 1st part. No. 94247 A.

Cabs.

Cars for Passenger Use in and About Cities. Compares the requirements of the taxicab and the town car, and matters related. Ills. 3500 w. Automobile—Aug. 6, 1908. No. 94195.

Competitions.

The Motor Trials of the Scottish Automobile Club. An editorial review of these trials, with tabulated information and results. 3500 w. Engng—July 31, 1908. No. 94267 A.

The *Grands Prix* of the Automobile Club of France in 1908 (Grands Prix de l'Automobile-Club de France en 1908). M. Girardault. Details of the competing cars and of the races. Ills. 3000 w. Génie Civil—July 18, 1908. No. 94532 D.

Farm Motors.

California Advanced in Motor Farm Machinery. Victor Lougheed. Brief account of the success with farm tractors and similar agricultural implements. Ills. 1500 w. Automobile—Aug. 6, 1908. No. 94196.

Franklin.

Franklin Motor Cars for 1909. Illustrates and describes improvements made in details of these cars. 2500 w. Automobile—Aug. 27, 1908. No. 94644.

Fuels.

Benzol as an Automobile Fuel (De l'Emploi du Benzol dans les Moteurs d'Automobiles). A. Grebel. An exhaustive discussion of the properties of benzol and its use as a motor fuel. Ills. 16000 w. Mem Soc Ing Civ de France—May, 1908. No. 94505 G.

Hillman-Coatalen.

The 12-15 H. P. Hillman-Coalalen Car. Illustrated detailed description. 1200 w. Autocar—Aug. 8, 1908. No. 94358 A.

Ignition.

Gearless Magnetos. Gives illustrated descriptions of the Henrique, and the Nieuport magnetos. 2200 w. Autocar—Aug. 15, 1908. No. 94449 A.

The Relation Between Power and Spark. W. Watson. Gives results of experiments on the influence of the character of the spark on the power developed, and the effects of using two sparks. 2000 w. Autocar—July 25, 1908. No. 94134 A.

Low-Priced.

Concerning the Eleventh Year Automobiles. Thomas J. Fay. The present discussion deals only with the lower-priced cars, claiming that they are the best the builders have ever turned out. Ills. 3500 w. Automobile—Aug. 13, 1908. Serial. 1st part. No. 94334.

Mercedes.

The 35-H.P. Live-Axle Mercedes. An illustrated detailed description of a model embodying many uncommon principles in design. 1200 w. Auto Jour—Aug. 1, 1908. Serial. 1st part. No. 94246 A.

Motors.

Valve Positions in Petrol Motors. Bertram C. Jay. Discusses the question from the point of view of the working conditions inside the combustion chamber. 1600 w. Autocar—Aug. 15, 1908. No. 94450 A.

What Is the Best Relation of Bore to Stroke? Gerard Laverque. Shows the importance of the stroke as a factor in the power of a motor, discussing particularly the long stroke. 2800 w. Automobile —Aug. 27, 1908. No. 94643.

Omnibuses.

The London Motor Omnibus Problem. Bernard Hopps. Abstract of a paper before the Rugby Engng. Soc. A brief summary of London's motor omnibus development with discussion of the petrol-electric system. 2500 w. Auto Jour—Aug. 15, 1908. No. 94448 A.

Panhard.

The 15 H. P. Chainless Panhard. Illustrated description of new features introduced. 1600 w. Autocar—Aug. 1, 1908. No. 94248 A.

Speed Regulation.

Governing the Speed of Motor Vehicles. Morris A. Hall. Considers the mechanical methods by which overspeeding may be prevented. 2500 w. Com Vehicle—Aug., 1908. No. 94311 C.

Tires.

The Torkington Solid Rubber Tyre. Illustrates and describes the construction of a new form of tyre that can be used for heavy, high-speed touring vehicles. 3000 w. Auto Jour—July 25, 1908. No. 94136 A.

A New Pneumatic Tire for Heavy Loads (Nouveau Dispositif de Pneumatique pour Poids lourds). A. Michelin. Discusses the advantages of a tire consisting practically of two tires joined together. Ills. 2300 w. Mem Soc Ing Civ de France—April, 1908. No. 94501 G.

The Action and Wear of Solid Rubber Tires on Industrial Vehicles (Mode d'Action et Usure des Bandages Pleins en Caoutchouc, sur les Automobiles Industrielles). E. Girardault. Ills. Serial. 1st part. 1500 w. Génie Civil—July 25, 1908. No. 94535 D.

Tractors.

War Office Competition for Light Tractors. Gives the requirements to be fulfilled, with editorial. 4000 w. Engng—July 24, 1908. No. 94163 A.

Wheels.

The Wicks Resilient Wheel. Illustrates and describes an invention of F. Wicks aiming to render suitable the use of steel tires on motor omnibuses and other heavy vehicles. 800 w. Auto Jour—Aug. 15, 1905. No. 94447 A.

Wire and Wood Wheels. Gives results of impact tests on the two types of wheels, which seem to demonstrate that wire wheels are able to withstand modern heavy side stresses better than wooden wheels. Ills. 1200 w. Autocar—July 25, 1908. No. 94135 A.

White.

The 1909 White Steam Cars. Illustrated descriptions of Models M and O, of 40 and 20 h.p. respectively. 2000 w. Automobile—Aug. 27, 1908. No. 94645.

Winton.

Winton Sixes for 1909. Illustrated description of features of new 6-cylinder cars. 1200 w. Automobile—Aug. 6, 1908. No. 94197.

COMBUSTION MOTORS.

Fuels.

Alcohol as a Fuel for Internal-Combustion Engines. Thomas L. White. This concluding article considers its practical carburation and adaptation as a gasoline substitute. 5000 w. Engineering Magazine—Sept., 1908. No. 94681 B.

Gas Engines.

The Turner-Fricke Gas Engine. Illustrates and describes some improvements introduced. 1500 w. Ir Age—Aug. 20, 1908. No. 94404.

Gasoline Engines.

See Motors, under AUTOMOBILES.

Gas Power Plants.

See Gas Producers, under COMBUSTION MOTORS; Power Plants, under POWER AND TRANSMISSION; and Plants, under MINING AND METALLURGY, MINING.

Gas Producers.

Suction Gas Producer for American Coals and Lignites. L. P. Tolman. Brief review of the early history of producer gas, with illustrated description of suction gas power plants in single circuits of 200 h.p., or smaller, and complete plants of 1000 h.p. or larger. 4000 w. Ind Wld—Aug. 10, 1908. No. 94243.

Progress in Use of Suction Gas Producer Power. L. P. Tolman. Discusses the efficiency and economy of producer gas power plants; the development and types of the suction gas producer. Ills. 3500 w. Min Wld—Aug. 15, 1908. No. 94357.

Important Considerations in the Construction and Operation of Gas Producer Plants for Open-Hearth Steel Plants (Wichtige Gesichtspunkte für den Bau und Betrieb von Gaserzeugeranlagen bei Martinwerken). C. Canaris. 4500 w. Oest Zeitschr f Berg- u Hüttenwesen—July 18, 1908. No. 94560 D.

Oil Engines.

See Pumping Plants, under HYDRAULIC MACHINERY.

HEATING AND COOLING.

Air Humidifying.

Air Washing and Humidifying, and Some of Its Applications to Industrial Purposes. W. A. Rowe. Condensed from paper read before the Ohio Soc. of Mech., Elec., & Steam Engrs. Discusses methods of adding moisture to air and also dehumidifying air. 1500 w. Eng News—Aug. 13, 1908. No. 94321.

Electric Heating.

Electric Heating and Cooking (Das elektrische Heizen und Kochen). E. R. Ritter. A description and comparison of systems and appliances. Ills. Serial. 1st part. 3800 w. Gesundheits-Ing—July 18, 1908. No. 94579 D.

Exhaust-Gas Heating.

A Heating System Utilizing the Waste Heat of a Gas Engine. F. C. Tryon. Describes a successful system of utilizing the waste heat for heating the buildings. Ills. 1000 w. Power—Aug. 4, 1908. No. 94127.

Hot-Water Heating.

Combined Power and Hot Water Heating Plant. Charles L. Hubbard. Illustrated description of the arrangement of the special apparatus and operation of the plant. 1500 w. Power—Aug. 25, 1908. No. 94601.

Rapid-Circulation Hot-Water Heating (Chauffage à Niveau et à Circulation accélérée). L. d'Anthonay. Describes and compares the principal systems, outlines the advantages and disadvantages of each and gives note on the cost of installation and operation. Ills. 5200 w. Mem Soc Ing Civ de France—May, 1908. No. 94504 G.

Houses.

Important Considerations in House Heating. From an article by E. D. Sidman, in *Building Management*. On the proper equipment and arrangement of house heating apparatus. 1500 w. Met Work—Aug. 22, 1908. No. 94432.

Refrigeration.

Ice Making and Refrigeration in Japan. Tatsujiro Uchimura. A brief account of the beginnings of this industry. 1200 w. Ice & Refrig—Aug., 1908. No. 94080 C.

Jacket Water on Single Acting Compressors. John E. Starr. Practical tests and deductions, explaining why jacket water is of little value. 2500 w. Ice & Refrig—Aug., 1908. No. 94079 C.

School Buildings.

Heating and Ventilation of School Buildings. Walter B. Snow. Describes a double-duct system of indirect heating. Ills. 2400 w. Power—Aug. 4, 1908. No. 94129.

Ventilation.

Purification of Air by Means of Ozone. Dr. G. Erlwein. An illustrated description of new ozone apparatus for ventilation. 900 w. Sci Am Sup—Aug. 15, 1908. No. 94338.

HYDRAULIC MACHINERY.

Centrifugal Pumps.

High Pressure Centrifugal Pumps (Les Pompes centrifuges à haute Pression). D. Banki. A translation into French of an article which appeared in the *Zeitschr. d. Oest. Ing. u. Arch. Vereines*, in 1903. Ills. 5500 w. Rev. de Mécan—July, 1908. No. 94521 E + F.

A Criticism of Biel's Work on Centrifugal Pumps and Fans (Kritik der Bielschen Arbeit über Kreiselpumpen und Ventilation). E. Eickoff. A criticism of a paper by R. Biel published in *Zeitschr. d. Ver. Deutscher Ing.* for March 21, 1908, *et seq.* Ills. Serial. 1st part. 1500 w. Die Turbine—July 20, 1908. No. 94569 D.

Hydrostatics.

Hydrostatics, or the Equilibrium of Fluids. Franklin van Winkle. Considers facts concerning compressibility of liquids, the transmission of pressure through them, head and pressure due to gravity, etc. Ills. 2400 w. Power—Aug. 11, 1908. No. 94279.

Pumping.

See same title, under MINING AND METALLURGY, MINING.

Pumping Plants.

The New Sewage Pumping Station, Washington, D. C. Illustrated detailed description of the station and its equipment. 4000 w. Eng Rec—Aug. 22, 1908. No. 94486.

Operating Results of the Wrentham and Wareham Fuel-Oil Pumping Stations. Information furnished by Edmund M. Blake concerning the operation and results of tests of these Massachusetts plants. Ills. 1200 w. Eng Rec—Aug. 29, 1908. No. 94687.

See also Pipe Lines, under CIVIL ENGINEERING, WATER SUPPLY.

Pumps.

Direct - Acting Compound - Condensing Steam-Pump. Brief detailed description, with illustrations. 300 w. Engng—July 31, 1908. No. 94268 A.

Turbine Governing.

The Glocker-White Turbine Governor. W. M. White and L. F. Moody. Illustrated description of a water-wheel governor having hollow balls containing a shifting charge of mercury. 2500 w. Power—Aug. 4, 1908. No. 94131.

Turbines.

Hydraulic Turbine Wear and Corrosion. Edward P. Buffet. An illustrated report of results of an investigation of abnormal wear, abrasion and corrosion of water turbines. 2000 w. Power—Aug. 4, 1908. No. 94128.

The Francis Turbine (Die Francis-Turbine). Adolf Knelles. A mathematical demonstration of the method of design. Ills. 3000 w. Elektrotech Rundschau—July 10, 1908. No. 94589 D.

Tests of a Lorenz Turbine (Versuche an einer Lorenz-Turbine). Ernst Reichel. Describes machine and tests and gives results in curves and tables. Ills. Serial. 1st part. 4500 w. Zeitschr f d Gesamte Turbinenwesen—July 10, 1908. No. 94570 D.

MACHINE ELEMENTS AND DESIGN.

Ball Bearings.

Modern Ball Bearings and Their Applications (Die heutigen Kugellager und ihre Anwendung). Aug. Bauschlicher. Illustrated discussion of new applications and developments. Serial. 1st part. Zeitschr d Ver Deutscher Ing—July 25, 1908. No. 94652 D.

Crank Shafts.

Crank Shafts. Norman S. Trustrum. A study of stresses in a moving crank. Ills. 1200 w. Mech Engr—Aug. 14, 1908. Serial. 1st part. No. 94458 A.

Flywheels.

The Functions of Flywheels. H. M. Sayers. Discusses flywheel effects and the purposes for which they are used. 3500 w. Elec Engng—Aug. 13, 1908. No. 94460 A.

Machine Frames.

The Designing of Machine Frames. E. A. Fessenden. Discusses a method of designing, explaining calculations and stating the advantages of this method. Ills. 3500 w. Mach, N Y—Aug., 1908. No. 94113 C.

Springs.

Sizes of Helical Springs without Mathematics. A. T. Nickerson. Gives charts for finding the proportions, illustrating their use by examples. 1200 w. Am Mach—Vol. 31, No. 33. No. 94314.

MACHINE WORKS AND FOUNDRIES.

Annealing.

Annealing Grey Iron Castings. Walter J. May. Explains the advantages gained by removing the casting stresses. 800 w. Prac Engr—Aug. 14, 1908. No. 94457 A.

Boring Machines.

A Jig Boring Machine of English Design. J. W. Chubb. Illustrated description of a vertical spindle tool using end measuring rods and micrometer adjusting devices. 2500 w. Am Mach—Vol. 31. No. 34. No. 94405.

Brass Founding.

New Brass Casting Regulations. New regulations, in Circ. 484, issued by the British Home Secretary. 1200 w. Ir & Coal Trds Rev—July 31, 1908. No. 94274 A.

Value of Liquid Fuel in Brass Foundry Practice. W. N. Best. Read before the Am. Brass Found. Assn. Considers burners for liquid fuel, regulating devices, air consumption, supply tank, etc. 1500 w. Foundry—Aug., 1908. No. 94187.

Burnishing.

Some Notes on Machine Burnishing. Illustrated descriptions of various burnishing machines with remarks on their operation. 1500 w. Brass Wld—Aug., 1908. No. 94386.

Castings.

See Annealing, under MACHINE WORKS AND FOUNDRIES.

Cupolas.

A Study of Cupola Blast Pressures. Walter B. Snow. Compares results of a series of forty-six recent tests. 1400 w. Foundry—Aug., 1908. No. 94189.

Chemical Reactions in Cupola Practice. Jules De Clercy. Read before the Am. Found. Assn. Examines experimental results giving conclusions concerning the conditions most suitable for the proper operation of a cupola. 2000 w. Found—Aug., 1908. No. 94191.

Cutting Tools.

Internal Cutting Tools for Screw Machines. C. L. Goodrich and F. A. Stanley. Illustrates and describes the spotting tools and drills used for starting holes, which are completed by drills, reamers and counterbores of various types. 2000 w. Am Mach—Vol. 31. No. 35. No. 94629.

Emery Wheels.

The Manufacture of Emery Wheels. Illustrates and describes the process as carried out at a new plant at Rochester, Pa. 1500 w. Ir Trd Rev—Aug. 13, 1908. No. 94332.

Filing.

How to Handle a File. W. A. Knight. Hints of value in regard to filing flat, concave and convex surfaces, and filing out a slot. Ills. 2000 w. Mach., N Y—Aug., 1908. No. 94115 C.

Foundry Materials.

See Metallurgy, under MATERIALS OF CONSTRUCTION.

Foundry Practice.

Malleable-Iron Founding. F. R. King. Describes the production of iron castings by the English or Reamur system. 1500 w. Mech Wld—Aug. 14, 1908. No. 94456 A.

Furnaces.

Electric Furnaces Used in Treating Steel. E. F. Lake. Different styles of furnaces are illustrated and described. 2000 w. Am Mach—Vol. 31. No. 33. No. 94316.

A Crucible Furnace Embodying a New Principle. Illustrated description of an oil-burning furnace invented by W. S. Rockwell. 1000 w. Brass Wld—Aug., 1908. No. 94388.

The Kroeschell-Schwartz Gyrating-Flame Crucible Furnace. Illustrated description of a new type invented by E. H. Schwartz. 400 w. Brass Wld—Aug., 1908. No. 94389.

See also Brass Founding, under MACHINE WORKS AND FOUNDRIES.

Galvanizing.

Galvanizing. Translated from Friedrich Hartmann's book, "Das Verzinnen, Verzinken, etc., der Metalle," giving practical suggestions. 1700 w. Sci Am Sup —Aug. 29, 1908. Serial. 1st part. No. 94642.

Gear Cutting.

A New Eberhardt Gear Cutter. Illustrates and describes an automatic machine for doing a wide range of work. 1700 w. Ir Age—Aug. 27, 1908. No. 94624.

The Evolution and Methods of Manufacture of Spur-Gearing. Thomas Humpage. An illustrated historical review of the development of gear-cutting machinery. 9000 w. Inst of Mech Engrs—July 28, 1908. No. 94262 N.

A New English Gear-Cutting Machine. J. W. Chubb. The work is rotated and moved up and down past rack tooth shaped cutters. Ills. 700 w. Am Mach—Vol. 31. No. 32. No. 94184.

Grinding.

Practical Points in Cylindrical Grinding. J. J. Thatcher. Considers the economy of roughing out in the lathe prior to grinding, and the advantages of higher work speeds. 2500 w. Am Mach—Vol. 31. No. 34. No. 94406.

A New Idea for Disk Grinders with Tests. F. N. Gardner. Illustrates and describes corrugated disks presenting points of abrasion. Gives comparative test results. 1700 w. Am Mach—Vol. 31. No. 32. No. 94185.

Grinding Machines.

Guest's Grinding Machines. Illustrated detailed description of a machine manufactured at Birmingham, Eng. 2200 w. Engng—Aug. 14, 1908. No. 94474 A.

Lathes.

The Bench Lathe as a Manufacturing Tool. F. A. Stanley. Illustrates and describes how dial-measuring gages and other tools are machined in bench lathes and tested with special devices. 2200 w. Am Mach—Vol. 31, No. 33. No. 94313.

Machine Tools.

A Machine for Milling, Grinding, Slotting, and Punching Cylindrical Machine Parts (Machine à Fraiser, Polir, Rainer, et Percer des Piéces Cylindriques de Machines). Illustrated description. 1700 w. Métallurgie—July 1, 1908. No. 94528 D.

Machine Tools at the International Automobile Exposition in Berlin, 1907 (Die Werkzeugmaschinen auf der internationalen Automobilausstellung in Berlin, 1907). Illustrated description of various models. Serial. 1st part. 3000 w. Zeitschr f Werkzeug—July 25, 1908. No. 94573 D.

Molding.

Spacing and Mounting Patterns. Alex. M. Thompson. Paper before the Ass. Found. Foremen. Gives a new means of quickly spacing and attaching patterns on the mold board. Ills. 2000 w. Mech Wld—Aug. 7, 1908. No. 94364 A.

Rack Cutting.

A Method of Cutting Racks on a Planer. Howard Hunt. Illustrated description. 700 w. Am Mach—Vol. 31. No. 35. No. 94631.

Shop Appliances.

Master Plates and Their Uses in Die Making. E. H. Crosby. Illustrates and describes methods used in producing master plates, and their use in actual shop practice. 3000 w. Am Mach—Vol. 31. No. 32. No. 94182.

Making Tools for Formed Gear Cutters and Hubs. Warren E. Thompson. The application of templets, fly cutters, formed tools and fixtures to the solution of the formed cutter problem. 5000 w. Am Mach—Vol. 31. No. 34. No. 95407.

Shops.

The Newark and Victoria Works, Bath. Illustrations and brief description of the works of Stothert and Pitt, Ltd. 2500 w. Engr, Lond—Aug. 7, 1908. No. 94374 A.

The Utica Drop Forge & Tool Company's Plant. Illustrated detailed description of plant and equipment for the manufacture of nippers and pliers. 2500 w. Ir Age—Aug. 6, 1908. No. 94179.

Tapping Machines.

Machines for Tapping Pipe Fittings. The machines are entirely automatic after the work is placed. Ills. 800 w. Am Mach—Vol. 31. No. 35. No. 94627.

Tempering.

Local Hardening and Tempering. William A. Painter. Describes the manipulations of tool steel by the flexible cover or shield method. Ills. 3300 w. Mach, N Y—Aug., 1908. No. 94114 C.

Welding.

Welding by Means of the Electric Arc. C. B. Auel. Describes the Zerener process, and the Benardos process. Ills. 2500 w. Am Mach—Vol. 31. No. 35. No. 94626.

Autogenous Welding and Metal Cutting (Die autogene Schweissung und das autogene Schneiden). August Bauschlicher. Describes the methods and results of using the oxy-acetylene and oxy-hydrogen blowpipes, giving costs. Ills. Serial. 1st part. 4400 w. Zeitschr f Werkzeug—July 25, 1908. No. 94574 D.

Wood-Working Machinery.

Wood-Working Machinery for Carriage and Wagon Building. Illustrated description of recent types of machines for preparing the woodwork of rolling-stock. 1200 w. Engng—July 31, 1908. No. 94266 A.

MATERIALS OF CONSTRUCTION.

Alloys.

Britannia-Metal and How It Is Made. Information concerning the composition and use of this metal. 1000 w. Brass Wld—Aug., 1908. No. 94387.

About Some Characteristics of Magnalium. M. R. Machol. Information concerning this aluminum alloy. 2000 w. Automobile—Aug. 20, 1908. No. 94413.

Silicides for Containers of Acids. From a paper by Ad. Jouvé, before the Faraday Soc., on new applications of electro-metallurgical alloys. Briefly considers the manufacture of apparatus, the resistance to acids and other reagents. 1000 w. Elec-Chem & Met Ind—Aug., 1908. No. 94122 C.

Recent Researches on Copper-Aluminum Alloys (Recherches Récentes sur les Alliages de Cuivre-Aluminium). L. Guillet. A general review of results. Ills. 4500 w. Rev de Métal—July, 1908. No. 94512 E + F.

Alloy Steels.

Special Steels for Electrical Purposes. Gives data in regard to steel for electrical machinery. 800 w. Elec Wld—Aug. 8, 1908. No. 94209.

Brass Refuse.

The Treatment of Ashes, Skimmings, Sweeps, Slags and Other Refuse by the Brass Rolling Mills in the United States. Erwin S. Sperry. Deals with methods of smelting brass refuse and other copper-bearing material. Ills. 1500 w. Brass Wld—Aug., 1908. No. 94385.

Metallography.

Micro-Structure of Foundry Irons. George Hailstone. Read before the Staffordshire Iron & Steel Inst. Discusses the action of the metalloids on the micro-structure of iron. Ills. 4000 w. Foundry—Aug., 1908. No. 94190.

Constitution of Iron and Phosphorus Compounds. B. Saklatwalla. A complete thermal and metallographic investigation of the subject. Ills. 4000 w. Jour Ir & St Inst—No. II, 1908. No. 94612 N.

Iron, Carbon, and Sulphur. Donald M. Levy. Reports a research made to investigate the action of sulphur, as it affected the relations of iron and carbon. Ills. 16500 w. Jour Ir & St Inst—No. II, 1908. No. 94611 N.

The Microscopic Features of Hardened Supersaturated Steels. Edward Hess. States the object and method of investigation described, stating conclusions. Ills. 1200 w. Jour Ir & St Inst—No. II, 1908. No. 94609 N.

Hardness of the Constituents of Iron and Steel. H. C. Boynton. Compares the hardness of the constituents with Mohs scale for the hardness of minerals, reports tests and conclusions. Ills. 5400 w. Jour Ir & St Inst—No. II, 1908. No. 94614 N.

Experimental Researches on the Cooling Power of Liquids, on Quenching Velocities, and on the Constituents Troostite and Austenite. Carl Benedicks. Ills. 27600 w. Jour Ir & St Inst—No. II, 1908. No. 94615 N.

The Specific Heat of Iron (Die spezifische Wärme des Eisens). P. Oberhoffer. Describes method and devices for its determination and gives results of a large number of tests. Ills. 3300 w. Zeitschr d Ver Deutscher Ing—July 25, 1908. No. 94653 D.

Packings.

The Development of Non-Metallic Packings. W. E. Sanders. A review of early forms of packing, giving classification, and stating objections to monkey-wrench packings. Ills. 2500 w. Power—Aug. 25, 1908. No. 94602.

Shaft Packing (Abdichtung von rotierenden Wellen). Leo Russmann. Describes recent developments in packing and stuffing boxes, particularly for steam turbines. Ills. Serial. 1st part. 1600 w. Elektrotech u Maschinenbau—July 26, 1908. No. 94595 D.

Steel.

Influence of Heat Treatment on Steel. Thomas J. Fay. Shows the various ways the grades of steel used in automobile work may be rendered best fitted. 4500 w. Automobile—Aug. 20, 1908. No. 94412.

See also Wire, under MATERIALS OF CONSTRUCTION.

Tool Steels.

The Manufacture of High-Speed Steel. O. M. Becker. Illustrates and describes workshop processes in the making of modern tool steels. 2500 w. Cassier's Mag—Aug., 1908. No. 94172 B.

Function of Chromium and Tungsten in High-Speed Tool Steel. C. A. Edwards. Report of an investigation, with conclusions. Ills. 7000 w. Jour Ir & St Inst—No. II, 1908. No. 94613 N.

Wire.

Investigations of the Flexibility of Wires (Untersuchung der Biegbarkeit von Drähten). Adolph Schuchart. Methods and results of tests of steel wires of various sizes and composition and subjected to various heat treatments. Ills. Serial. 1st part. 2400 w. Stahl u Eisen—July 1, 1908. No. 94551 D.

MEASUREMENT.

Dynamometers.

Barr and Stroud's Dynamometer. Diagrams and description of an electrical appliance for ascertaining the power transmitted by a revolving shaft. 3500 w. Mech Engr—Aug. 7, 1908. No. 94363 A.

Gauges.

A Measuring Machine of Simple Construction. Oscar E. Perrigo. Illustrates and describes a work gauging machine. 1800 w. Am Mach—Vol. 31. No. 34. No. 94408.

Pressure Gauges.

Gages for Measuring Pressures of Liquids. Franklin van Winkle. Describes the essential features of different types. Ills. 2500 w. Power—Aug. 18, 1908. No. 943[illegible]1.

Scleroscope.

The Shore Scleroscope. J. F. Springer. Illustrated detailed description of an instrument for the measurement of hardness, and some of its applications. 2800 w. Ir Age—Aug. 27, 1908. No. 94623.

Test Indicator.

A Test Indicator and Some of Its Applications. An instrument for setting and testing lathe, miller, shaper and surface plate work is illustrated and described. 900 w. Am Mach—Vol. 31. No. 35. No. 94630.

Testing Materials.

The Characteristics of Materials in Rupture Tests and in Flexure and Impact Tests on Nicked Bars (Ueber Materialeigenschaften im Zerreiss-, Kerbreiss-, und Kerbschlagversuche). O. Thallner. An experimental study of the accuracy of these methods. Ills. Serial. 1st part. 3000 w. Stahl u Eisen—July 29, 1908. No. 94557 D.

POWER AND TRANSMISSION.

Air Compressors.

The Design of Air Compressor Valves. States the conditions for good working of an air compressor, and the various types of valves. Ills. 2000 w. Mech Wld—Aug. 7, 1908. No. 94365 A.

New Norwalk Compressors and Unloading Devices. Illustrated detailed description of two new types of unloaders, explaining their advantages. 2000 w. Ir Age—Aug. 13, 1908. No. 94309.

Steam Consumption of Air Compressors. W. A. Macleod and J. P. Wood. From *Pro. Aust. Inst. of Min Engrs.* A report of tests, with an outline of the type and guarantee of the machines tested. 1400 w. Aust Min Stand—July 8, 1908. Serial. 1st part. No. 94361 B.

See also Turbines, under STEAM ENGINEERING.

Belts.

The Modern Lenix System of Transmission (Transmissioni moderne Lenix). W. Zuppinger. Description and discussion of this system for keeping belts at proper tension. Ills. Serial. 1st part. 1200 w. Industria—July 12, 1908. No. 94542 D.

Compressed Air.

An Air Receiver and Pipe Line Explosion. S. A. Newton. An illustrated account of a disastrous accident to a compressed air system. 1000 w. Power—Aug. 25, 1908. No. 94600.

Costs.

Operating Results of the McKees Rocks Power Plant of the Pittsburg & Lake Erie Railroad. Explains briefly the operating organization and system of accounting, giving a study of results. 2500 w. Eng Rec—Aug. 22, 1908. No. 94494.

Electric Driving.

Electric Motor Printing Press Drive. S. H. Sharpsteen. Describes different methods. 2200 w. Elec Wld—Aug. 8, 1908. No. 94208.

Electrical Machinery in a Great Corn Products Plant. Illustrated description of the electrical equipment of a large factory at Roby, Ind. 2500 w. Elec Rev, N Y—Aug. 1, 1908. No. 94105.

See also Textile Mills, under POWER AND TRANSMISSION.

Lubricants.

The Engineer and Oil Analysis. Editorial aiming to show where the service of the oil analyst may be usefully engaged, and where dispensed with in the field of marine engineering. 1500 w. Engng—July 31, 1908. No. 94271 A.

Power Plants.

Modern Gas Engines vs. Steam Turbines in Mining. Frank C. Perkins. Reports tests made with turbine, gas, steam, and alcohol engines to ascertain their efficiency. Ills. 1700 w. Min Wld—Aug. 22, 1908. No. 94495.

Power System of the Henry Vogt Machine Co. Osborne Monnett. Illustrated description of an up-to-date steam-electric plant in Louisville, Ky. 2500 w. Power—Aug. 18, 1908. No. 94376.

The New Gas-Electric Power Plant at Gary, Ind. Claude Aikens. Description of engines in what is to be the largest power station in the world. Ills. 2500 w. Power—Aug. 18, 1908. No. 94379.

Power Plant of the New Union Terminal Station at Washington, D. C. Illustrated description of this terminal power plant, which supplies electricity for light and power, steam for the heating, compressed air for signal operation, hydraulic pressure for elevators, and refrigeration. 5000 w. Eng Rec—Aug. 8, 1908. No. 94231.

The Choice of Power for the Factory of Small or Medium Size (La Forza motrice nelle Officine di Piccola e Media Potenza). Salvatone Spera. A discussion of the relative economy of steam, gas, water and electric power. Serial. 1st part. 2500 w. Il Monit Tech—July 20, 1907. No. 94543 D.

Textile Mills.

Some Aspects of the Power Problems for the Textile Industries. Charles J. Kavanagh. An illustrated article considering the relative advantages of steam, gas, and electricity. 2200 w. Cassier's Mag—Aug., 1908. No. 94177 B.

STEAM ENGINEERING.

Boiler Design.

Boiler Headers and Connections. H. J. Ott. The design and the difficulties are briefly considered. Ills. 1500 w. Power—Aug. 11, 1908. No. 94278.

Boiler Explosions.

The Most Frequent Cause of Boiler Explosions. William H. Boehm. Explains how serious is scale in boilers. 900 w. Am Mach—Vol. 31. No. 32. No. 94183.

Boiler Furnaces.

Pin Hole Grate Firing. Warren H. Miller. Describes this system and its operation, giving costs. 2000 w. Power—Aug. 18, 1908. No. 94377.

Boiler Inspection.

Necessity for Uniform Laws Covering the Construction and Inspection of Boilers. H. J. Hartley. Read before the Am. Boiler Mfrs. Assn. Ills. 3000 w. Boiler Maker—Aug., 1908. No. 94133.

Boiler Management.

Boiler Management in the Central Station (Du Contrôle de la Chauffe dans les Stations Centrales). J. Izart. A practical discussion. Ills. Serial. 1st part. 2000 w. L'Elecn—July 4, 1908. No. 94522 D.

Boiler Scale.

See Boiler Explosions, under MACHINE WORKS AND FOUNDRIES.

Boiler Theory.

The Law of Heat Transfer Through Steam Boiler Heating Surface. F. Kingsley. An examination of the theories advanced, giving results of tests. 1700 w. Eng Rec—Aug. 29, 1908. No. 94696.

Boiler Waters.

Experimental Electrical Treatment of Water to Remove Incrustating Solids. J. L. Campbell. Describes a plant, on the El Paso & S.-W. Ry. for softening water for locomotives. Ills. 1000 w. Eng News—Aug. 13, 1908. No. 94318.

Condensers.

The Modern Surface Condenser. George A. Orrok. An outline of recent progress in the development of condensers. 1200 w. Power—Aug. 11, 1908. No. 94276.

Cylinder Condensation.

Leakage and Condensation of Steam in Reciprocating Steam Engines. A report of experiments, stating conclusions. 4000 w. Engr, Lond—Aug. 14, 1908. No. 94479 A.

Engine Governors.

Inertia Governors (Sur les Regulateurs à Force d'Inertie tangentielle). M. Busset-Schiller. Describes and discusses mathematically recently developed types. Ills. 10500 w. Bul Soc Int d'Elecns—July, 1908. No. 94510 F.

Engine Lubrication.

See Superheating, under STEAM ENGINEERING.

Engine Reconstruction.

Increasing the Power of an Old Engine. Herbert L. Towle. Discusses in detail changes safe and unsafe in altering an old engine. Ills. 2500 w. Rudder—Aug., 1908. Serial, 1st part. No. 94186 C.

Feed-Water Heating.

The Feed-Water System for the Power Plant. Charles A. Howard. A summary of boiler-feed practice, discussing points in design, equipment, and operation. 3000 w. Engineering Magazine—Sept., 1908. No. 94682 B.

Fuels.

Coalesine Fuel: Utilization of House Refuse. Herbert Coales. A proposed method of converting refuse into fuel. Short discussion. 2200 w. Surveyor—Aug. 7, 1908. No. 94359 A.

The Nature of the Volatile Matter of Coal as Evolved Under Different Conditions. Horace C. Porter and F. K. Ovitz. Abstract of paper before the Am. Chem. Soc. describing investigations of the hydrocarbons given off at different temperatures. 2200 w. Elec Rev, N Y—Aug. 22, 1908. No. 94418.

Some Things a Power User Should Know About Coal. E. G. Bailey. Read at the Nat. Assn. of Cotton Mfrs., Boston. Discusses knowledge necessary for the continuous and economic operation of the plant. 3500 w. Can Engr—Aug. 7, 1908. No. 94239.

Fuel Testing.

Relation of Government Fuel Investigation to the Solution of the Smoke Problem. D. T. Randall. Statistics concerning the enormous amount of fuel consumed annually, and the efforts to correct wasteful methods. 1400 w. Cent Sta—Aug., 1908. No. 94288.

Plant Management.

The Present Status of Coal-Power. D. B. Waters. A lecture on the methods of utilizing coal-power, steam plants and their efficiency, etc. 4500 w. N Z Mines Rec—June 16, 1908. Serial, 1st part. No. 94622 B.

Superheating.

The Specific Heat of Superheated Steam. Gives reply of Doctors Jakob and Knoblauch to Prof. Reede's criticism; and Prof. Heck on Reeve's views of terminology and nature of entropy. 3000 w. Power—Aug. 4, 1908. No. 94130.

The Effect of Superheated Steam on Hydro-Carbon Cylinder Oils. G. W. Worrall. Abstract from *Jour. Soc. of Chem. Ind.* A report of experiments undertaken to gain information on the problem of cylinder lubrication. 1000 w. Engr, Lond—July 24, 1908. No. 94167 A.

The Theory of Superheated Steam Taking Account of the Variability of Its Specific Heat at Constant Pressure (Théorie de la Vapeur d'Eau surchauffée, tenant Compte de la Variabilité de sa Chaleur spécifique à Pression constante). M. Thonet. A theoretical discussion. Ills. 6000 w. Rev de Mécan—July, 1908. No. 94520 E + F.

Turbines.

The Application of Exhaust-Steam Turbines (Die Verwendung von Abdampfturbinen). Dr. A. Gradenwitz. A general description of the Rateau low-pressure turbine system. Ills. Serial, 1st part. 1700 w. Zeitschr f d Gesamte Turbinenwesen—July 30, 1908. No. 94572 D.

The Application of the Work Diagram to the Design of Steam Turbines and Compressors (Die Beurteilung der Dampfturbinen und Kompressoren auf Grund des Arbeitsdiagrammes). Guido Zerkowitz. A mathematical discussion. Ills. Serial, 1st part. 1600 w. Zeitschr f d Gesamte Turbinenwesen—July 20, 1908. No. 94571 D.

Valve Gears.

The Reynolds Long Range Cut-Off. Hubert E. Collins. Illustrates and describes the essential features of design and operation of this valve-gear as usually employed on the Allis-Chalmers engines of this type. 1500 w. Power—Aug. 11, 1908. No. 94277.

TRANSPORTING AND CONVEYING.

Coal Handling.

A Coaling Staith and Hoist on the Tyne. Illustrations, drawings, and brief description. 400 w. Engr, Lond—Aug. 14, 1908. No. 94482 A.

Inclined Retort Coal- and Coke-Handling Plant at Bristol. William Stagg. Describes in detail the plant for the mechanical handling of materials. Ills. 4000 w. Inst of Mech Engrs—July 28, 1908. No. 94260 N.

The Coal Industry of Greater New York. Werner Boecklin. Illustrates and describes the storage and machinery facilities for handling 30,000,000 tons annually. 2000 w. Engineering Magazine—Sept., 1908. No. 94683 B.

Mechanical Unloading, Loading and Storage Appliances for Materials in Bulk (Zur Frage der mechanischen Lösch-, Lade- und Lager-Vorrichtungen für Massengüter). M. Buhle. Describes new coal- and ore-handling installations in Europe. Ills. 2200 w. Glasers Ann—July 1, 1908. No. 94576 D.

Conveyors.

The Gibb Underground Conveyor. Illustrated description of this conveyor and its application to the working of thin seams. 3000 w. Col Guard—Aug. 7, 1908. No. 94369 A.

See also Cyaniding, under MINING AND METALLURGY, Gold and Silver.

Cranes.

The Equipment of Electrical Cranes. R. H. Fenkhausen. Considers the choice and care of motors, hoists and brakes, and troubles liable to be encountered. 2000 w. Power—Aug. 4, 1908. No. 94126.

Elevators.

The High Pressure Hydraulic Elevator. William Baxter, Jr. Considers the adjustment and care of automatic stop valves and mechanism, and packings in the present number. Ills. 2500 w. Power—Aug. 18, 1908. Serial, 1st part. No. 94380.

High Speed Elevators. W. W. Lighthipe. Gives statistics showing that twice as many people are carried vertically as are carried horizontally in New York City every 24 hours, and describes the types of high-speed elevators used. 2000 w. Sch of Mines Qr—July, 1908. No. 94285 D.

Materials Handling.

Hoisting and Handling Machinery in Steel Works and Rolling Mills (Hebe- und Transportmittel in Stahl- und Walzwerksbetrieben). G. Stauber. Illustrated description of many types. Serial, 1st part. 1500 w. Stahl u Eisen—July 15, 1908. No. 94554 D.

MISCELLANY.

Aeronautics.

Advance in Aeronautical Motor Building. W. F. Bradley. An illustrated article considering the new principles in aero engine design. 3000 w. Automobile—Aug. 13, 1908. No. 94335.

Recent Foreign Aeroplanes. Illustrates and describes recent types experimented with in France. 1200 w. Sci Am—Aug. 22, 1908. No. 94423.

Conditions of Success with Aeroplanes. L. J. Lesh. Suggestions, dealing exclusively with aeroplanes. 2500 w. Sci Am Sup—Aug. 8, 1908. No. 94226.

The Wright Brothers' Aeroplane in France and the United States. Photographs and description of the aeroplane and its operation. 1800 w. Sci Am—Aug. 29, 1908. No. 94639.

The Zeppelin Air-Ships. Describes the type of balloon advocated by this aeronaut and gives a brief review of what he has accomplished. 2500 w. Engng—July 31, 1908. No. 94265 A.

The Design of Recent Airships (Die neueren Luftschiffe, ihre Bauart und technischen Einrichtungen). Herr Buchholtz. A review of recent progress in design, means of propulsion, etc. Ills. 5500 w. Glasers Ann—July 1, 1908. No. 94575 D.

Practical Notes on the Construction of Air Ships (Erfahrungen beim Bau von Luftschiffen). Count Zeppelin. A general review of the problems encountered. 3800 w. Zeitschr d Ver Deutscher Ing—July 25, 1908. No. 94651 D.

Guns.

The 2.95-In. Deport Field-Gun at the Franco-British Exhibition. Illustrated description of the principal features and dimensions. 2000 w. Engng—Aug. 7, 1908. No. 94372 A.

The Normal Automatic Gun, Sjogren System. Illustrates and describes a self-acting, recoil-operated shot-gun, fitted with a rigid non-recoiling barrel. 1000 w. Engng—July 24, 1908. No. 94160 A.

Gyroscopes.

I. The Gyroscope and How We May Make It Useful. Arthur Gordon Webster. Illustrates and describes its powers. II. Some Applications of the Gyroscope. J. F. Springer. In mono-railroads and ship steadying. Ills. 5000 w. Am Rev of Revs—Aug., 1908. No. 94282 C.

Match Machinery.

How Matches Are Made. O. Bechstein. Illustrates and describes the ingenious machinery used. 1800 w. Sci Am Sup—Aug. 29, 1908. No. 94641.

Sugar Plant.

Eleven-Roll Sugar-Cane-Crushing Plant. Illustrated description of a mill recently built for a plant in Brazil. 1200 w. Engng—Aug. 14, 1908. No. 94475 A.

Textile Machinery.

Safety Appliances on Cotton-Twiners. Illustrates and describes methods of guarding these machines. 2000 w. Engng—Aug. 7, 1908. No. 94371 A.

Watches.

The Mechanism of the Watch You Carry. W. H. Ebelhare. Illustrated detailed description of a watch movement. 4500 w. Am Mach—Vol. 31, No. 33. No. 94315.

MINING AND METALLURGY

COAL AND COKE.

Accidents.

Causes of Accidents in Mines and Their Prevention. D. J. Roderick. Especially considers causes in the Hazleton, Pa., coal fields, but reviews a number of disasters in the anthracite region. 3000 w. Ind Wld—Aug. 10, 1908. Serial, 1st part. No. 94244.

Bins.

See Tipples, under COAL AND COKE.

Blasting.

Shot Firing by Electricity. D. Harrington. Describes the method of firing all shots from the surface, as used by the Utah Fuel Co. Ills. 3000 w. Mines & Min—Aug., 1908. No. 94078 C.

Briquettes.

Briquetted Coal in Brooklyn. Clifford D. Meeker. Illustrated description of a coal briquetting plant in Brooklyn, its machinery and conveyor layout. 2800 w. Eng Rec—Aug. 15, 1908. No. 94342.

Coke Ovens.

A New System of Modern Coke Ovens. F. Fieschi. Gives details of construction and operation which permit saving by-products and excess gases. Ills. 4500 w. Eng & Min Jour—Aug. 22, 1908. No. 94445.

New Coke Oven Installations by the Koppers Company. Explains the difference between retort ovens and beehive ovens and their working, and reviews the progress in both fields, giving illustrated description of the new system of Koppers, and stating its advantages. 6000 w. Ir & Coal Trds Rev—July 24, 1908. No. 94170 A.

Technical Criticism of the Coke Oven Industry (Kritische Streifzüge durch das technische Gebiet der Koksofenindustrie). C. Still. Application of Bernoulli's law to retort-oven construction. Mathematical. Ills. Serial, 1st part. 4000 w. Glückauf—July 4, 1908. No. 94563 D.

Electric Power.

The Electrical Equipment of the Ferndale Collieries, South Wales. Illustrated detailed description. 2500 w. Elec Rev, Lond—July 31, 1908. No. 94253 A.

See also Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Explosions.

Preventing Mine Explosions. George H. Ashley. Gives a suggested method of working and ventilating. 3000 w. Mines & Min—Aug., 1908. No. 94075 C.

Mexico.

Coal Mines of Mexico. Manuel Schwarz. Gives the locations of the different coal basins, the extent of development and output. Ills. 1500 w. Mines & Min—Aug., 1908. No. 94077 C.

Mine Fires.

Report on the Hamstead Colliery Fire. Reviews the report of R. A. S. Redmayne on the causes of, and circumstances attending, the underground fire at this colliery near Birmingham, Eng. Ills. 7500 w. Col Guard—Aug. 14, 1908. No. 94469 A.

Mine Gases.

The Fight Against Fire Damp and Carbon Monoxide in Coal Mines (La Lutte contre le Grisou et contre l'Oxyde de Carbone dans les Mines de Houille). M. Gréhant. Describes the author's apparatus and methods for gas analysis and testing. Ills. 3800 w. Bul Soc d'Encour—June, 1908. No. 94514 G.

Mine Inspection.

Coal Mines Inspection in 1907. Digest of the reports of H. M. inspectors of mines. Ills. 60700 w. Col Guard (Sup.)—Aug. 7, 1908. No. 94368 A.

Mine Rules.

Rules of the H. C. Frick Coke Co. Gives rules required to be printed in the various languages spoken by the miners and posted at all the mines of the company. 1500 w. Mines & Min—Aug., 1908. No. 94074 C.

Mining.

Losses of Coal in Mining a Flat Seam. Audley H. Stow. Considers points of importance in securing economy of operation. 5060 w. Eng & Min Jour—Aug. 8, 1908. No. 94236.

Suggested Mining Method for Pittsburg Seam. R. Y. Williams. Presents a new plan, claiming greater safety and a 30 per cent. reduction of losses of coal. Ills. 2000 w. Eng & Min Jour—Aug. 15, 1908. No. 94351.

See also Conveyors, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Peat.

The Utilization of Peat for Industrial and Metallurgical Purposes. E. Nystrom. Brief discussion of the conditions in Canada for the manufacture of peat fuel. 1400 w. Qr Bul of Can Min Inst—July, 1908. No. 94394 N.

Scotland.

The Coal Measures of the Carron and Slamannan District. The Falkirk area and the Greengairs district are described, and also the character of the deposits. 2500 w. Ir & Coal Trds Rev—Aug. 14, 1908. No. 94484 A.

Storage.

Some Experiments in the Storage of Coal. E. A. Fessenden and J. R. Wharton. Remarks on coal storage systems, with report of experimental investigations. 5000 w. Bul Univ of Missouri—No. 1. No. 94499 N.

Tipples.

Steel Tipples and Bins. W. R. Elliott Discusses causes of deterioration and precautions advisable in design to insure their preservation at bituminous coal mines. 2200 w. Mines & Min—Aug., 1908. No. 94070 C.

Washing.

Coal Washing (Le Lavage des Charbons). H.-A. Henry. A theoretical discussion of principles and a description of a system of hydraulic control and operation of the various machines used. Ills. 7000 w. All Indus—July, 1908. No. 94525 D.

Modern Coal Washing and Iron-Ore Dressing (Ueber moderne Aufbereitung von Kohle und Erzen). E. Ruland-Klein. The first part describes new devices for screening and washing coal. Ills. Serial, 1st part. 3000 w. Oest Zeitschr f Berg- u Hüttenwesen—July 25, 1908. No. 94562 D.

COPPER.

Alaska.

The Copper Deposits of Kasaan Peninsula, Alaska. Charles W. Wright. Map, with description of the geology, ore deposits, etc. 2200 w. Ec-Geol—July, 1908. No. 94301 D.

Blast-Furnace Slag.

Alumina in Copper Blast-Furnace Slags. Charles F. Shelby. A study of a variety of slags with evidence to show that alumina acts as an acid combining with more basic oxides. 7000 w. Eng & Min Jour—Aug. 8, 1908. No. 94234.

British Columbia.

The "White Bear Mine," Rossland, B. C. H. H. Yuill. Illustrations, drawings and description. 3500 w. Qr Bul of Can Min Inst—July, 1908. No. 94400 N.

Granby Mining Methods. C. M. Campbell. Illustrates and describes methods aiming at a large daily tonnage. 4000 w. Qr Bul of Can Min Inst—July, 1908. No. 94399 N.

California.

See Ore Deposits, under MISCELLANY.

Cornwall, Eng.

Geological Aspect of the Lodes of Cornwall. Donald A. MacAlister. A general geological description is given, the tin and copper districts, lode structures, genesis of the ores, etc. Map. 5000 w. Ec-Geol—July, 1908. No. 94-299 D.

Electro-Metallurgy.

The Direct Production of Copper Tubes, Sheets, and Wire. Sherard O. Cowper-Coles. Describes methods of direct production by electrolysis from impure copper. Ills. 3500 w. Inst of Mech Engrs—July 28, 1908. No. 94261 N.

Mexico.

Prospecting for Copper in Southern Michoacan, Mexico (Prospection pour Cuivre au Sud de l'Etat de Michoacan, Mexique). Raoul Bigot. A description of the ores and prospects of the district. Ills. 11000 w. Mem Soc Ing Civ de France—May, 1908. No. 94506 G.

Nevada.

Mining and Reduction of Ely Ores. R. L. Herrick. Gives the location of this Nevada camp, describing the copper ores, geological conditions, and methods of mining. Ills. 4500 w. Mines & Min—Aug., 1908. Serial, 1st part. No. 94076 C.

Smelter Smoke.

Cottrell Process for Condensing Smelter Fumes. Describes the apparatus employed and the principles involved in this electrostatic system. 3000 w. Eng & Min Jour—Aug. 22, 1908. No. 94444.

GOLD AND SILVER.

Cobalt.

Wanted—A Capitalization Basis for Cobalt Companies. Alexander Gray. Discusses the financing of Cobalt flotations. 3500 w. Min Jour—Aug. 1, 1908. No. 94256 A.

The Nipissing Mines and Their Numerous Veins. Alex. Gray. Information concerning these silver mines, the production costs and profits, and problems. 3500 w. Min Wld—Aug. 22, 1908. No. 94497.

Property and Prospects of La Rose Mines, Cobalt. Alex. Gray. Information concerning the geology and development; ore shipments and recovery of silver, cobalt, nickel, and arsenic during the past four years. 4000 w. Min Wld—Aug. 15, 1908. No. 94355.

Methods of Concentration at Cobalt, Ontario. George E. Sancton. An outline of the manner in which the ores are concentrated in the three mills which are now working, and of the proposed method of treatment at the Muggley concentrator. 3000 w. Qr Bul of Can Min Inst —July, 1908. No. 94398 N.

Cyaniding.

Cyanidation in Mexico. Francis J. Hobson. A report of experience, considering the adaptability of the cyanide process for the extraction of silver from its ores. 2000 w. Min & Sci Pr—Aug. 1, 1908. Serial, 1st part. No. 94202.

Cyanide Sand Handling at the Robinson Mine. Albert F. Crank. Extracts from a paper read before the S. African Assn. of Engrs. Illustrates and describes the automatic handling machinery and its working. 2800 w. Min Jour—July 25, 1908. No. 94156 A.

Dredging.

Dredge Working in Severe Cold. E. N. Barbot de Marny. Gives experience and opinion in Russia. 2500 w. Min Jour—Aug. 1, 1908. No. 94258 A.

Recent Developments in Gold Dredging. Frank W. Griffin. An illustrated review of progress. 2500 w. Min & Sci Pr—Aug. 15, 1908. No. 94415.

History.

Gold: Its History and Economic Development. Evans W. Buskett. Its properties, occurrence, etc. 2000 w. Min Wld —Aug. 1, 1908. Serial, 1st part. No. 94094.

India.

The Auriferous Deposits of India. Dr. Malcolm Maclaren. Reviews the history of gold mining in India, and describes the geology of the auriferous areas, in the present number. 3000 w. Min Jour —Aug. 15, 1908. Serial, 1st part. No. 94467 A.

Mexico.

Mining Camp of Topia, State of Durango, Mex. T. C. Graham. Gives the history and development of this silver-lead district. Ills. 1400 w. Min Wld—Aug. 1, 1908. No. 94091.

The Silver-Lead Mines of Santa Barbara, Mexico. Claude T. Rice. An illustrated article giving the history and geology of the district, the character of the ores and their treatment. 3000 w. Eng & Min Jour—Aug. 1, 1908. No. 94081.

Mines of Penoles Company, Mapimi, Mex. Claude T. Rice. Brief review of the history of these old silver-lead mines, and the modern methods of mining. The ore occurs in chimneys and pipes in limestone. Ills. 4500 w. Eng & Min Jour —Aug. 15, 1908. Serial, 1st part. No. 94347.

Geology of the Mining Districts of Chihuahua, Mexico. Rufus M. Bagg, Jr. Illustrates and describes this gold-bearing region and its development. 1500 w. Min & Sci Pr—Aug. 1, 1908. Serial, 1st part. No. 94200.

The Silicious Silver Mines of Parral, Mexico. Claude T. Rice. Gives the history and geology of the district, account of the mines, etc. Ills. 3300 w. Eng & Min Jour—Aug. 8, 1908. No. 94235.

New Zealand.

Te Coromandel Goldfield. Colin Fraser and James Henry Adams. Description and history of gold-mining in this district. 5000 w. N Z Mines Rec—June 16, 1908. No. 94620 B.

Gold-Deposits in Central Otago. From a Bulletin by Prof. James Park. The present number treats of some principles of concentration in river-bed gravels. 2000 w. N Z Mines Rec—June 16, 1908. Serial, 1st part. No. 94621 B.

The Great Waihi Mine. J. M. Bell. Describes the general geology, the principal veins, and the vein material in the present number. Ills. 4000 w. Can Min Jour—Aug. 15, 1908. Serial, 1st part. No. 94433.

Oregon.

Notes on Southern Oregon as Prospecting Field. Dennis H. Stovall. Information concerning conditions, geology, and peculiar occurrence of gold. 1000 w. Min Wld—Aug. 1, 1908. No. 94093.

Placers.

Some Principles of Concentration in River-Bed Gravels. James Park. Considers the progress of river erosion, the river bed bottom, position of pay wash, etc. 2500 w. Min Jour—Aug. 1, 1908. No. 94257 A.

Quebec.

Gold in the Eastern Townships of the Province of Quebec. J. Obalski. Notes on the distribution, and discoveries made. Map. 1500 w. Qr Bul of Can Min Inst—July, 1908. No. 94395 N.

Rand.

New Mining and Milling Practice on the Rand. Eustace M. Weston. Recent improvements in efficiency and reduced cost. 2000 w. Eng & Min Jour—Aug. 15, 1908. No. 94349.

Some Striking Features of Rand Gold Production. Ralph Stokes. Considers factors that have influenced mining and milling. Thinks the Robinson will prove the greatest gold mine in the world. Ills. 1000 w. Min Wld—Aug. 1, 1908. No. 94092.

Silver.

Silver. Theo. F. van Wagenen. Interesting information in regard to its production, value, etc. 4500 w. Pop Sci M—Sept., 1908. No. 94618 C.

Silver Refining.

Refining of Silver Bullion Containing Arsenic and Antimony. B. Neilly. Students' competition paper. An account of experimental investigations. Ills. 1500 w. Qr Bul of Can Min Inst—July, 1908. No. 94402 N.

Yukon.

Mining and Mining Methods of the Yukon. A. A. Paré. Notes on the placer and gravel mining methods, with sketches of the geology and other details. Ills. 6500 w. Qr Bul of Can Min Inst—July, 1908. No. 94401 N.

IRON AND STEEL.

Alabama.

Gray Hematites of Eastern Alabama. Edwin C. Eckel. Information concerning this new ore field. 3000 w. Ir Trd Rev—Aug. 6, 1908. No. 94193.

Assaying.

The Determination of Tungsten in Steel in the Presence of Chromium (Ueber die Bestimmung von Wolfram im Stahl bei Gegenwart von Chrom). G. v. Knorre. A review of recent literature. 2700 w. Stahl u Eisen—July 8, 1908. No. 94553 D.

Blast-Furnace Charging.

Electrical Operation of Blast-Furnace Charging Devices (Die elektrischen Betriebsmittel für die Hochofenbeschickung). C. Schiebeler. Discusses electrical operation and describes apparatus used. Ills. 3000 w. Stahl u Eisen—July 8, 1908. No. 94552 D.

Blast Furnaces.

The New Vanderbilt Furnace of the Birmingham Coal & Iron Co. Illustrated description of a southern furnace fitted with a revolving distributor, auxiliary dust catchers, and many devices looking to economical operation. 2200 w. Ir Trd Rev—Aug. 6, 1908. No. 94194.

Bombshell Ore.

The Origin of Bombshell Ore. H. M. Chance. Describes the ore to which this term is applied and gives a theory to account for its origin. 1800 w. Can Min Jour—Aug. 15, 1908. No. 94434.

Electro-Metallurgy.

Experimental Electric Smelting. Louis D. Farnsworth. An illustrated report of experiments made to learn some of the fundamental principles of electric smelting and to obtain data of their working. 1200 w. Elec-Chem & Met Ind—Aug., 1908. No. 94123 C.

Progress in the Electric Iron and Steel and Ferro-Alloys Industries. John B. C. Kershaw. Information concerning progress in the electric furnace methods of manufacture. Ills. 3300 w. Elect'n, Lond—Aug. 7, 1908. No. 94367 A.

Treatment of Iron and Steel in the Electric Furnace. Ernesto Stassano. Gives a report of results regularly obtained, with illustrated descriptions of electric furnaces used at Stassano Steel Works, Turin, Italy. 4000 w. Elec-Chem & Met Ind—Aug., 1908. No. 94121 C.

The Desulphurization of Ingot-Iron in the Electric Induction Furnace (Die Entschwefelung des Flusseisens im elektrischen Induktionsofen). Bernhard Osann. Gives results of tests. 3000 w. Stahl u Eisen—July 15, 1908. No. 94555 D.

England.

The Hematite Mines of Cumberland, England. Lucius W. Mayer. The caving system is employed with varying methods for removing the pillars and supporting the ground. Ills. 4500 w. Eng & Min Jour—Aug. 22, 1908. No. 94440.

Ferro-Alloys.

Formation and Properties of Electrically Produced Ferro-Alloys (Zusammensetzung und Eigenschaften von auf elektrischem Wege darstellbaren Eisen-Legierungen). A review of recent progress. Serial, 1st part. 1200 w. Elektrochem Zeitschr—July, 1908. No. 94549 D.

France.

The Iron Industry of the World and the Exploitation of the Briey Basin (Le Minerai de Fer dans le Monde et la Mise en Valeur du Bassin de Briey). A. Couroux. Concerned chiefly with the iron ore supplies of France, and particularly the Briey deposits. 12500 w. Mem Soc Ing Civ de France—May, 1908. No. 94503 G.

Open Hearth.

See Gas Producers, under MECHANICAL ENGINEERING, COMBUSTION MOTORS.

Pig Boiling.

Iron Scrap or the Issue of an Old Shoe Heel, Being the Origin of the Discovery of Pig Boiling. Joseph Hall. Reprint of a pamphlet published in London in 1864. 4400 w. Jour Ir & St Inst—No. II, 1908. No. 94617 N.

Refining.

Preliminary Results of Trials in Refining Iron and Steel by Means of Vapors of Metallic Sodium. Albert Hiorth. Describes methods and apparatus used and results obtained. Secretary's note given. 2500 w. Jour Ir & St Inst—No. II. 1908. No. 94616 N.

Rolling Mills.

The Inland Steel Company's New Morgan Merchant Mill. Illustrated description of a mill of the semi-continuous type. 1500 w. Ir Age—Aug. 27, 1908. No. 94625.

Sheets.

The Etching of Thin Plates (Das Beizen der Feinbleche). B. Clement. A description of methods and machines for dipping plates preparatory to surface treatment for the production of zinc, lead, tin, or other deposit. Ills. 4000 w. Stahl u Eisen—July 1, 1908. No. 94550 D.

Steel Making.

Tool Steel Making in Styria. R. F. Böhler. An account of this industry in the Styrian Alps, Austria, outlining its history. 3300 w. Sch of Mines Qr—July, 1908. No. 94286 D.

Steel Works.

New Works of the Whitehead Iron and Steel Company, Limited, Tredegar, Mont. Outlines the history of this industry, and illustrates and describes the improved plant. 5000 w. Ir & Coal Trds Rev—Aug. 14, 1908. No. 94483 A.

LEAD AND ZINC.

Great Britain.

Zinc-Mining in Great Britain. Editorial, considering briefly the condition of the industry and the principal mining districts. 2500 w. Engng—July 24, 1908. No. 94161 A.

Lead Pigments.

Making a Zinc-Lead White at Canyon City. Illustrates and describes how the U. S. Smelting Co. utilizes zinc-lead ores, after concentration, for making a high-grade pigment. 1500 w. Min Wld —Aug. 1, 1908. No. 94095.

Lead Smelting.

Zinc and Lead Smelting in Silesia. J. S. G. Primrose. Illustrated description of methods used. 3300 w. Eng & Min Jour—Aug. 8, 1908. No. 94233.

The Cost of Silver-Lead Smelting. Walter Renton Ingalls. A study of the American Smelting and Refining Company, which is estimated to have made a profit of $2 per ton of ore smelted. 8500 w. Eng & Min Jour—Aug. 15, 1908. No. 94348.

See also Zinc Smelting, under LEAD AND ZINC.

Mexico.

Treatment Locally of the Ores of Topia, Mexico. T. C. Graham. Outline of the practice of crushing and milling (by lixiviation). 1000 w. Min Wld—Aug. 22, 1908. No. 94496.

See also same title, under GOLD AND SILVER.

Missouri.

See Plants, under MINING.

New Mexico.

The Ore Deposits of Magdalena, New Mexico. Philip Argall. An illustrated description of the geology, the deposits of lead-carbonates, zinc-carbonates, mixed iron oxide, zinc blende, and pyrite, etc. 4500 w. Eng & Min Jour—Aug. 22, 1908. No. 94442.

Zinc Smelting.

Modern Developments in the Metallurgy of Lead and Zinc. A. Selwyn-Brown. Considers the treatment of low-grade ores, showing that it also leads to the recovery of gold and silver. Ills. 3500 w. Engineering Magazine—Sept., 1908. No. 94679 B.

See also Lead Smelting, under LEAD AND ZINC.

MINOR MINERALS.

Antimony.

The Herrenschmidt's Process of Antimony Smelting. C. Y. Wang. Describes the apparatus and process, and gives results of experiments. Ills. 1200 w. Min Jour—July 25, 1908. No. 94155 A.

Cement.

Some British Cement Plants. A general illustrated description of three large works. 1500 w. Eng Rec—Aug. 29, 1908. No. 94690.

Limestone Island, Whangarei Harbor. Alex. Kyle. A short description of this island of New Zealand and the works of the N. Z. Portland Cement Co. 1000 w. N Z Mines Rec—May 16, 1908. No. 94-138 B.

A Great Cement Plant in Tennessee. Wm. H. Stone. Illustrated detailed description of plant at Richard City. 3500 w. Mfrs Rec—Aug. 20, 1908. No. 94409.

See also Hydro-Electric, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Graphite.

A Contribution to the Discussion on

the Genesis of Graphite in Argenteuil and Labelle Counties, in the Province of Quebec. F. Hille. Discussion of paper by H. P. H. Brumel. 2700 w. Can Min Jour—Aug. 1, 1908. No. 94132.

Gypsum.

Gypsum Plant in Southwest Virginia. William H. Stone. Illustrated description of mine and plant. 1500 w. Mfrs Rec—Aug. 20, 1908. No. 94410.

Nickel.

Electrodeposition of Nickel. Edward F. Kern and Francis G. Fabian. Based on investigations. 10000 w. Sch of Mines Qr—July, 1908. No. 94287 D.

Oil.

The Petroleum and Manjak Industry of Barbados. Edmund Otis Hovey. Describes the oil deposits and their development. 2200 w. Min Wld—Aug. 15, 1908. No. 94356.

The Quest for Oil in the Poverty Bay District. William E. Akroyd. Gives details of what has been done toward developing this district of New Zealand. 3300 w. N Z Mines Rec—May 16, 1908. No. 94137 B.

Platinum.

The Platinum Situation. Trans. from *Torgovo Promysshlennaya Gazeta*. Discusses the position of Russia. 3000 w. Min Jour—July 25, 1908. No. 94157 A.

Tin.

Mining Lode Tin in Malaya. Describes the deposits and methods of tin mining. 2000 w. Eng & Min Jour—Aug. 22, 1908. No. 94443.

Progress and Developments in the Metallurgy of Tin, with Special Reference to Electro-Chemistry in 1907 (Fortschritte und Neuerungen in der Metallurgie des Zinns, speziell in Elektrochemischer Hinsicht im Jahre 1907). Dr. H. Mennicke. Serial, 1st part. 1800 w. Electrochem Zeitschr—July, 1908. No. 94548 D.

See also Cornwall, Eng., under COPPER.

MINING.

Balances.

Balances. A. Austin and Swift Hunter. A discussion of laboratory balances, their care and operation. 2500 w. Min & Sci Pr—Aug. 15, 1908. No. 94416.

Drilling.

Prospect Drilling in the Joplin District. Otto Kuhl. Discusses the difficulties encountered and cost. Ills. 2500 w. Mines & Min—Aug., 1908. No. 94071 C.

Steam Churn Drill in Hot and Cold Climates. John Power Hutchins. Explains the difficulties and causes of expense, describing the equipment best suited to the regions. Ills. 2200 w. Eng & Min Jour—Aug. 1, 1908. No. 94083.

Drills.

Report of a Committee on Rock Drill Tests Conducted at the Meyer & Charlton G. M. Co., Ltd., and a Discussion of Some Special Observations. Paper by E. J. Laschinger, with committee report. 10000 w. Jour S African Assn of Engrs —June, 1908. No. 94141 F.

Education.

See same title, under INDUSTRIAL ECONOMY.

Electric Power.

Electric Power at the Mines of the Ilse Mining Company (Der elektrische Kraftbetrieb auf den Werken der Bergbau-Akt.-Ges. Ilse). W. Bolz. Illlustrated description of extensive installations. Serial, 1st part. 1600 w. Elek Kraft u Bahnen—July 24, 1908. No. 94-591 D.

Applications of Electric Power in the Clausthal District (Die Anwendung elektrischer Triebkraft in den Betrieben der kgl. Berginspektion zu Clausthal). Herr Schennen. Describes applications to hoisting, ore dressing plants, etc. Ills. 4000 w. Elek Kraft u Bahnen—July 14, 1908. No. 94590 D.

Geological Surveys.

Topographical Methods Used for the Special Map of Rossland, B. C. W. H. Boyd. Describes methods used, giving maps. 4000 w. Qr Bul of Can Min Inst —July, 1908. No. 94392 N.

Haulage.

Comparison of Horse and Benzine-Locomotive Haulage (Vergleich einer Pferde- und Benzinlokomotivförderung am Michael-Schachte der Kaiser Ferdinands-Nordbahn in Michalkowitz). Franz Steller. A comparison of costs from actual operation. 3000 w. Oest Zeitschr f Berg- u Hüttenwesen—July 25, 1908. No. 94561 D.

See also Track Laying, under MINING.

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The St. Louis-Montana Co.'s Apex Litigation. Matt W. Alderson. An explanation of a peculiar case in which a 30-ft. strip has been granted the usual apex right and a vertical right, also. 2000 w. Min Wld—Aug. 8, 1908. No. 94245.

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Power Systems of the Mines of the Joplin District. D. F. Boardman. The types in use are described; the gas engine plant showing the greatest economy. 3000 w. Eng & Min Jour—Aug. 15, 1908. No. 94350.

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Back-Stoping vs. Underhand Stoping in Large Bodies of Iron Pyrites. J. J. Rutledge. Considers the conditions which led to the adoption of the underhand method. 1000 w. Eng & Min Jour—Aug. 22, 1908. No. 94441.

Surveying Instruments.

The Gebrüder Rost, Vienna, Universal Support and Mining Transit (Universal-Grubenspreize und Zentrierapparat der Gebrüder Rost in Wien). E. Doležal. Illustrated description of a transit carried on an extensible shaft and capable of being set in any position, for use in mine gallieries and stopes. Serial, 1st part. 2200 w. Oest Zeitschr f Berg- u Hüttenwesen—July 4, 1908. No. 94559 D.

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A Discussion of Mine Curve Problems. J. E. Tiffany. Gives approved methods of alinement. 3500 w. Eng & Min Jour—Aug. 1, 1908. No. 94085.

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Calculating the Value of a Mine. J. Bowie Wilson. Describes the practice at Mount Morgan G. M. Co. (Q.). 2500 w. Aust Min Stand—July 8, 1908. Serial, 1st part. No. 94362 B.

ORE DRESSING AND CONCENTRATION.

Drying.

The Thermal Principles of Industrial Drying (Fonctionnement Thermique du Séchage industriel). Paul Razous. Discusses and gives formulæ relating to the drying of materials by evaporation. 3000 w. Rev d'Econ Indus—July 16, 1908. No. 94500 D.

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Continuous Slime Filter. Robert Schorr. Illustrated description of an invention of the writer. 800 w. Min & Sci Pr—Aug. 8, 1908. No. 94331.

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Milling Practice in Nevada Goldfield Reduction Works. E. S. Leaver. Describes practice at a custom plant, ores being received from various mines. 500 w. Min & Sci Pr—Aug. 22, 1908. No. 94646.

Yellow Jacket Mill, Comstock Lode. Whitman Symmes. Illustrated description of methods of milling low-grade ore. 1200 w. Min & Sci Pr—Aug. 1, 1908. No. 94201.

Iron Ores.

See Washing, under COAL AND COKE.

Silver Milling.

Inexpensive Home-Made 20-Ton Mill. Teodoro Köhncke. Describes a mill built in Central America to treat dump-sortings, etc. 1000 w. Min & Sci Pr—Aug. 8, 1908. No. 94330.

Stamp Mills.

Notes on the Stamp Mill Water Feed and Packed Up Dies, Introducing the Shallow Front Mortar Box. Harry T. Pitt. Gives results of trials made both with the back water feed and with packed up dies. Ills. Discussion. 2500 w. Jour Chem, Met, & Min Soc of S Africa—June, 1908. No. 94139 E.

Tube Mills.

Tube Mill Crushing. E. B. Wilson. Illustrates and describes different styles of mills, considering their use for crushing in connection with the cyaniding of slimes. 3500 w. Mines & Min—Aug., 1908. No. 94072 C.

A Laboratory Comparison of Tube Mill Pebbles. G. H. Stanley, with an Appendix on Liners, by M. Weber. Ills. 1400 w. Jour Chem, Met, & Min Soc of S Africa—June, 1908. No. 94140 E.

MISCELLANY.

Alloys.

Notes on the Metallographic Researches Carried Out at the Göttingen Institute for Inorganic Chemistry (Bericht über die im Göttinger Institut für anorganische Chemie ausgeführten metallographischen Arbeiten). G. Tammann. Gives in a table a brief *resumé* of the results so far obtained. 4500 w. Zeitschr d Ver Deutscher Ing—July 4, 1908. No. 94596 D.

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Through the Bolivian Highlands. E. P. Mathewson. Description, with illustrations. 1700 w. Min & Sci Pr—Aug. 15, 1908. Serial, 1st part. No. 94417.

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Minerals and Ores of Northern Canada. J. B. Tyrrell. A review of the present knowledge of the mineral resources. 6500 w. Qr Bul of Can Min Inst—July, 1908. No. 94391 N.

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The Libyan Desert Railroad. An illustrated account of this project and its far-reaching influence in Egypt. 3000 w. Sci Am Sup—Aug. 22, 1908. No. 94424.

Geological Maps.

Note on a System of Conventional Signs for Mineral Occurrence Maps. Elfric Drew Ingall. Gives signs used by the Geol. Survey of Canada, with explanatory notes. 1500 w. Qr Bul of Can Min Inst—July, 1908. No. 94393 N.

Nova Scotia.

Development of Nova Scotia's Mineral Resources. Arthur S. Barnstead. Gold, coal, iron and gypsum are the principal products. 1500 w. Min Wld—Aug. 29, 1908. No. 94710.

Ontario.

Notes on Early Mining Endeavor in Ontario. E. L. Fraleck. A short review. 1600 w. Qr Bul of Can Min Inst—July, 1908. No. 94397 N.

Ore Deposits.

A Graphic Comparison of the Alteration of Rocks by Weathering with Their Alteration by Hot Solutions. Edward Steidtmann. A study of the chemical and mineralological changes, showing that these differences may be satisfactorily measured, and help in a better understanding of the nature of thermal solutions. 6000 w. Ec-Geol—July, 1908. No. 94300 D.

The Origin of the Silver of James Township, Montreal River Mining District. Alfred Ernest Barlow. An illustrated description of this region and conclusions from the study. 7000 w. Qr Bul of Can Min Inst—July, 1908. No. 94-390 N.

The Genesis of the Copper Ores in Shasta County, West of the Sacramento River. William Forstner. Describes these deposits in California, concluding that they were formed by action of ascending thermal waters. 1200 w. Min & Sci Pr—Aug. 22, 1908. No. 94649.

The Pyritic Origin of Iron Ore Deposits. H. Martyn Chance. An examination of the evidence for and against the theory that oxidized ore bodies are the result of the decomposition of pyrite. 3500 w. Eng & Min Jour—Aug. 29, 1908. No. 94702.

The Formation of the Schneeberg Ore Deposits (Die stoffliche Zusammensetzung der Schneeberger Lagerstätten). B. Granigg. A discussion of these complex zinc-lead-copper deposits in the Austrian Tyrol. Ills. Serial, 1st part. 3500 w. Oest Zeitschr f Berg- u Hüttenwesen—July 4, 1908. No. 94558 D.

The Permian Limestone Formation Between the Diemel and Itter Valleys on the East Side of the Rhine-Westphalian Slate Mountains, with Special Reference to the Deposits of Copper, Gypsum, Iron, Manganese, Zinc, Lead, Clestine, and Barytes (Die Zechsteinformation zwischen dem Diemel- und Itter-Tale am Ostrande des rheinisch-westfälischen Schiefergebirges unter besonderer Berücksichtigung der Kupfer-, Gips-, Eisen-, Mangan-, Zink-, Blei-, Cölestin-, und Schwerspat-Vorkommen). Herr Kipper. Ills. Serial, 1st part. 5000 w. Glückauf—July 18, 1908. No. 94564 D.

See also Graphite, under MINOR MINERALS.

Panama.

The Geology of the Isthmus of Panama. Ernest Howe. 10700 w. Am Jour of Sci—Sept., 1908. No. 94741 D.

Philippines.

The Philippines. Letters describing ancient mining methods, and giving information concerning deposits of copper, gold, etc. Ills. 2000 w. Min Jour—Aug. 15, 1908. No. 94468 A.

Volumetric Apparatus.

The Testing of Glass Volumetric Apparatus. N. S. Osborne and B. H. Veazey. Gives general specifications, an account of tests made, and methods of testing, etc. Ills. 12000 w. Bul Bureau of Stand—May, 1908. No. 94308 N.

Zambesia.

More About Zambesia Minerals. Stephen J. Lett. A general review of the country, with special reference to its mineralogy, mining laws and conditions of work. Map. 3500 w. Min Jour—Aug. 22, 1908. Serial, 1st part. No. 94-773 A.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

Indiana Commission on Causes and Remedies for Railroad Accidents. Information from Bul. No. 4, for April, May and June, 1908. 1800 w. R R Age Gaz —Aug. 7, 1908. No. 94216.

Signals.

Automatic Block Signals on the Brooklyn Bridge. Plate, and illustrated description of the costly arrangement of signals adopted to insure the minimum distance between trains. 1200 w. R R Age Gaz—Aug. 28, 1908. No. 94664.

See also Switches, under CONDUCTING TRANSPORTATION.

Switches.

Mechanical and Power Switch Control (Mechanische und Kraft-Stellwerke). G. Bode. A discussion of appliances for the distant control of switches and signals. Ills. Serial, 1st part. 3500 w. Glasers Ann—July 15, 1908. No. 94577 D.

Trains.

The California Limited. Describes this train on the A., T. & S. Fe Ry., and the country through which it passes. Ills. 2000 w. Ry & Loc Engng—Aug., 1908. No. 94097 C.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Automatic Rapid-Acting Vacuum Brakes for Goods Trains. Gives results of brake trials on the Austrian State Railway. Ills. 2000 w. Engng—July 24, 1908. No. 94159 A.

Air Pipes.

Broken Air Pipes. Shows how different breaks in air pipes can be handled to prevent engine failure. Diagram. 1600 w. Ry & Loc Engng—Aug., 1908. No. 94101 C.

Axle Lubrication.

Forced Lubrication for Axle-Boxes. T. Hurry Riches and Bertie Reynolds. Describes a system as arranged for the driving axle-boxes of some of the steam-cars of the Taff Vale Ry. Co. Ills. 1200 w. Inst of Mech Engrs—July 28, 1908. No. 94259 N.

Cab Signals.

Cab Signals in England. C. M. Jacobs. Considers systems that have been tried or suggested. Ills. 3500 w. Ry & Engng Rev—Aug. 1, 1908. No. 94125.

Cars.

The Ralston General Service Car. Views and sections, with detailed description. 1000 w. R R Age Gaz—Aug. 28, 1908. No. 94666.

New Vegetable and 20-Ton Freight Cars of the Paris-Lyons-Mediterranean Railway (Note sur les nouveaux Wagons à Primeurs et les nouveaux Wagons à Marchandises de 20 Tonnes de la Compagnie P.-L.-M.). Henri Lancrenon. Illustrated detailed description of new cars. 2000 w. Rev Gen d Chemins de Fer—July, 1908. No. 94519 G.

Electrification.

Experimental Electric Traction on the Swedish State Railways, 1905-1907. Extract from the full report of these trials and their satisfactory results. 2500 w. Engng—Aug. 21, 1908. No. 94784 A.

Locomotive Boilers.

The Care of Locomotive Boilers. F. P. Roesch. Discusses the causes of stay-bolt breakage and how it may be decreased. 3000 w. Ry & Loc Engng—Aug., 1908. No. 94103 C.

Diagonal Joints and Tube-Hole Rows. Discusses fully the diagonal riveted joint in boilers and lines of weakness caused by tube-holes in a drum or shell. Ills. 10000 w. Locomotive—July, 1908. No. 94798.

Locomotive Feed Water.

See Boiler Waters, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Locomotives.

Recent Narrow Gage Locomotives for Heavy Service. Illustrates and describes three recently built locomotives for tracks of 3-ft. gage. 1500 w. R R Age Gaz—Aug. 21, 1908. No. 94439.

Four Cylinder Simple Engine. Illustrates and describes a 4-6-0 engine used on the Great Western of England. 1000 w. Ry & Loc Engng. No. 94100 C.

Large Tank Locomotive; London, Brighton & South Coast Railway. Illustration, dimensions, and short description. 400 w. R R Age Gaz—Aug. 28, 1908. No. 94667.

Bogie Tank Engines, North Staffordshire Railway. Drawings and short description. 300 w. Engr, Lond—Aug. 21, 1908. No. 94786 A.

Oil-Burning Ten-Wheeler. Illustrated description of a 4-6-0 engine for the Southern Pacific Ry. 800 w. Ry & Loc Engng—Aug., 1908. No. 94098 C.

Details of Heavy Pacific Type Locomotive. Drawings and description of heavy passenger locomotives for the N. Y. C. lines. 700 w. Am Engr & R R Jour—Aug., 1908. No. 94087 C.

Pacific Type Locomotives, Chicago & Alton R. R. Illustrated description of recently completed engines. 1300 w. Ry & Engng Rev—Aug. 29, 1908. No. 94713.

The New Pacific Type Compound Locomotives of the Western Railway of France. Detailed drawings and particulars. 1200 w. Mech Engr—July 24, 1908 No. 94145 A.

A New Locomotive on the Northern Railway of France. Illustrated description of a heavy new compound locomotive. 800 w. Mech Engr—Aug. 21, 1908. No. 94764 A.

4-Cylinder Compound Locomotive, North-Eastern Railway. Detailed drawings and description. 800 w. Mech Engr—Aug. 14, 1908. No. 94459 A.

Twelve-Wheeled Mallet Compound Locomotive for North China. Illustrations and brief description of engines built in Glasgow for the Imperial Peking-Kalgan Ry. 600 w. Engng—July 31, 1908. No. 94270 A.

Compensated Locomotives. Herbert T. Walker. Remarks on early designs, introductory to a detailed description of engines of each of three classes embracing old-time locomotives of this type. Ills. 2000 w. R R Age Gaz—Aug. 14, 1908 Serial, 1st part. No. 94353.

Mountain Locomotives (Lokomotiven

mit Hilfsmotoren). Hermann Liechty. A historical review of the various types of locomotives, rack, adhesion, etc., which have been applied on heavy grades. Ills. Serial, 1st part. 2500 w. Glasers Ann—July 15, 1908. No. 94578 D.

Locomotive Stacks.

Locomotive Smokestacks. W. E. Johnston. Discusses the requirements of a smokestack formula. 1800 w. Am Engr & R R Jour—Aug., 1908. No. 94088 C.

Locomotive Stoking.

Bank Firing of Bituminous Coal. Clarence Roberts. Reply to an article on the same subject by R. G. Donaldson. 1800 w. Ry & Loc Engng—Aug., 1908. No. 94099 C.

Motor Cars.

Compound, Superheated Steam, Motor Car. Illustrated detailed description of a car for the C., R. I., & P. R. R. 1000 w. Am Engr & R R Jour—Aug., 1908. No. 94086 C.

The Petrol-Electric Drive and Other Mixed Systems. Frank Broadbent. Discusses the driving of trains by electro-mechanical or mixed systems. 3000 w. Elec Rev, Lond—July 24, 1908. No. 94-151 A.

The Accumulator-Car Traffic on the Palatinate Railways. A. Giesler, in *Zeit. des Ver. deut. Eisenbahnverwaltungen.* An account of the results obtained during more than ten years trial on the main lines. 6500 w. Bul Int Ry Cong—July,

NEW PROJECTS.

Lackawanna.

The New Cut-Off Line of the Lackawanna Railroad. F. L. Wheaton. Map and description of the present lines and the cut-off, showing the improvements and saving. 2200 w. Eng News—Aug. 13, 1908. No. 94322.

Surveying.

Railway Surveying in Canada. Description from an address by Hugh Lumsden, of the surveys of the unexplored "backwoods" of north-eastern Canada. 2500 w. Engr, Lond—July 24, 1908. No. 94165 A.

PERMANENT WAY AND BUILDINGS.

Construction.

The Smyth Camp Embankment, C. M. & St. P. An illustrated account of difficult and costly railroad building, especially the construction of a large embankment by the hydraulic method. 1800 w. R R Age Gaz—Aug. 7, 1908. No. 94213.

Crossings.

Abolition of Grade Crossings in the City of New Bedford. William F. Williams. An illustrated description of the scheme as now being carried out, with a brief explanation of points of controversy. 5500 w. Jour Assn of Engng Socs—July, 1908. No. 94382 C.

Curves.

Spiral Tables of the Canadian Pacific Railway. Gives the tables used since 1894 which have given satisfaction, explaining their use. 7000 w. Eng Rec—Aug. 1, 1908. No. 94067.

Location.

Methods and Cost of Mountain Railway Location. J. J. Cryderman. Gives an outline of the work. 3000 w. Engng-Con—Aug. 5, 1908. No. 94206.

Rails.

Some Causes Which Tend Toward the Fracture of Steel Rails. James E. Howard. An illustrated article dealing with causes due to service; and with causes due to the structure of the steel. Discussion. 6500 w. Jour Assn of Engng Socs—July, 1908. No. 94383 C.

Shops.

The Great Western Railway Works at Swindon. Illustrated description of these fine works. 4000 w. Engr, Lond—Aug. 14, 1908. No. 94480 A.

Shops of the Panama Canal. Information from the *Canal Record* concerning the principal shops on the Panama Canal work. 6500 w. Ry & Engng Rev—Aug. 8, 1908. No. 94280.

The McKees Rocks Shops of the Pittsburg & Lake Erie Railroad. B. A. Ludgate. Gives the layout, cross-sections, and description. 6500 w. Eng Rec—Aug. 8, 1908. No. 94229.

Stations.

Egmore Station, Madras; South Indian Railway. Illustrated description of a fine station in India. 700 w. R R Age Gaz—Aug. 7, 1908. No. 94219.

The New Chicago Passenger Terminal of the Chicago & North Western Ry. Illustration, with detailed description of this immense structure. 1200 w. Eng Rec—Aug. 15, 1908. No. 94341.

Ties.

Wood or Steel Ties (Holzschwelle oder Eisenschwelle). A. Haarmann. A discussion of criticisms of a paper by the same author on the steel tie. Ills. 3000 w. Stahl u Eisen—July 22, 1908. No. 94556 D.

Track Construction.

Developments in Railway Track Design. Editorial discussion of suggested improvements. 2400 w. Eng News—Aug. 20, 1908. No. 94429.

The Supporting Power of Track Ballast (Ueber die Tragfähigkeit der Geleisebettung). A. Schneider. Mathematical discussion. Ills. 2500 w. Zeitschr d Oest Ing u Arch Ver—July 17, 1908. No. 94584 D.

Recent Progress in Railway Equipment

(Recenti Progressi nella Tecnica degli Armamenti Ferroviari). Ugo Cerreit. Illustrates and describes fish-plates and chairs used in Italian practice. 2800 w. Ing Ferro—July 31, 1908. No. 94545 D.

Investigation of the Resistance Opposed to the Longitudinal Slipping of Rails by Fish Plates and Chairs (Essais sur la Resistance opposée au Glissement longitudinal des Rails par les Eclisses renforcées et par les Coussinets à Coins en Acier des Chemins de Fer de l'Etat). Ills. 1700 w. Rev Gen d Chemins de Fer—July, 1908. No. 94518 G.

Water Supply.

The Supply of Drinking Water on Trains and in Stations (La Fornitura di Acqua Potabile sulle Linee e nelle Stazioni). A discussion of the hygiene of various systems of supply. Ills. 3000 w. Ing Ferro—July 16, 1908. No. 94544 D.

TRAFFIC.

Car Interchange.

Joint Interchange and Inspection Bureaus. Gives some of the advantages claimed for the bureau plan, and the status of interchange and inspection at a number of traffic centers. 3500 w. R R Age Gaz—Aug. 7, 1908. No. 94214.

Freight Rates.

The Theory of Railroad Rates. William Z. Ripley. The present number gives an analysis of railroad expenditures. 4500 w. R R Age Gaz—Aug. 28, 1908. Serial, 1st part. No. 94668.

Reasonable Rates. William G. Raymond. An editorial letter discussing the regulation of American railroad rates. 2500 w. R R Age Gaz—Aug. 7, 1908. No. 94212.

Improvements.

Some Effects of Railroad Improvements. Shows the changes in the capacity of the railroads following improved tracks, more powerful locomotives, and cars of larger capacity. 800 w. R R Age Gaz—Aug. 21, 1908. No. 94437.

Standard Oil Case.

The Alton-Standard Oil Case. Richard W. Hale. Discusses the principles involved. 1600 w. Ir Age—Aug. 13, 1908. No. 94310.

The Alton-Standard Oil Case. R. L. Ardrey. A brief review of the facts, showing the cause of the suit, evidence submitted, etc. 2200 w. Ir Age—Aug. 6, 1908. No. 94180.

MISCELLANY.

Accounting.

Operating Department Accounts—The Basis of Accounting Department Records. Frank H. Crump. Explains the principles of a system of accurate railway accounting. 1500 w. R R Age Gaz—Aug. 21, 1908. No. 94438.

Canadian Northern.

The Canadian Northern Railroad System. An interesting account of the upbuilding of this system. 2500 w. R R Age Gaz—July 24, 1908. No. 93937.

Capitalization.

Overcapitalization. Henry Fink. Discusses the meaning of this term and recent legislation for the regulation of railroads, etc. 4500 w. R R Age Gaz—July 10, 1908. No. 93747.

France.

The French State Railways. Editorial discussion of State ownership and the results in France, the mismanagement, etc. 2500 w. Engng—Aug. 7, 1908. No. 94-373 A.

Government Control.

Five Years of Railroad Regulation by the States. Grover G. Huebner. Extracts from a paper in the *Annals of the Am. Acad. of Pol. & Soc. Sci.* Classifies and analyzes the chief provisions enacted to regulate intrastate traffic. 6500 w. R R Age Gaz—Aug. 7, 1908. No. 94217.

State Control of Railroads in England. R. L. Wedgwood. From a paper read before the York Ry. Debating Soc. Considers the general situation with regard to state control over creation of the road, its construction and operation. 6000 w. R R Age Gaz—Aug. 28, 1908. No. 94665.

Government Ownership.

See France, under MISCELLANY.

Guatemala.

Guatemala's Transcontinental Route. M. A. Hays. An illustrated account of this latest line connecting the Atlantic and Pacific coasts. 2200 w. Am Rev of Revs—Aug., 1908. No. 94281 C.

Management.

Obstructions to Inventive Progress. Editorial letter criticizing the conditions which govern railroad supplies and practice in the United States. 2000 w. Ry & Engng Rev—July 25, 1908. No. 93961.

Manchuria.

From the Chinese Capital to Harbin and Moscow, via Siberia. Emil S. Fischer. On the improved conditions of travel through Manchuria, and the difficulties. Ills. 5000 w. Ry & Engng Rev—Aug. 22, 1908. No. 94498.

New England.

The New England Railroad Situation. A review of the situation and remarks on the work accomplished by President Mellen of the New Haven road. 2200 w. R R Age Gaz—July 17, 1908. No. 93821.

N. Y., P., and N.

The New York, Philadelphia & Norfolk. An illustrated account of this important short line, which has passed into the hands of the Pennsylvania R. R. Co.

3000 w. R R Age Gaz—Aug. 7, 1908. No. 94220.

United States.

Railways: A Foundation of Wealth. G. D. Baker. Brief review of railway development and the benefits derived; especially considering statistics relating to Alabama and Arkansas. 3500 w. Mfrs Rec—Aug. 6, 1908. No. 94192.

Valuation.

Valuation of Railroad Property. Henry Fink. A brief review of methods suggested. 2000 w. R R Age Gaz—July 24, 1908. Serial, 1st part. No. 93941.

STREET AND ELECTRIC RAILWAYS

Berlin.

The Traffic Problem of Large Cities, with Special Reference to Berlin (Zur Verkehrspolitik der Grosstädte, mit besonderer Berücksichtigung der Berliner Verhältnisse). Ills. Serial. 1st part. 7000 w. Zeitschr d Ver Deutscher Ing—July 4, 1908. No. 94598 D.

Boston, Mass.

See Elevated Railways, and Interurban, under STREET AND ELECTRIC RAILWAYS.

Brakes.

The Car Equipment Department of the Interborough Rapid Transit Company—Brake Shoe Studies and Changes. An illustrated general survey of brake-shoe practice in New York City. 1200 w. Elec Ry Jour—Aug. 22, 1908. No. 94435.

Electric Braking on Three-Phase Railways, especially Mountain Lines (Ueber elektrische Bremsung bei Drehstrombahnen und besonders bei Drehstrombergbahnen). W. Kummer. An examination of the advantages of the system. Ills. 3000 w. Schweiz Bau—July 18, 1908. No. 94566 D.

Car Barns.

Reinforced Concrete Car House for Municipal Railways of Nurnberg. Reinhold Herzog. Illustrates and describes the features of interest. 1000 w. Elec Ry Jour—Aug. 1, 1908. No. 94061.

Car Repairing.

Rehabilitation of the Metropolitan Street Railway Company's Rolling Stock. Reports practice followed in the overhauling of about 800 double-truck and 500 single-truck cars. Ills. 2500 w. Elec Ry Jour—Aug. 22, 1908. No. 94436.

Cars.

Need for Lighter Cars. M. V. Ayres. Favors the reduction of weight, to reduce power consumption, stating the principles that should govern their design. 1200 w. Elec Ry Jour—Aug. 1, 1908. No. 94063.

Elevated Railways.

The Forest Hills Extension of the Boston Elevated Railway. Illustrates and describes a 2½-mile extension recently erected. 1800 w. Elec Ry Jour—Aug 8, 1908. No. 94198.

Freight Traffic.

Forms Used in Handling Freight and Express Business on Interurban Lines. M. W. Glover. Gives the methods used by the Ohio Electric Railway Co. 1500 w. Elec Ry Jour—Sept. 5, 1908. No. 94846.

History.

The History of Electric Motive Power. Prof. Silvanus P. Thompson. Abstract from paper read before the British Assn. for Adv. of Sci. A brief record of rapid development. 3500 w. Sci Am Sup—Aug. 29, 1908. No. 94640.

Tramways of the World. Sir Clifton Robinson. Read before the Tram. & Lgt. Ry. Assn. A brief review of what has been accomplished and the present prevailing conditions. 9500 w. Tram & Ry Wld—Aug. 6, 1908. No. 94452 B.

Interurban.

The Kokomo, Marion & Western Traction Co. C. A. Tupper. An illustrated description of the equipment of the new power station of this system in Indiana. 4500 w. Elec Age—Aug., 1908. No. 94290.

The Proposed Boston & Eastern Electric R. R.: An Account of Hearings Before the Massachusetts Railroad Commission. H. S. Knowlton. Map. 4500 w. Eng News—Aug. 20, 1908. No. 94426.

Long Interurban Line in Texas. Illustrated detailed description of a line to extend from Dallas to Sherman, a distance of over 60 miles, and by connections gives opportunity for an electric railway ride of over 100 miles. 6000 w. Elec Ry Jour—Aug. 1, 1908. No. 94059.

London.

London County Council Overhead Trolley Lines. Illustrated description of the Hammersmith to Harlesden tramway is given as typical of the overhead system on all this company's lines. 1500 w. Tram & Ry Wld—Aug. 6, 1908. No. 94451 B.

Rail Creeping.

Track and Third Rail Creeping. E. Goolding. Gives results of experiments and general discussion of rail movements. 2000 w. Elec Engng—Aug. 13, 1908. No. 94461 A.

Rail Joints.

Tramway Rail Joints. Alfred H. Gibbings. Describes some methods that have been adopted to make the joint in operation as nearly as possible like the rest of the rail. Ills. 7000 w. Surveyor—Aug. 7, 1908. No. 94360 A.

San Francisco.

The Street Railway System of San Francisco. J. C. Lathrop. Illustrates and describes the work of reconstructing the lines after the earthquake and fire. Elec Ry Jour—Sept. 5, 1908. No. 94845.

Single Phase.

Single-Phase Road at Locarno, Switzerland. Illustrated detailed description of a line on which the rod collector is used. 2000 w. Elec Ry Jour—Aug. 1, 1908. No. 94060.

Some Novel Features of the Seebach-Wettingen Single-Phase Line. A short illustrated account of a road equipped with the curved-rod collector, with report of its service. 1000 w. Elec Ry Jour—Aug. 1, 1908. No. 94062.

Electric Trunk Line Operation, with Special Reference to Single-Phase Railways (Der Stand der elektrischen Vollbahnen mit besonderer Berücksichtigung der Einphasenbahnen). Fr. Eichberg. A review of recent developments and present conditions. Ills. 3800 w. Zeitschr d Ver Deutscher Ing—July 18, 1908. No. 94650 D.

Substations.

Concrete Substations in Minneapolis. Illustrates and describes examples of recent construction. 700 w. Elec Ry Jour—Aug. 29, 1908. No. 94647.

Subways.

Progress on the Subway Bridge Loop, New York. An illustrated account of the work, explaining some of the difficulties encountered. 3500 w. Eng Rec—Aug. 15, 1908. No. 94340.

Subway Ventilation.

Cooling and Ventilating the New York Subway. Abstract of the fifth report of Bion J. Arnold, which considers available methods of cooling. 2500 w. Elec Ry Jour—Aug. 29, 1908. No. 94648.

Cooling and Ventilating the New York Subway. Fifth report of Bion J. Arnold to the N. Y. Public Service Commission, dealing with present conditions, possible methods of cooling and recommendations. 3500 w. R R Age Gaz—Aug. 28, 1908. No. 94663.

Sweden.

See Electrification, under RAILWAY ENGINEERING, Motive Power and Equipment.

Switzerland.

The Works of the Bernese Alpine Railway (Travaux du Chemin de Fer des Alpes Bernoises). Ch. Dantin. Reports progress on the Berne-Lötschberg-Simplon line. Ills. 2500 w. Génie Civil—July 18, 1908. No. 94533 D.

The Approaches to the Simplon Tunnel (Les Lignes d'Accès au Simplon). Ch. Dantin. Reviews traffic conditions in France and western Switzerland. Ills. 2000 w. Génie Civil—July 4, 1908. No. 94530 D.

The Martigny-Châtelard Railway (Le Chemin de Fer de Martigny au Châtelard). M. M. Brémond. An illustrated description of a metre-gauge mountain railway in Switzerland using the rack system on heavy grades. Serial. 1st part. 2700 w. Bul Tech d l Suisse Romande—July 10, 1908. No. 94527 D.

The Mountain Lines of the Bernese Highlands (Les Lignes de Montagne de l'Oberland-Bernois). V. Amilhau. Describes adhesion, rack, and electric lines in this district. Ills. Plate. 16000 w. Ann d Ponts et Chaussées—1908—I. No. 93608 E + F.

Track Construction.

Reconstruction of Street Railway Track at Charlotte, N. C. Illustrated detailed description of the construction. 1200 w. Eng News—Aug. 6, 1908. No. 94222.

Track Maintenance.

Roadbed Maintenance in the Slide Country. Illustrated description of troubles on an interurban line near Davenport, Iowa. 700 w. R R Age Gaz—Aug. 14, 1908. No. 94354.

Train Intervals.

Relation Between the Capacity of a Metropolitan Line and the Train Interval. G. Brecht. An investigation to find whether there is a definite ratio which gives the best results. 1500 w. But Int Ry Cong—Aug., 1908. No. 94797 G.

Trunk Lines.

Electric Trunk Line Operation (Bahntechnische Forderungen an den elektrischen Vollbahnbetrieb). Artur Hruschka. Discusses some of the questions regarding locomotives and transmission lines, etc. Ills. Serial, 1st part. 4800 w. Elektrotech u Maschinenbau—June 7, 1908. No. 93677 D.

Wire Suspension.

Catenary Trolley Construction. Oliver S. Lyford, Jr. Outlines some of the governing conditions on roads using steam for motive power during electrification and the means adopted to meet these conditions on the Denver & Interurban Railroad. Ills. 4000 w. Pro Am Soc of Civ Engrs—Aug., 1908. No. 94669 E.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated: W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.

Camptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *w.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electric Railway Review. *w.* Chicago.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *m.* Milan.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *w.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Men. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *b-m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Age Gazette. *w.* New York.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Rivista Gen. d Ferrovie *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Street Railway Journal. *w.* New York.
Surveyor. *w.* London.
Technology Quarterly. *qr.* Boston, U. S. A.
Technik und Wirtschaft. *m.* Berlin.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagon Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

THE ENGINEERING MAGAZINE
"THE WORLD IS ITS FIELD"

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THE EFFECTIVENESS OF THE BUREAU SYSTEM IN NAVAL ORGANIZATION.

This article was prepared, at the request of the editors of THE ENGINEERING MAGAZINE, by an authority amply qualified through intimate familiarity with Naval affairs. His facts are drawn from his own knowledge and from official data. It is, of course, evident where he belongs, and evident also that he cannot afford to incur the dislike of the powerful line of the Navy by disclosing his identity. We shall say only that he is a man of the highest standing and integrity, with a reputation for absolute fairness; and that his name, if published, would be ample guarantee of the accuracy of his statements and the soundness of his judgment. It is very interesting to place his conclusions in parallel with those expressed by Mr. Emerson in a following article in this issue, and to see how true it holds that in naval and military affairs, as in civil pursuits, pure line organization or administration resists progress and results in low efficiency, and that effectiveness and advance can be secured only by constantly vitalizing the line through the ideals and standards originating with the staff.—THE EDITORS.

FROM time to time articles have appeared in the daily papers, and occasionally in some of the magazines, criticising the present organization of the United States Navy Department and asserting that its efficiency would be vastly increased if a different plan were adopted. While the various critics are not agreed as to the best plan, the great majority of them advocate a system which would in effect make the Secretary of the Navy a figure head, and would practically turn over the entire naval administration to that branch of the Navy called the "Line." It may be explained for the benefit of readers not familiar with naval terminology that the line officers are the ones whose duties, when at sea, are principally on deck, namely, admirals, captains, watch officers, etc. Of late, they quite often call themselves the "sea-going officers," and they constitute the vast majority of the commissioned officers at sea.

When a serious change is proposed in any organization, it naturally ought to be on the ground that the new method would be more efficient or more economical, and it would ordinarily be expected that examples would be given of the inefficiency of the organization which it was proposed to supersede. In most of the articles which are written to advocate a change, there is never any attempt to go into details, but there is a lot of special pleading to show that the line of the Navy ought to be given control, and no attempt to point out the defects of the present Bureau system. This is not always the case, however, and last year the newspapers were full of the accounts of the Congressional investigation into the condition of the ships of the United States Navy, which resulted from charges of gross mistakes of design made by a gentleman whose work in connection with Navy matters has been that of a newspaper artist. It was charged that American ships were decidedly inferior to those of other large navies in almost every respect; and, indeed, if this artist had been believed, the people of the country could only have thought that millions of dollars had been spent in producing a very defective lot of ships.

Those who followed this investigation carefully, and especially those who took the trouble to get the published official report of the hearings, will remember how completely this artist's story was demolished by the extremely able testimony and record of facts produced by Admiral Capps, Chief of the Bureau of Construction. He showed conclusively not only that the criticisms were unfounded and false, but that, as a matter of fact, in almost every point which had been brought up by the critic American ships were superior to those of other navies. In doing this Admiral Capps was defending the work of his bureau, although not his own, as the ships which were criticised had been designed and built under the administration of his predecessors.

One feature which was brought out very strongly during this investigation to those who have been familiar with naval matters for the last twenty or thirty years, was the evident existence of a concerted effort on the part of certain ambitious line officers to discredit the Bureau system, with a view to bringing about the change which this element in the Navy has so often urged—namely, the organization of the Navy Department into two or three divisions, each under the control of a vice-admiral. One of the recent newspaper articles, when boiled down, amounts to this; that as the line officers are the men who handle the ships, including their guns and machinery (for it must not be forgotten that there are no longer any engineers by that name in the Navy, marine engineering having become one of the essential qualifications of line officers by the Personnel Law of 1899) they ought also to be the ones to say just how the ships shall be built; and, in short, they are the Navy, or in the slang of the day "the whole thing." To any one who stops to reflect on the ordinary conditions of daily life this claim must seem flimsy and without any foundation. According to this, only pianists should make pianos, only organists should build organs, only chauffeurs should build automobiles, Hank Haff and Charlie Barr would be the best yacht builders. This pretence at an argument is really so flimsy that it is useless to waste time on it.

A development of the same idea, however, is worthy of attention—namely, that the officers who handle the ships should have a voice in their design. The appropriate answer to this is that there has never been a time in the Navy (and probably never will be) when the sea-going officers did not have a very strong voice in the design of the ships. At the present time (and for many years) there is a board of officers in the Navy Department known as the Board of Construction, which consists of the heads of the bureaus which have to do with the design and building of the ships. For quite a period recently, in addition, there was as president of this board an admiral who had been a chief of bureau but who had retired. The point is that a majority of the members of this board are line officers. Indeed, since the engineer in chief became a line officer, all the members, except the chief constructor, are members of the sea-going branch. This board has the final say, under the Secretary, respecting all matters of the design and construction of vessels, which certainly seems to provide adequately for giving sea-going officers an opportunity to have their views considered and the benefit of their actual handling of ships at sea put to good account.

It by no means follows, because it is desirable that sea-going officers should have a chance to present their opinions, that the Department should be so organized that their opinions are necessarily final—or rather, that other officers (and especially the technical ones) should be put in the position of not having access to the Secretary, except through superiors who are sea-going officers. This is a point which is perhaps not thoroughly appreciated by non-military people. The military organization, while not going quite so far as the Church of Rome in believing that its head cannot be wrong, does theoretically assume that the higher an officer's rank, the more nearly apt he is to be right. As the Department is now organized all chiefs of bureaus are peers and all of them have the same right of access to the Secretary. The proposed organization, mentioned a short time ago, of several grand divisions, each presided over by a vice-admiral, would relegate the technical officers to a secondary position where they could not have access to the Secretary without going over the heads of their immediate superiors. This is such a serious matter militarily that no junior ever resorts to it except in desperation.

Among staff officers of the Navy it is the general belief that the scheme of grand divisions controlled by sea-going officers has for its distinct aim to prevent them from having access to the Secretary. It is sad to have to say so, but the experience of the Navy has shown that the possession of practically absolute authority has about the same effect in the Navy as it has everywhere else—namely, a decided tendency to cause narrowness of view with tenacity of opinion in a very high degree. In other words, if the Department were reörganized in this way the technical experts would practically be forced to do what their military superiors insisted upon, whether it was best or not.

That the views of sea-going officers are unfortunately often in the nature of fads or whims has been shown in a number of cases; but Admiral Capps' testimony called very marked attention to this in the case of the "superposed" turrets—generally regarded as defects in a number of our battle ships—whose adoption was strongly opposed by the Bureau of Construction. At least two special boards, composed almost entirely of line officers, discussed this question; and it was on their recommendation that the superposed turrets were adopted, although opposed to the last by the constructors.

Another scheme which has been proposed as a modification of the existing organization is the addition of a naval general staff, which has thus far been escaped owing to the opposition of Senator Hale, chairman of the Senate naval committee. One part of the work which a general staff would perform is undoubtedly very necessary and would be highly beneficial—namely, that relating to personnel and to the planning of naval campaigns. It is a little hard for the ordinary observer, however, to understand why this could not be done just as well under the auspices of the Bureau of Navigation, which at present is charged with the administration of personnel matters and could easily arrange for enough assistants to the chief of bureau with proper rank and experience to do this important work. Staff officers, however, are inclined to feel that if a general staff were introduced, it would have for them about the same effect as the organization by grand divisions, and they cannot see that the Department or the country would receive any benefit, while they believe the Department and they themselves would be injured. Standard reference books say that, in the army, the chief of staff has supervision of all bureaus, thus requiring all matters to go to the Secretary through him.

An argument which is sometimes advanced for turning over the control of the Navy Department to the sea-going officers is, that as the Secretary is a civilian and without intimate knowledge of naval details, he cannot intelligently decide the questions which come before him, so that he should be relieved of such a responsibility by having naval aides (such as the vice-admirals already mentioned or a chief of the general staff) who will decide them for him and make his official life a sweet dream, whose chief duty would be to pose on occasions of ceremony. This argument is probably perfectly natural to naval men who have been in command a long time. Each commanding officer in his own ship is a little king, whose word is law and who does not have to justify his intellectual processes to those with him, for all are his subordinates. He can not see how a lawyer or a business man can possibly tell him anything about his own profession. While many naval line officers are men of broad culture, it does seem that, as their work is mainly executive on a small scale, they pay no attention to the executive work on a vastly larger scale which is performed with such high efficiency in the railroads and other large organizations on shore. If they understood about this, they would know that it is the exception, rather than the rule, where the head of these great concerns is a technical expert in the line of work over whose administration he exercises supervision. For example, Carnegie, Frick and Judge Gary —none of them is a technical steel man. The presidents of most of our large shipbuilding concerns are not shipbuilders by training. The presidents of most of the large electrical companies are not electrical engineers. A number of the most successful railroad presidents are lawyers by training. The fact is that executive ability is largely a natural gift; at all events, it is entirely separate from technical skill. The able executive does not have to decide minute points of technical detail, but handles the great questions of policy, and he knows how to extract from subordinates enough of the technique to make his decisions sound. It is conceivable, as an intellectual diversion, that a conspiracy to deceive a civilian Secretary might be so general as to lead him astray; but this would be to assume that our naval officers, to advance their personal ends, would lose all sense of honor. Even their worst enemy would hardly charge them with this, although an analysis of what some of them charge against others, in their desire tc grasp exclusive control, comes very near it. The term "politician" has come to have so many unpleasant associations that one is apt to forget that even a politician cannot attain sufficient prominence to secure a cabinet office unless he is a man of decided ability, and that ability, from its very field of operation, is executive—the handling of men. It all comes to this: that the questions which come to the Secretary for decision are either of simple justice, in which case a man free from all naval prejudices is decidedly the best man; or, if of a technical nature, they are on broad lines which he decides just as the head of any other large organization would do, by careful weighing of advantages and disadvantages. And here again the freedom from naval prejudice should, at least, not be a disadvantage.

It is apparently forgotten by the critics of the bureau system that it did not start full-fledged with the organization of the Navy Department, but on the contrary has been a gradual evolution corresponding quite accurately to Herbert Spencer's definition of evolution, which substantially says that it is a change from unorganized sameness to a definitely organized variety with specialization of functions. For a long time the Navy Department was managed by what was known as the "Board of Navy Commissioners," and the sea-going officers were supreme; so that the evolution has been away from the very plan that the critics are now recommending. Long after the first organization into a few bureaus, when steam came into the Navy, engineering was only a subdivision of another bureau, and it was not until the stress of the Civil War made it absolutely necessary that the Bureau of Steam Engineering was formed as a separate one. At this same time the former Bureau of Construction, Equipment and Repair was divided into the three new bureaus, of Equipment, Construction and Repair, and Steam Engineering.

This specialization of function has naturally tended to the development of experts along particular lines, and the line of the Navy, with its multifarious duties, has developed these specialists in ordnance, electricity, torpedoes, gunnery, etc. Unless the history of the Navy were to be absolutely contrary to all other experience, it would be expected that where each bureau is charged with a special duty and its chief has full responsibility for the work coming within his cognizance, there would be a decided increase of efficiency and an incentive to keep his work in the very forefront of progress. Those who believe that the Bureau system is right maintain that this has been the fact, and certainly engineers who look back over the administration of that grand old man, Melville, while he was Engineer in Chief of the

Navy, cannot doubt that he illustrated this point most thoroughly. The mention of Melville's case is quite appropriate as pointing out what might happen if the suggested changes were made. Those who remember the details of their design will recall that Melville, against much opposition and well-meant advice not to do it, decided to use three screws in the wonderful flyers, Columbia and Minneapolis, which at the date of their trials (1893 and 1894) and for a number of years after were the fastest large vessels in the world. The construction bureau provided splendidly designed hulls and was entitled to more credit than it received, but the papers generally called them Melville's ships and gave him nearly all the credit. Whether it was due to jealousy of his success cannot, of course, be said, but it is nevertheless a fact that from the date they were put into service they were never popular with the line officers. The late Admiral Meade is on record in the proceedings of the Society of Naval Architects abusing them roundly. Some unkind people have said that as there are three screws to operate, it made more trouble for the deck officers and that this was the cause of their unpopularity. This, of course, is absurd, as the professional skill of our line officers is rarely called in question.

This is not an isolated case. Isherwood, more than twenty years before, had made the Wampanoag even more of a success for her day than the Columbia and Minneapolis were in theirs. She was the fastest steam vessel afloat by more than three knots. It has been asserted that the possession of the Wampanoag and her class by the United States was an important factor in the settlement of the Alabama claims at Geneva. Did the sea-going officers take pride in this wonderful ship? They did not. They still thought that sails were supreme. They hated engineers and machinery. The Wampanoag was never put into regular service but promptly laid up in "ordinary." A board of sea-going officers pronounced her a failure because of lack of sail power! They recommended removing part of her boilers and rearranging the masts so as to make her a full rigged sailing vessel! This board even had the delicious (but unconscious) humor to say that the utter failure (in their opinion) of the Wampanoag as a war vessel was a signal illustration of the danger of "ignoring experienced and intelligent naval minds as to the properties to be secured in the construction and arrangements of a vessel of war." (These statements are not made from memory but are found in the reports of the Secretary of the Navy.).

When such cases as these are only sample illustrations of the intense prejudice of the sea-going officers and of the way in which they allow their prejudices to blind them to the best interests of the Government, can any one believe that the public welfare would be increased by giving them absolute control of the Navy Department and making the Secretary a mere ornament?

As further illustrating this point of giving sea-going officers complete control, it is a matter of history and official record that during Grant's first term, his Secretary of the Navy, Borie, for a time turned the actual administration over to Admiral Porter. Admiral Porter was a sailor in the strict etymological sense of the term, in that he believed there was nothing like sails. As soon as he was in authority he caused the four-bladed propellers of the vessels to be removed and replaced by two-bladed ones in order that the ships might manœuver better under sail. The inefficiency thereby brought about is, of course, apparent to any engineer, as the size of the propeller opening was fixed and the two-bladed screw could not be made large enough. A few years later, in a report to the Department, he actually claimed that the vessels were faster under steam with the mutilated screws. The facts, of course, were just the reverse, and when his influence became less, proper propellers were again fitted. This was when he was still in his prime and his judgment was, at least, not impaired by age. About twenty years later, when the Roach cruisers were being built, the dear old man, then over seventy, went before the Naval Committee and said that the plans of these vessels were wrong because they had only auxiliary sail power. In his judgment they should have been given full sail power with steam as an auxiliary. He was still a sailor! The world had not moved for him.

Repeated attempts have been made to injure the Bureau system, sometimes directly and sometimes indirectly, but in almost every case the result was a decided misfortune to the Department and the Government. With the beginning of the new Navy and the building of what were known as the "Roach cruisers," a special board, known as the "Advisory Board" was organized, two of whose members were civilians. The result of their work was so unsatisfactory that broad-minded line officers came out frankly and said that it was an entire mistake to attempt to build ships under such a plan.

When Secretary Whitney took office, certain line officers secured his ear and persuaded him to buy plans abroad, instead of having them prepared by the bureaus. A long and interesting story could be told about this, and of how the non-technical line officers who bought the plans were gold-bricked. The fact is, however, that two out of the three ships which were thus built were always unsatisfactory and were known to be so throughout the service.

Just how far the distribution of work among divisions or bureaus of equal rank should be carried in any organization is difficult to say; but there can be no doubt that, in general, when there is enough specialized work to require a large force under competent executive direction, the time has come for giving the head of this office real standing and real responsibility. This principle is carried out in all large undertakings in civil life, such as the great railroads, the manufacturing plants, etc., and it has been found the best system for securing economy and efficiency. It has been carried out in the other departments of the Government as well as in the Navy Department, and it is true abroad, as well as at home. It can hardly be possible that the general practice of the world is wrong, and that it has been reserved for a few ambitious line officers of the United States Navy (to whom this proposed reorganization is only an incident to more rapid promotion) to be right.

The statement can be made with confidence that the Bureau system of the Navy Department has proved its efficiency. Responding to the environment and the survival of the fittest, the system carried the Navy through the Civil War most successfully. When the war with Spain came, it again proved entirely adequate and highly efficient. If any weaknesses developed, such as the circumstances that led to the Sampson-Schley controversy, and lack of developed campaign plans, they were distinctly due to the line officers themselves and not to the Bureau system. The War College, the Naval Intelligence Office, the General Board—everything they have asked for along the lines of general policy, strategic plans, etc., has been given them. All that has been refused is the right to dominate every detail of naval organization, and to the careful student of American naval history and of American institutions, it seems most fortunate that this has been the case.

EFFICIENCY AS A BASIS FOR OPERATION AND WAGES.

By Harrington Emerson.

V. THE REALIZATION OF STANDARDS IN PRACTICE.

Mr. Emerson's series began in the issue of THE ENGINEERING MAGAZINE for July last. The topics and scope of the preceding installments are well defined in the opening paragraphs of this section.—THE EDITORS.

THE four preceding essays were general in character, showing that inefficiency is almost universal, that each nation has to some extent offset general inefficiency by good qualities of its own, differing from the good qualities of other nations, that American advantages in the past lay in great natural resources and in wonderful opportunities, pursued by keenly adaptable rather than specially skilled men.

Inefficiencies everywhere were ascribed to the primitive and elementary character of the directing organization, which has progressed very little beyond the military line evolved centuries ago, continuing unchanged even in armies until the latter half of the nineteenth century. To lessen inefficiency, not *less* of military line but *more* of supplementary staff was urged, and a specialized staff was indicated as the logical and inevitable forward step. It is the business of the staff, not to accomplish work, but to set up standards and ideals, so that the line may work more efficiently.

In attempting to better and strengthen great American repair and manufacturing plants, it was found necessary to use the perseverance of the British, the innovating logic of the French, the thoroughness of the Germans, the open-mindedness of the Japanese, and the adaptability of the American, and also to use staff first to determine and then to facilitate their attainments. The outlines of a successful attempt to apply staff and standards to a particular shop will now be described.

To enter a shop employing 2,000 men, each one doing an average of four different jobs each day, aggregating for all the men 8,000 separate tasks, these tasks changing from day to day, so that there is a total of tens of thousands of different tasks in a year—to be expected to standardize each and every one of the tasks as to both time and cost, is dismaying; not more dismaying perhaps than the proposition would have been to the primitive woman, whose hair was a mass of matted tangles, that each and every one of the separate hairs of her head ought to be brushed and combed into its perfect place at least twice every day. It does not require much experience to distinguish between the well arranged head of hair and the matted one, nor does it require much experience to recognize in a machine shop the difference between what is and what ought to be.

In the particular shop under investigation there were great natural opportunities, such as abundance and steady supply of work, no financial worry as to income, the shop itself manned by an unusually fine, progressive, and experienced body of officials and employees. If under these conditions there was great inefficiency, great discrepancy between actual results and reasonable standards, the presumption is that the inefficiency was not due to conditions but to form of organization and to methods of administration.

The organization was the usual line organization; a president, a vice-president in charge of operation, a general superintendent in charge of all shops, a superintendent in charge of each large shop, a general foreman, foremen over each department, gang bosses directly over each subdivision of department. Each of the higher officials had his own individual staff, these individual staffs being weaker and cheaper towards the bottom, as when a foreman appropriated a machinist's helper to act as general utility assistant in the foreman's office. In two directions only were there embryonic staffs in parallel with the line, extending from the top to the bottom. One of these staffs was the detective service, whose operators, circulating among the employees in the guise of machinists, boiler makers, helpers, etc. reported through their own chief whatever they thought would be of interest to the head of the line. While the staff idea was here, while it was felt that the line by itself was inefficient, the two essentials of modern staff were wanting, since the secret operators were not only without standards but they were not helpful to the line members whose doings they were adversely reporting.* The other staff, the accounting department, was of very high character, had high ideals and exact standards, was in helpful touch from top to bottom with all members of the line. The head of the accounting staff was the general auditor, on the president's staff; under him were the division auditors, mechanical accountants, shop accountants, down to the time keepers and pay-roll distributors.

The accounting staff, fully organized and capable, proved of the greatest assistance as a type on which to model other staffs.

* A staff-supplemented shop would need very little detective reporting, since standards and their attainment would result in eliminating nearly everything of importance that detectives now report on.

Before beginning standardizing work a number of surveys were run through the shop to ascertain what was not covered by the existing line and accounting organizations. The first survey was to ascertain whether materials were being properly handled and checked; the second survey covered the condition of the machines and tools; in the third survey a number of labor assays or audits determined the relation between what men were actually doing and what they should do; the fourth survey showed as to a few operations the relation between current costs and standard costs, and the fifth survey the speed of movement of work through the shop. It does not follow because a shop is lax in one of these directions, that it is equally lax in others; it does not follow that being excellent in one direction it will be excellent in the others. Good work had always been an ideal in this shop, also a large output; but neither costs nor speed had been ideals.

The preliminary investigations revealed certain organic weaknesses of operation, due to the absence of ideals or standards and to the absence of a staff organization able to create and realize standards. To eliminate these weaknesses a staff was gradually created supplementary to the line. This staff organization would not have had necessary powers unless it had started very high up, the chief of staff in charge of standardizing and efficiency methods being on the vice-president's staff, without whose support in many an hour of need nothing could have been accomplished.

Under the chief of staff were various specialists, selected or promoted for their demonstrated experience, each one of these specialists becoming the head of a special staff line. The staff, in fact, was evolved not theoretically but in direct response to necessity.

The five different lines of preliminary survey were each made permanent fields of investigation and control.

A staff specialist was put in charge of everything appertaining to materials, his duties being to evolve methods which would always supply the right material at the right place, at the right time, in the required quality, minimum necessary quantity, and at lowest cost. Another specialist was put in charge of all matters appertaining to the maintenance and operation of machines and tools. A third and most important organization of specialists was given the duty of standardizing every task as to time; a fourth specialist took up the matters of standard costs, and a fifth specialist provided methods by which all work could be dispatched through the shop even more carefully and accurately than trains are dispatched on a railroad.

Although in this particular shop—a repair shop for a large corporation—costs had never been considered of commercial importance, it was found absolutely necessary to provide a standard method of determining costs, applicable equally to the five-minute task of a single worker or to the month's output of the whole shop.

Costs can be subdivided into three divisions: (1) Material costs, (2) direct-labor costs, and (3) indirect or overhead or surcharge costs, this last division embracing everything that is not material or direct labor. Indirect charges (3) were subdivided into four classes: (1) Power (2) Maintenance (3) Rent (4) Administration. As a general production proposition, there is no difference between a man and a machine, the mere fact that the man is paid wages and the machine is virtually a slave, in which capital is invested, which has to be maintained and which in time perishes, being a financial and not a productive difference. Therefore all the expenses of power, maintenance, rent, and administration were subdivided partly to men and partly to machines, thus giving the foundation for a standard cost of any operation for any unit of time. Each of the four subdivisions of surcharge was put under the care of a staff specialist.

When a simple system of stating all costs—whether for a single task for man or machine, or for all a man's work for any period, or for all the work of a gang or department, or for a whole plant—is available; when this system permits parallel statement of actual and standard costs—then the whole problem is well-nigh solved, patience, persistence, fidelity and high ideals accomplishing the results, through the use of staff specialists.

The system under which costs were standardized will be made the subject of a separate paper, it being at present more important to see the results of this system, when applied to a single department of a great works, than to understand the system in its details.

DEPARTMENT F.

Statement of Condition for 12 Months Preceding June 30 on Basis of Standard Volume of Output.

	Actual.	Standard.	Reduction.
Costs per Hour.			
Direct wages	$36.93	$27.77	25 per cent.
Overhead or indirect expenses	18.98	11.11	41.5 per cent.
Machine expenses	48.94	29.17	40 per cent.
Totals	$104.85	$68.05	35.1 per cent.
Total Costs per Annum.			
Direct	$99,794	$75,000	$24,794
Overhead	51,255	30,000	21,255
Machine expenses	117,470	70,000	47,470
Totals	$268,519	$175,000	$93,519

This statement shows that whereas the actual cost per hour for a given output averaged over a period of 12 months had been $104.85, it was determined by the staff officials that it should cost only $68.05, a reduction of 35.1 per cent.

This statement is remarkable. The actual expenses were those of the preceding twelve months. The standard expenses are theoretically predetermined by standardizing *not* the cost of work, but the efficiency of men, of machines and of methods.

The standard costs were those possible at the date the work was undertaken. By the time actual costs are reduced to $68.05 per hour new standards will have come into existence, making the standard costs as low, perhaps, as $60 per hour, so that the standard is always elusively ahead of the actual.

The president of the company does not need to see each month much more than this one statement (prepared however in the form of a flowing record) so that, at a glance, he can see the trend of progress. In this particular case a time limit was set within which the reduction was to be accomplished.

That the reduction from $104.85 per hour cannot be effected in a single month is obvious, and equally so that it ought not to take ten years. Whether it is to take a year or two years or four years depends solely on the willingness of the management. The shaded area in the diagram measures the exact cost of taking two years instead of one, and it amounts to about $100,000.

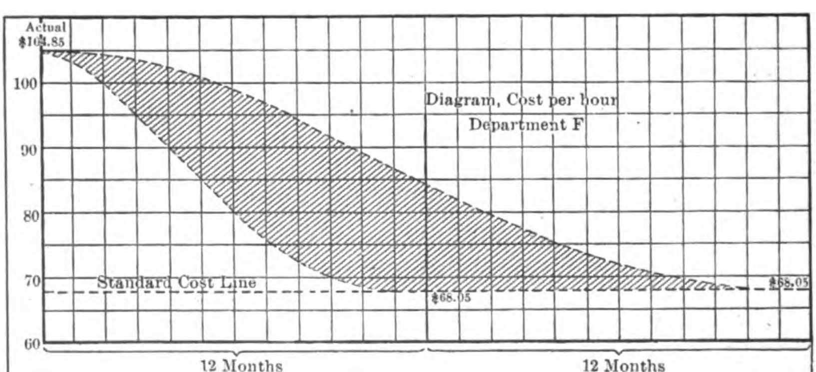


DIAGRAM SHOWING COST OF DELAY IN REDUCING COSTS TO STANDARD.

This epitomized statement of standard hourly cost is for a definite number of standard cost units, so that whatever fluctuations in kind or volume of work occur from month to month, standard comparisons hold good. The assumptions on which standard costs are based for Department F were as follows:—

Standard annual hours per machine	2,400
Standard annual hours of shop work	2,700
Standard value of equipment	$200,000
Standardized surcharges	$100,000

SUBDIVISION OF INDIRECT CHARGES.

	Actual.	Standard.	Reduction.
Power	$26,100	$13,000	50 per cent.
Maintenance	96,618	48,000	50 per cent.
Rent	14,587	12,000	17 per cent.
Administration:			
Direct	9,870	12,000	21.5 inc.
Indirect	21,550	15,000	30 per cent.
Total	$168,725	$100,000	40.8 per cent.

In pursuing the location of responsibility the indirect charges were apportioned partly to machine and partly to men.

	Actual.	Standard.	Reduction.
Overhead charges:			
Assessed to machines	$117,470	$70,000	40.4 per cent.
Assessed to men	51,255	30,000	41.2 per cent.
Total	$168,725	$100,000	40.8 per cent.
Direct pay roll	99,794	75,000	.25 per cent.
Total	$268,519	$175,000	35.1 per cent.

Standard practice propositions are generally wrecked on the fact that to secure a net reduction of 40 per cent as to the whole, the cost of direct supervision is increased.

Managers are reluctant to incur an increased cost for direct supervision (in this case of 21 per cent or $2,130) to effect the 40 per cent net reduction amounting to $68,725, because they find it impossible to believe that so great a gain is attainable especially as it is not made the first month. They are certain that the very extensive staff organization must necessarily cause an unbearable increase in indirect expenses. This is not the case for three reasons:

1—A portion of the expense, the preliminary studies and investigations, are properly charged to capital investment as they have lasting value—as much as drawings or patterns, more than machines.

2—When the output of a plant aggregates $15,000,000 a year, with a pay roll of $3,000,000, the pro rata expenses of the general staff officials pro-rated to a department shop whose direct and indirect roll is only $150,000 a year is only 5 per cent of the total, so that if the general staff cost $40,000, the assessment to Department F would be only $2,000.

3—All the particular staff expenses are charged directly to the account benefited. If a staff advisor for, or a designer of, tools is employed his expenses are charged directly to the maintenance account.

The employment of so complete a staff will necessarily highly specialize operations, and economies result, not from an effort to secure them, but from an effort to do everything in a standard practical manner. Standard power conditions mean the same power with less coal and less power for the same output. As power happens to be one of the subdivisions of surcharge, the surcharge per unit is reduced without any thought or worry as to whether it is related to direct labor increases or decreases.

Standard maintenance conditions means far better tools for less cost, greater output from the same machines; and as maintenance is one of the surcharge accounts, when it decreases the maintenance surcharge per unit decreases. In Department F, actual expenses for power were $26,100; predetermined standard power expenses were placed at $13,000. This astounding reduction was realized in practice and was effected in the following manner: A power specialist is made responsible for the production of power. If the actual expense is $60 a year per horse power of 3,000 hours, every item of expense is analyzed, and it is ascertained that under standardized conditions the expense should not exceed $45, so this standard cost is set up for the man in charge of power production to aim at. On the other hand, the foreman of the department uses power, it being entirely beyond his control whether the rate to him is $60 a year or $45; but wasteful use of power is not beyond his control, so another staff expert scrutinizes every item of power use, ascertains that by the elimination of destructive frictions, leaks and wastes of various kinds, the total annual consumption of power can be reduced from 435 to 300 horse power; 435 horse power at $60 amounts to $26,100, but 300 horse power at $43.33 amounts only to $13,000. No one acquainted with the scandalous inefficiencies of the average factory power plant, consuming from 5 to 7 pounds of coal per horse power per hour, will question the ability to lower costs 28 per cent, and no one acquainted with the leaks of air and steam and water, leaks of light and heat, all the frictional losses due to lack of alinement, too tight belts, etc., will question the possibility of reducing power consumption 30 per cent. to 33 per cent.

The standards of $43.33 per horse power per hour, and of 300 horse power for the department, are by no means final. As long as it pays to follow them, further reductions are in order until standard minimum practice is attained. The essential of the system is that the item of power, as to production, distribution, and use, is set up monthly in two parallel columns, one showing actual, the other standard results, and the chief of staff in conjunction with chief of line combine their efforts until facts and theory coalesce—until the victory is won, a victory not less inspiring because it is bloodless.

The item of maintenance is treated in exactly the same way. There must be a general supervisor of maintenance who standardizes the quality, custody, and issue of small tools, who remodels the larger machines, who anticipates breakdowns or repairs them so that the same collapse will never occur again. There is in addition all the economy that results from the careful and checked use of machines and tools. On even a larger scale than the one now being discussed, the staff assistant of the writer, in charge of maintenance of shop machinery and tools, effected the following results:

Year.	Output.	Expense.	Unit Cost.
1905	47,854	$486,620	$10.16
1906	57,760	376,106	6.51
1907	64,628	315,844	4.89

The reduction in unit cost is more than 50 per cent, the economy on a unit basis being more than $300,000.

In connection with this account my experience was amusing. The general superintendent was so alarmed at the direct staff expenses and the expenses of the improvements recommended by the staff, that he ordered a special account to be opened, in which they were all entered, so that at the end of the year he might point to this account as the cause of the, to him, inevitable and abhorrent increase. After absorbing all these special expenses, the actual net saving in money at the end of the year was $110,514, for a 20 per cent greater output.

It is unnecessary to discuss "rent" in detail. Standard expenses show slight reductions below actual owing to standardization of repairs, better custody of buildings, etc. There are occasions when rent can be very greatly reduced, by increased use of old instead of building new buildings, or the double-shifting of a shop. Using the building 20 hours a day instead of 10 hours will very greatly reduce rent per unit of output. The actual result of standardizing the legitimate cost of all these different items of surcharge is to reduce general expenses per unit or per hour about 40 per cent.

The method has been more fruitful than the usual methods of effecting economies in shop operation because an ideal standard cost is ascertained at which to aim, and realization is facilitated not by sub-dividing expenses to departments, thus frittering away responsibility, but by grouping all expenses under a few heads and putting each group in charge of a specialist, whose ideal is not to reduce cost of specific output but to standardize operations.

The problem of standardizing direct pay roll is much more difficult, as it involves the determination of a standard time and cost for every task. For every work order issued to employees there is a determinable standard time. This time must be ascertained by the Taylor system of time studies. The specialist at the head of time-study work must be able at a moment's notice to state, before the work is begun, what the standard time is. The determination of standard time is a profession in itself at which specialists become very expert, so that on the average their determinations will not vary more than 1 or 2 per cent from ideal standards. Standard times may be anywhere from 10 per cent to 90 per cent less than actual times.

Standard time is lower than the time which a good worker would take to accomplish the task set. The worker is limited by conditions as they are, but standard time pre-supposes standard power and maintenance conditions—ideal, not actual, conditions for the worker.

It must be made pleasanter and more agreeable for the worker to attain standard output or to surpass it than to fall below it. His co-operation is secured by appealing to some of the strongest human instincts—some urging him forward, as ambition and hope, an increased wage rate set by himself, pleasure in the work; others impelling him from behind, as apprehension of discharge.

The result of standard efficiency in workers, coupled with standard other conditions, was to reduce direct-labor costs 25 per cent, an unusually small reduction.

I do not lay much stress on names or forms. I have been in shops of very high efficiency whose managers would not have understood the meaning of the word *staff*. Yet staff talent and staff activity were in full swing, the manager by natural intuition having selected foremen who had the double gift of line and staff ability. I also recognize that Mr. F. W. Taylor's shop organization based on functional foremanship is but another way of securing staff results, through staff specialists.

Whatever the names given to the line foreman or the staff specialist, it has been demonstrated over and over again, and on the largest scale, that staff investigation will show standard costs to be far below actual costs, and that predetermined standard costs can be attained through the direct and indirect assistance given to the line by the staff. The possible volume of the economy depends solely on the magnitude of the business, the rapidity with which economy can be effected solely on the courage and thoroughness with which the work is prosecuted. The labor difficulties are virtually nil, if there is persistent and conscientious effort to give the worker a square deal. The greatest impediment is the reluctance of the line to accept staff assistance, methods, and standards, including equity towards employees.

THE MOST IMPORTANT HYDRO-ELECTRIC INSTALLATION IN EUROPE.

By Enrico Bignami.

THE hydro-electric installation of Brusio at Campocologno (Canton Griscon), recently inaugurated, transmits the electric energy to the sub-stations of the "*Societa Lombarda per distribuzione di energia electrica*" of Milan, (which already disposes of 20,000 horse power from its installation at Virzola), at Lomazzo and Castellanza, Lombardy. The power transmitted, the length of the line, and the tension adopted, make it at the moment of installation the most important in Switzerland—and actually in Europe. It is undoubtedly the first of international character—for, according to conventions between the Swiss and Italian authorities, the electric energy produced in the Swiss canton is used entirely in Italy.

The water power supplying this installation is given by fall of the river Poschiavino flowing from the Lake of Poschiavo (Figure 1) at Meschino at the Swiss frontier. This lake, which has an area of about 2 square kilometres and a depth of 80 metres (260 feet), besides being an excellent basin of decantation, serves as a reservoir in times of low water; for according to the concessions, the water may be raised 1 metre above, and lowered 8½ metres below, the normal level. There are thus 17,000,000 cubic metres of water for disposal in times of low water. The lake is closed at some metres from the outflow by a sluice (Figure 2) by means of which the level of the lake can be raised 1 metre.

The water is taken out of the lake by a siphon, which leads it through a tunnel (Figure 3) cut through the solid rock, for a distance of 5 kilometres (3.12 miles) and reaches a storage basin (Figure 5) 435 metres (1,450 feet) above the central station. Six pressure mains of an exterior diameter of 800 millimetres (31½ inches), lead the water to a special building where are valves and penstocks to equalise the pressure (Figure 6) and from thence to the central station, situated on the Swiss-Italian frontier. The length of each main is about 1,350 metres (4,500 feet). They are composed of riveted tubes for pressure up to 20 atmospheres, and welded tubes for higher pressures. The walls increase from 6 to 23 millimetres in thickness, the exterior diameter of the tubes being constant. At every change of inclination the mains are fixed in blocks of concrete, but they rest freely on the foundations, so that they can withstand changes of length. The pressure mains enter the central station of Campocologno (Figure 4) at right-angles to their axis, and after having passed a valve chamber, enter the turbines which are coupled in pairs to one main. In the valve chambers all the mains can be joined to a collector. The mains are provided with everything which will protect them from damage. The opening of the intake of water can be worked electrically from the central station. Expansion joints allow slight extension. Along the pressure main is a cable railway worked by an electric motor.

The necessary power during the period of construction was given by a small central station of 500 horse power, which was made solely for this end, but which will be allowed to remain for the future with a view to furnish the necessary power to light the central station, work the cranes, machine tools and pumps. The water power of this central station is given by the Sajento. The central station of Campocologno is a building 104 metres (334 feet) long, 21 metres (70 feet) wide and 15 metres (48¾ feet) high. It is divided in three parts (Figure 7)—the machine hall, 104 metres (334 feet) long, 16 metres (52 feet) wide, and 15 metres (48¾ feet) high; the room for switchboard and bus-bars, equally long, but 4 metres (13 feet) wide; and the building for offices and feed lines of the valley of Brusio and of the Bernina railway. The machine hall has room for 12 groups of turbines coupled to three-phase generators (Figure 8) each of 3,000 horse power; and 4 groups of turbines coupled to constant-current generators each of 225 horse power. For the use of the machines there is a 25-ton electric crane.

The turbines are Pelton wheels regulated automatically. The large ones are 3,000 to 3,500 horse power, with 375 revolutions per minute; the small ones 225 horse power, with 430 revolutions. They were constructed partly by Escher, Wyss & Co., of Zurich, and partly by Piccard, Pictet & Co., of Geneva. Each turbine is coupled to the electric machine by a Zodel-Voith elastic connection.

The three-phase generators are made after the system of alternate poles with fixed high-tension coils and with moveable exciting coils. The stator is in two parts, and the high-tension coils are placed in half-closed grooves lined with micanite. The rotor is of steel in one piece, and has on the cast-iron poles the exciting coils, which consist of copper ribbons. The normal power of the machine is 3,000 kilowatts and the normal tension 7,000 volts, with 50 fre-

FIG. I. THE LAKE OF POSCHIAVO.
FIG. 2. HEADGATES AT POSCHIAVO.

FIG. 3. TUNNEL OPENING INTO THE CHARGING BASIN.

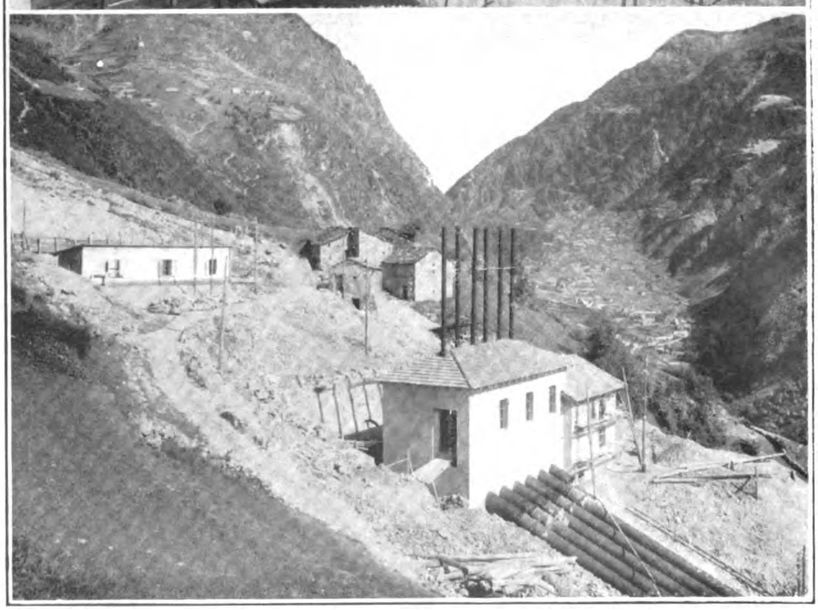
FIG. 4. CAMPOCOLOGNO STATION.

quency. It can, however, be regulated from 6,300 to 7,800 volts in order to compensate for losses on the line.

The continuous-current machines have a power of 150 kilowatts at 115 volts. Each at the same time serves for the exciting of four generators with 25 per cent. of surcharge and 0.7 as factor of power.

While, till now, in central stations, it has been the endeavour to concentrate as much as possible all the apparatus of control and command on one switchboard, here they have tried to decentralize, for each three-phase generator has a switchboard to itself (Figure 9). And that is considered as an advantage for the connections of the switchboard, as well as for the safety of working, so that a disturbance on one board does not extend to others. In spite of this the unity of service is maintained, because the entire installation can be seen at a glance from a distributing column placed before the exciting switchboard, whence the tension of the whole installation can be regulated. This central column has a voltmeter intercalated in each half of the central station and a commutation amperemeter, on which can be read the current of each machine, and an amperemeter for the line going to transforming station at Piattamala. The regulators of each exciter can be coupled, and by means of a wheel their tensions can be regulated from the central column, and consequently the tension of the whole installation.

Each switchboard generator forms a circuit by itself. Opposite the machine is the space where are the instruments and levers of control for the interrupters and regulators. The apparatus is placed in the bus-bar chamber, separate from the machine hall. Each switchboard, besides the necessary apparatus for use and for putting in parallel, has also an oil interrupter worked by hand as well as automatically with a relay, and a de-exciting switch, putting the exciting coil in short circuit by the introduction of an auto-inductive resistance (Figure 10). This switch is connected electrically with a high-tension interrupter, in such a way that the automatic interruption of the latter attracts to itself the former. By this means all damage is prevented from a contingent acceleration of the machine due to a sudden discharge, for the generator has only this acceleration to support, as increased tension is excluded. The position of closed or open interrupter is indicated by small signal lamps. All the instruments of the switchboard for the high tension are connected to the high-tension lines with tension and current reducers. The putting in parallel with the other machines can be done on the same board. Each switchboard is enclosed on its sides by diaphragms of concrete, and in front by an iron door. In the same way on the inside of the



FIGS. 5 AND 6. DETAILS OF CHARGING BASIN BUILDING, WITH STANDPIPES FOR EQUALIZING PRESSURE.

switchboard, the part for the high tension is separated from that for the low tension by fireproof walls. The upper covering is made from a sheet of marble. The switchboard can be disconnected from the bus-bars by means of cut-outs, which being removed the examination of the switchboard presents no danger even when working.

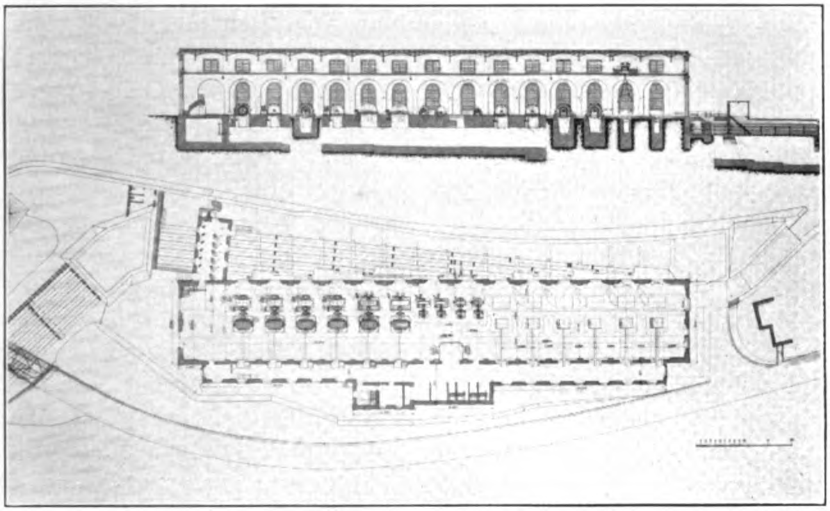


FIG. 7. PLAN OF THE CAMPOCOLOGNO STATION.

In the bus-bar chamber, which is divided into two floors, below are the exciting bus-bars, and above those for the three-phase current. The installation is entirely divided into two equal parts, each consisting of six generators and exciting dynamos, which work independently of one another, but which can always be put in parallel. This division allows one-half of the central station to supply the sub-station of Lomazzo, while the other half supplies the sub-station of Castellanza. The first three generators on the left side of the central commutation column can be joined to the separate bus-bars, and be excited by a special dynamo; they are intended to supply the energy for the valley of Poschiavino, and for the use of the Bernina railway.

The tension transformers are at some distance from the central station of Brusio and are situated in the sub-station at Piattamala, which is on Italian soil. The transmission line from the central station at Campocologno to the sub-station at Piattamala, a distance of 600 metres (1,968 feet) was one of the most difficult problems. An aerial line would have required 36 wires for the transmission of about 2,400 amperes and its up-keep did not promise too much safety on account of the possibility of falls. The use of underground cables would have involved an enormous cost, and the safety of the installation would not have been guaranteed. The most natural solution was the digging of a tunnel between the two stations, in which the lines could be placed, but this solution encountered the greatest difficulties, for the tunnel crosses the frontier, and it was believed it would be used for smuggling. The two lines of the tunnel form a direct connection with the two bus-bars of the parts right and left of the central station, and as such are installed there. On each side of the tunnel there are three lines of copper bars, one above the other, each 150 millimetres square; the joints are united by screws. The bars are mounted on triple petticoat insulators, which are fixed on straight supports between two U-shaped irons and serving at the same time to support the concrete diaphragms between the different phases.

The lines right and left are separated from the central passage by a trellis of iron wire, so that the passage is always free from danger. The tunnel is 625 metres (2,049 feet) long, 2 metres (6½ feet) wide, and 3 metres (9 feet, 10 inches) high, and is watched night and day by custom-house officials. Most of the tunnel is dry; at one point only was found a spring of water, which has been used to cool the transformers and for the water lightning protectors. The tunnel ends in the basement of the transforming station at Piattamala,

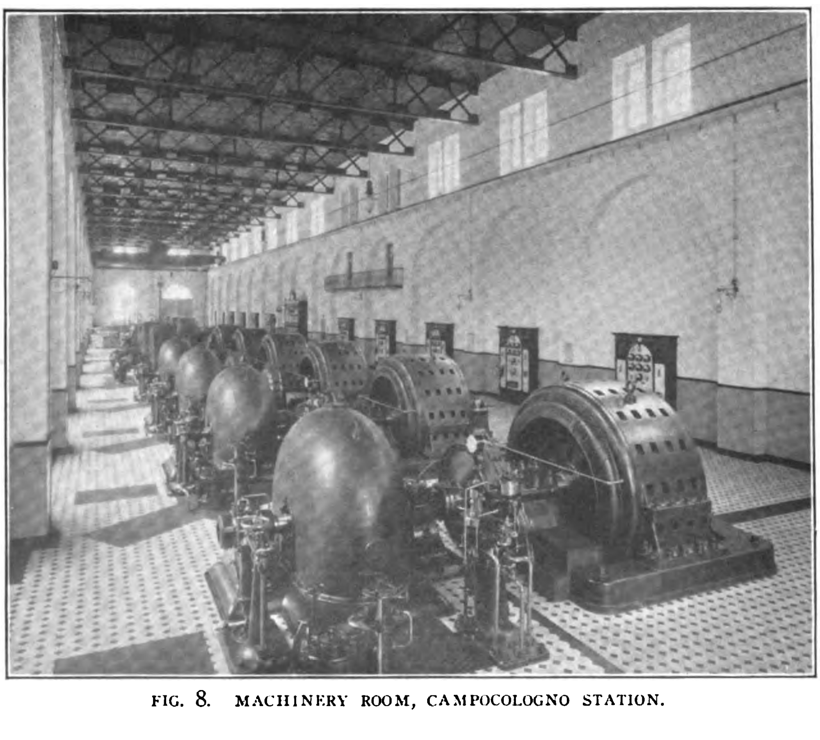


FIG. 8. MACHINERY ROOM, CAMPOCOLOGNO STATION.

FIG. 9. SWITCHBOARD AND DISTRIBUTING COLUMN.

to which the energy from Campocologno is carried at a tension of 7,000 volts. The station is constructed to receive 24 mono-phase transformers of 1,250 kilowatts each (Figure 11), which, star connected in sets of three, increase the tension from 7,000 to 45,000 volts of three-phase current. The transformers are oil and water-cooled. The station is 55 metres (180 feet) long, 21 metres (68 feet) wide, and 8 metres (26 feet) high, and towards Toriano has two towers for the exit of the lines. It is connected with the high road by a stone bridge capable of carrying the heavy transformers (Figure 12). The station has the duplex design characterizing the whole installation and is divided lengthways in two symmetrical parts, which can be at any time electrically joined. The lines leaving the tunnel enter the so-called measuring room, where the energy coming from Brusio is measured. Each half is provided for this purpose with three amperemeters, one per phase, a commutation voltmeter, a registering voltmeter, and two registering wattmeters wired in series, of different origin and construction, which are reciprocally controlled. Finally in this room are installed three ammeters and a commutating voltmeter for the two lines, beginning at 50,000 volts, so that the working of the whole installation can be controlled from one point. From the measuring room the lines descend to the rooms below, situated right and left of the transformer house, and from these pass to the transformers themselves. The lines passing from the transformers, after having passed the interrupter, are joined to 50,000-volt bus-bars placed on the first floor (Figure 13).

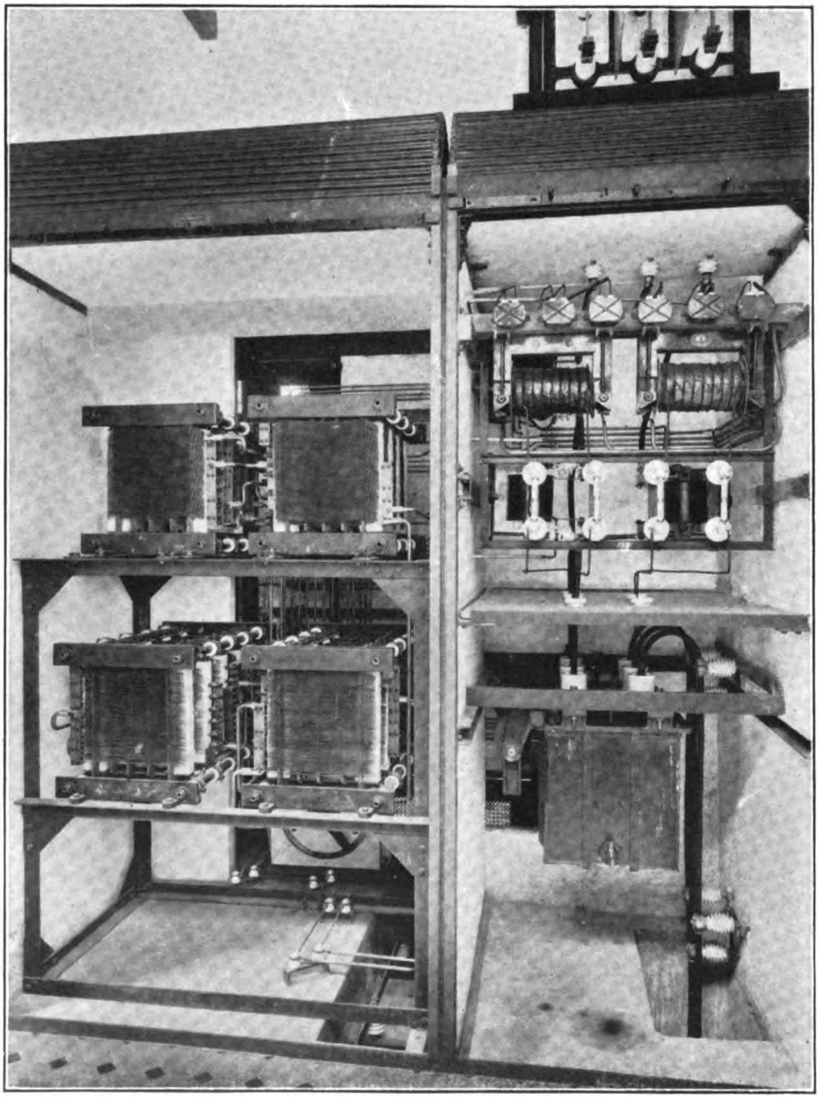


FIG. 10. RESISTANCES, SWITCHES AND CIRCUIT BREAKERS, CAMPOCOLOGNO STATION.

Each group of transformers has a tripolar oil interrupter for 70,000 volts, and a unipolar oil interrupter for each phase for the high tension. All the interrupters of one group are mechanically united with one another, and can be opened automatically by a retarded induction relay. Each group of three ammeters has small signal lamps to show if a group is joined or not. In front and behind each transformer are choking coils, and the neutral wires common to the groups

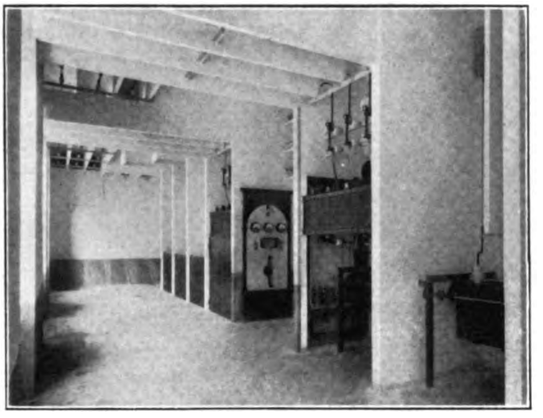


FIG. 11. TRANSFORMER ROOM, PIATTAMALA.

are brought to earth after having passed from horn-shaped lightning protectors. Each group can be separated on both sides by cut-outs and so placed out of tension. All the lines are separated by walls and also all the apparatus of each phase, except those of the 70,000 volts, work in company with their interrupter. The transformers are mounted in the central building of the station, the whole length of which can be seen from the measuring room. Each transformer is placed in a fireproof chamber (Figure 14), which can be completely closed, and is provided with a ventilating chimney, which in case of fire acts as a vent of the smoke of the oil. The transformers rest on toothed rails on which they can be easily moved. Between the two series of transformers are two guides, one on each side, on which they can be

FIG. 12. BRIDGE AT THE PIATTAMALA STATION.

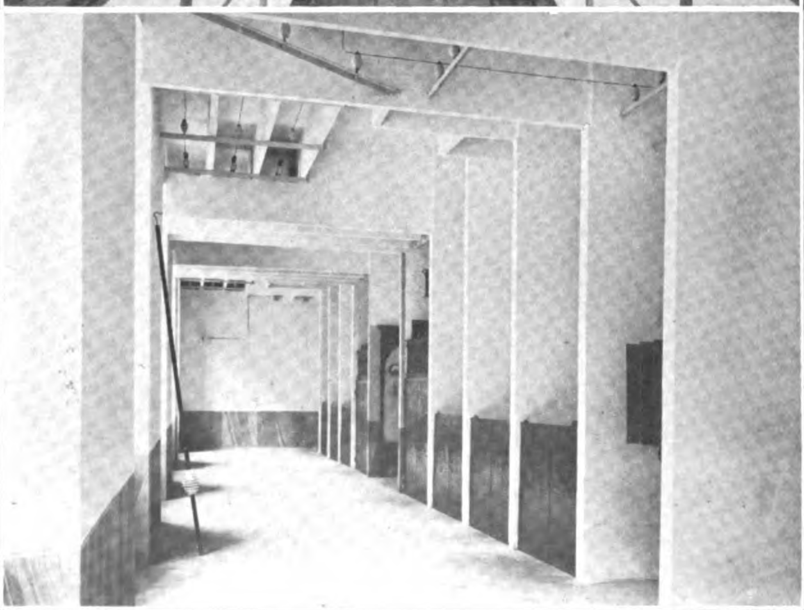


FIG. 13. BUS BARS AND COLLECTORS, PIATTAMALA STATION.
FIG. 14. FIREPROOF TRANSFORMER ROOM, PIATTAMALA.

moved into the space between the two towers for the outgoing lines; there is also a 10-ton crane for handling the machinery.

The two high-tension bus-bars lead first to the general interrupter of the exit lines, which consists of three large oil interrupters coupled together; and after passing apparatus protecting against lightning and elevation of tension, go to the outside line. Although the central station at Campocologno is not so protected, the sub-station at Piattamala is well provided. In correspondence with each feed line are mounted reaction coils, which prevent any superelevation of tension. There are protectors *à rouleau* for the discharge of high-tension due to changes of induction or static, and by protectors of jets of water, by means of which the lines are earthed by a continuous flow of water, and the superelevation of tension independent of the working

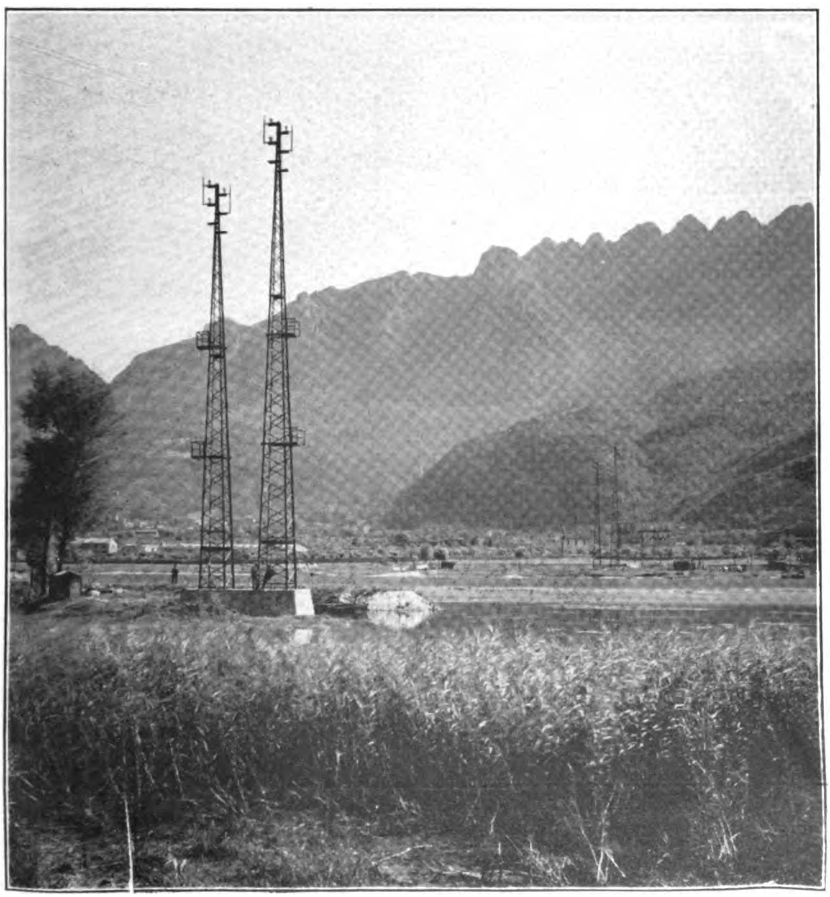


FIG. 15. AERIAL TRANSMISSION LINE LEAVING PIATTAMALA.

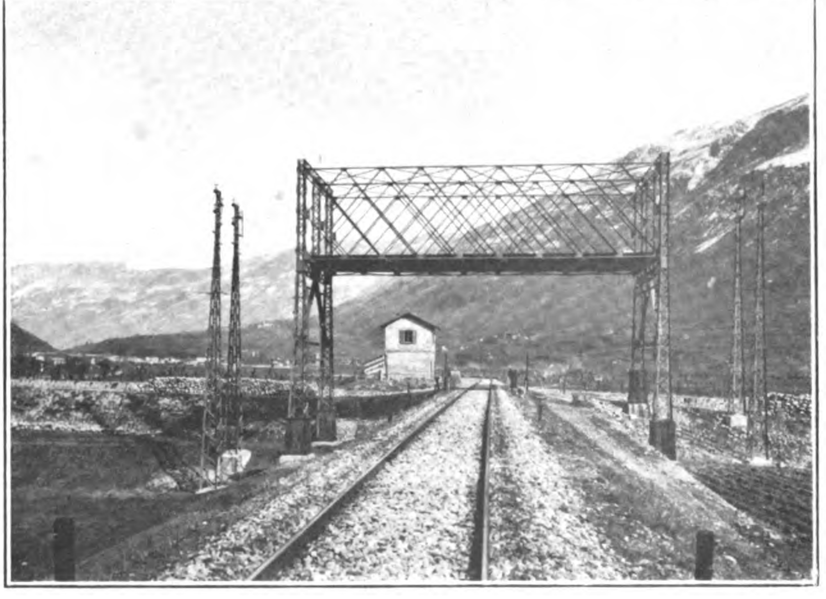


FIG. 16. TRANSMISSION LINE CROSSING THE HIGHWAY NEAR MADONNA DE TIRANO.
FIG. 17. TRANSMISSION LINE CROSSING THE RAILWAY NEAR TIRANO.

produces no damage. Finally, horn-shaped lightning protectors with water resistances are provided against the atmospheric discharges. Each protector can be separated from the line.

The ammeters inserted in the water earth lines, beside serving for the control of the current passing through the jet of water, also for the state of isolation of the overhead aerial line current and tension transformers, are inserted in each line of which the secondaries lead to instruments placed in the measuring room. The lines can be separated by cut-outs, and by cut-ins can be earthed for the safety of workmen.

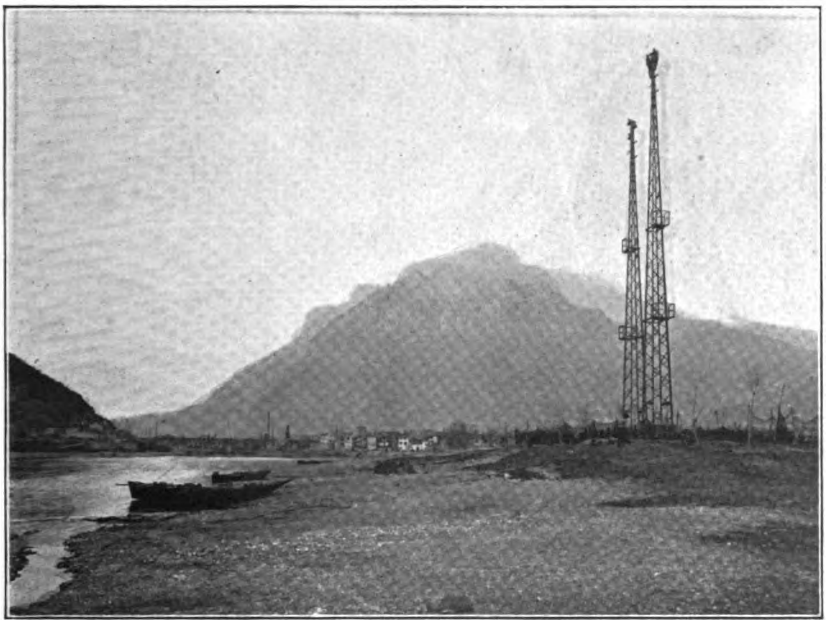
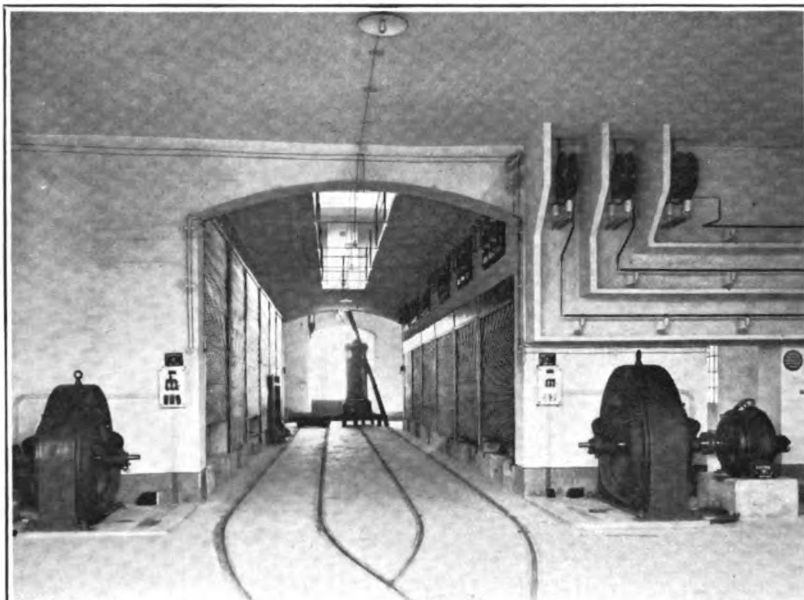


FIG. 18. CROSSING OF THE RIVER ADDA, NEAR LECCO.

The line leaving Piattamala (Figure 15), to the sub-station at Lomazzo is 147 kilometres (81 2/3 miles) long. From here to Castellanza (near Legnano) is 19 kilometres (11⅞ miles) long. It follows the neighboring mountains in the section Sondrio-Colico (Figures 16 and 17), and ends across the Val Sesina at Lecco (Figure 18), on the lake of Como. From there it follows the plain. Complete, it consists of four parallel lines of three copper cables, 105 square millimetres in section, mounted on two parallel rows of iron lattice poles, six wires on each pole. The rows of poles are paralleled and from 4 to 5 metres (13 to 17 feet) apart. In places where they are not so wide apart from condition of the ground, the poles of one




FIGS. 19 AND 20. INTERIOR OF LOMAZZO STATION.

row are higher than those of the other by several metres, so that approach of the two lines is prevented. The average height of the poles is 12 metres (39 feet 4 inches) and they are 100 metres (328 feet) apart. At some places the height of the pole is as much as 30 metres (98 feet), and crossing certain valleys as much as 400 metres (1,312 feet) apart. Each wire is mounted on porcelain insulators tested to 100,000 volts and placed 1.20 metres (47¼ inches) from each other. They are fixed on straight supports fixed on blocks of wood carried on double iron supports. The current when running without load measured at the beginning was about 14 amperes under 50,000 volts tension for each line of 3 wires. For the safety of the line there have been placed at Sondrio, Cortenova, at the commencement of the passage across the mountains, at Lecco, the commencement of the plain, and at Gerenzano, cabins with lightning protectors and safety apparatus against superelevations of tension. In these cabins are fitted U-shaped lightning protectors, protectors *à rouleaux,* and water earth lines.

The sub-station at Lomazzo constitutes the starting point for the distribution of the power. It consists of an H-shaped building 36 metres (124 feet) long, 17 metres (55¾ feet) wide in the middle, and 10 metres (32 feet) high. It is arranged for the reception of six monophase transformers, each with a capacity of 1,250 kilowatts to step down from 40,000 to 11,000 volts, and six three-phase transformers of 500 kilowatts from 11,000 to 20,000 volts (Figures 19 and 20). At present there are installed three monophase transformers of 1,250 kilowatts (Figure 21) and three three-phase

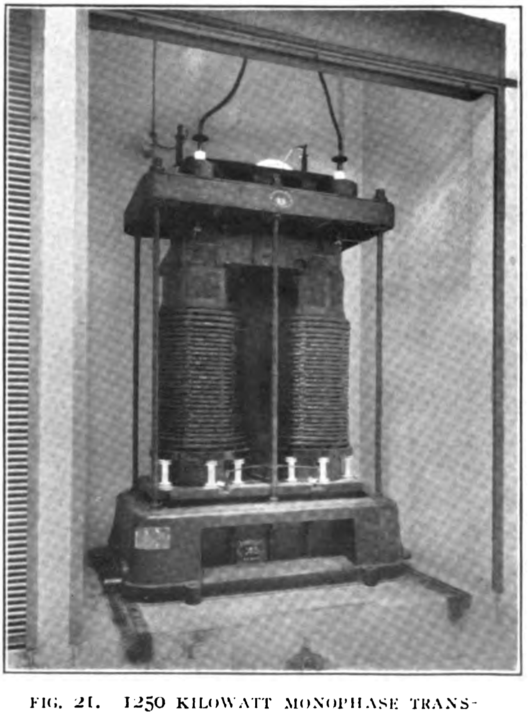


FIG. 21. 1250 KILOWATT MONOPHASE TRANSFORMER, WITH FORCED VENTILATION.

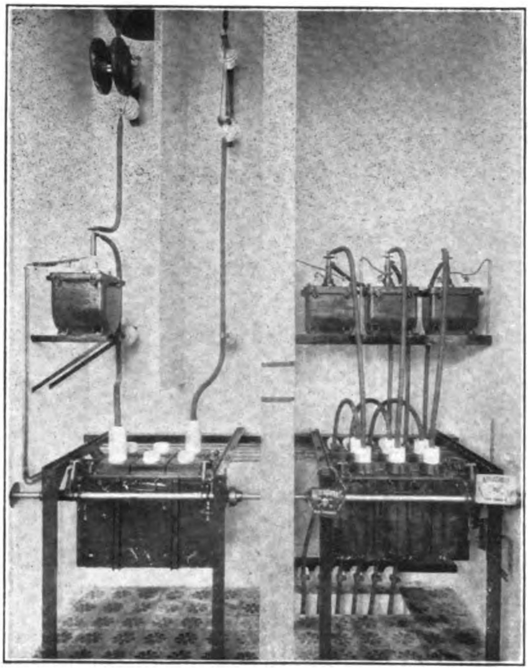


FIG. 22. DETAIL OF THE TERMINAL STATION AT CASTELLANZA.

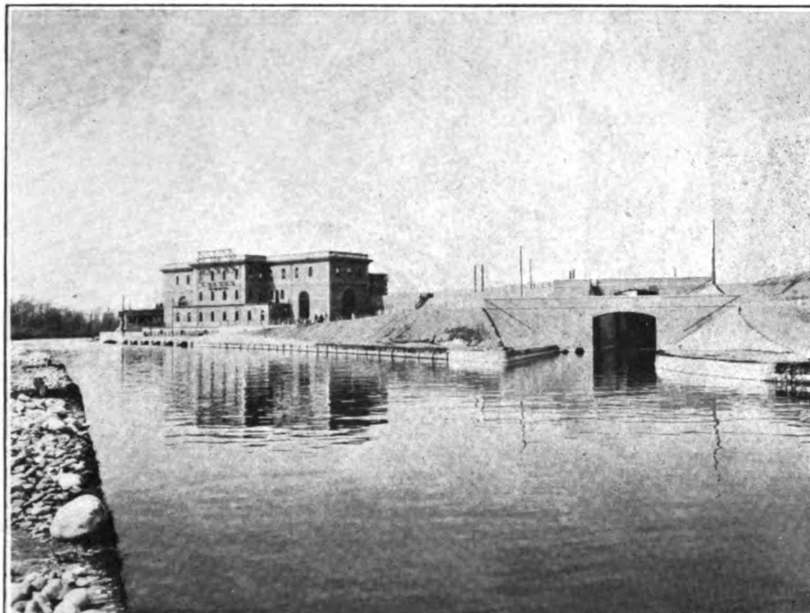
transformers of 500 kilowatts. A monophase transformer is in reserve, and three others will be installed next year.

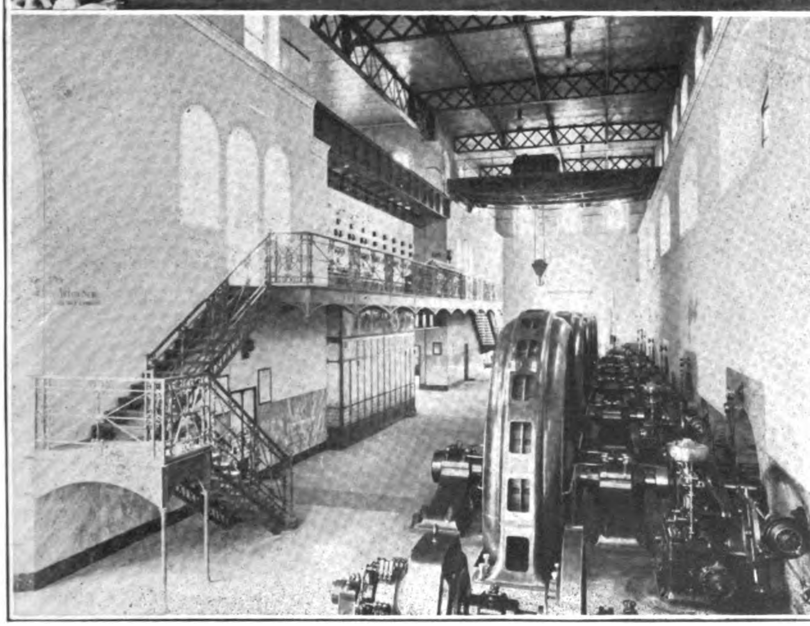
The station is remarkable for the lines. The two lines coming from Piattamala, called A and B, are introduced there, although generally only the line A supplies Lomazzo, whilst the line B is intended for Castellanza. The third line, C, joins Lomazzo to Castellanza and these connections are possible:

A supplies Lomazzo—B (by means of C) Castellanza.
A supplies Lomazzo and Castellanza.
B supplies Lomazzo and Castellanza.
A supplies Lomazzo or Castellanza.
B supplies Lomazzo or Castellanza.
C supplies Lomazzo.

In the last case the power is supplied by the central steam station of the above mentioned "Società Lombarda" at Castellanza, which constitutes the reserve for the hydraulic installations at Turbigo, Vizzola, and even at Brusio. The last combination can be arranged so that there can be a supply at 40,000 volts, in case of serious interruption, by means of high-tension transformers. Or when a longer interruption is feared, the supply can be made directly at 11,000 volts by the generators at Castellanza by means of two hydraulic installations. The working at Lomazzo is thus fully protected.

Another feature of this station is that all the transformers in use are of the dry type with ventilation of compressed air. At present they are the largest transformers for such a high-tension ventilated by compressed air.





FIGS. 23 AND 24. EXTERIOR AND INTERIOR, TURBIGO STATION.

FIGS. 25 AND 26. EXTERIOR AND INTERIOR OF VIZOLA STATION.

The part A of the station at Lomazzo is similar to that at Piattamala. The part B serves for six three-phase transformers of 11,000 to 19,000 volts, by means of which it is supplied by a line of 50 kilometres (30 miles) leading to Como.

Other lines lead to different large factories. The station is plentifully supplied with lightning protectors, and safety apparatus against superelevation of tension, namely, the lines A, B and C, as well as the other exit lines.

In the terminus station of Castellanza (Figure 22) part of the steam central station has been reserved for a transformer station. Owing to very limited space, the lines and apparatus were necessarily arranged on three floors, the height of the central station lending itself readily for this purpose. The station is also divided into two parts. The left side is furnished with three transformers of 1,250 kilowatts. On the upper floor are the attachments of the line, the cut-outs, and the short circuiter for the entering lines, and lightning protectors *à rouleaux*. On the middle floor are the bus-bars, and on the lower floor the distribution and the lightning protectors of water jets. The chambers for the transformers occupy two floors and are the same as those at Piattamala. The transformers are oil, water-cooled. The distribution corresponds to that at Piattamala. The right side is at present being built. It is similar to the left side, but has not the apparatus for the protection of the lines. The two parts are joined together by a gallery. The horn-shaped interrupters are placed in a special chamber, where later the lightning protectors will be placed.

The central station at Campocologno and all the other stations were built from the plans of the Alioth Co., of Münchenstein (Bâle), which has supplied and mounted all the electrical parts of the entire installation. The whole work was finished in 26 months, the mounting of the electrical part requiring 14 months.

On account of the failing of the water of the central stations at Turbigo (Figures 23 and 24) and Vizzola (Figures 25 and 26) the installation commenced work without any previous trial, and worked from the first without any interruption or inconvenience. New demands, made by the communes and private consumers in the large district supplied by the "Societa Lombarda," follow without interruption and prove the foresight displayed in incurring the large expense of an installation on the other side of the frontier. The conditions under which the installation was made, as well as its power, allow it to be called the most important hydro-electric installation in Europe.

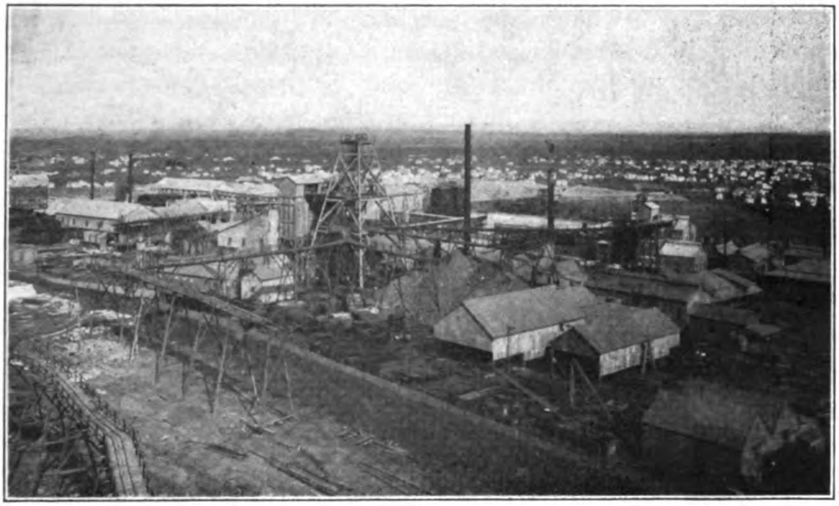
THE GOLD FIELDS OF WEST AUSTRALIA.

By Arthur Selwyn-Brown.

Mr. Selwyn-Brown's discussion of West Australian gold mining in this number reviews the development, geological features and production of the principal fields. A subsequent article will deal with the special milling and metallurgical methods employed in the treatment of the ores. THE EDITORS.

AN enormous amount of gold has been added to the world's treasuries during the past sixty years. The gold fields of Australia and the United States alone have produced in this short period more than $6,000,000,000 worth. The significance of these figures is emphasized when we remember that before the discovery of the California gold fields in 1848 the world's gold reserves amounted to less than $4,000,000,000. The immense production of gold in recent years has resulted in a correspondingly large expansion in commercial credits which in turn have been important factors in assisting the marvellous advancement in commercial activities and in human prosperity witnessed throughout the world in the past half-century. This glorious period is destined to become an important epoch in history. As history is now democratic, the great gold fields, which contributed the gold from which so many blessings have been derived, and which so appreciably promoted the advancement of trade and commercial power and the comforts of mankind, will, doubtless, attract the attention of historians as much as the deeds of warriors and churchmen did in mediæval times. The gold fields of West Australia are among the youngest and richest of all. They have added in the last twenty-two years over $400,000,000 to our gold supplies, and their histories are brimful of interest.

The development of West Australia has been unique in many respects. This State has always possessed extraordinary and mysterious attractions for explorers and pioneers. In consequence of this it has experienced an unusually romantic history. From the time Juvenal described its "*Rara avis in terris nigroque simillima cygno.*" or black swan, until about 1511, when it was visited by Portuguese sailors, we definitely learn very little about it. There is some evidence to show that not infrequently Oriental navigators visited its shores to secure cargoes of sandal wood, pearls, fish, and other products. In the six-



GOLDEN HORSESHOE HEAD WORKS AND MILL.

teenth and seventeenth centuries Portuguese, Spanish, Dutch and English sailors, who roamed the eastern seas, occasionally ran down the western shores of Australia for various purposes. These men frequently explored and described the country. In many of their accounts wonderful tales were told of gold discoveries. It was such tales that earned Australia the prophetic titles of *Provincia Aurifera,* and *Terra Australis Aurifera* under which it was marked on the early maps. The gold finds they described, as well as those of the buccaneers, were, doubtless, to a large extent pure fiction. The persistency of many of the accounts of the occurrence of gold nevertheless, evidently indicates that some gold was discovered in West Australia at an early date. It was not, however, until as recently as 1883 that payable gold was actually discovered. In that year Messrs Hall and Slattery, while prospecting in the Kimberley district, in the north-western portion of the State, found payable alluvial gold in a locality previously indicated as auriferous by E. T. Hardman, the Government geologist. When this discovery became known throughout Australia a great gold rush set in which led to the discovery of gold and the development of gold-mining industries practically all over the State.

Topographical and Geological Features of West Australia.

West Australia may be divided in regard to its broader topographical features into the three following divisions:

1.—The coastal plain, consisting of a fringe of strata around the coast having a slight tendency to slope seaward. Sandstones, conglomerates, shales, clays, and other detrital formations constitute its geological features. This plain has an average width of about 70 miles, but in the south-eastern portions of the State, in the vicinity of the Great Australian Bight, the coastal plain extends inland a distance of about 200 miles from the sea. The inner rim of this plain rises to an elevation of 600 feet above sea level.

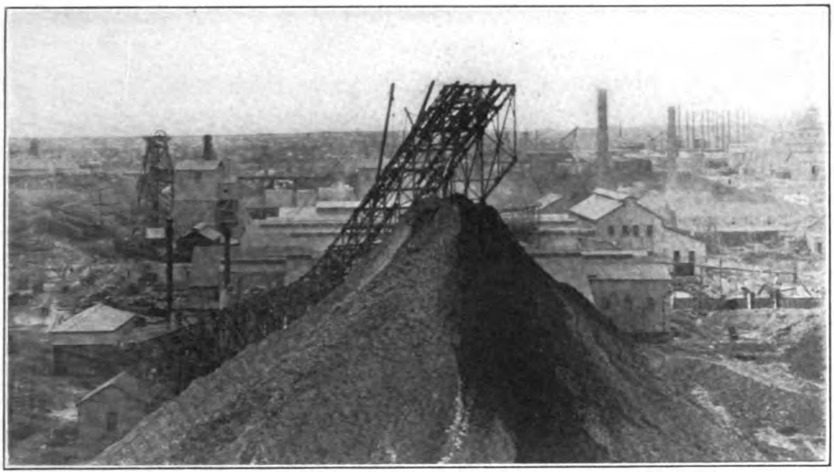
2.—The coastal plain is separated from the plateau and plains of the interior by numerous mountain chains having an average elevation of 1,200 feet. This mountainous country is composed, largely, of granitic and metamorphic rocks. Many important mining centers are located in this belt.

3.—The three topographical division comprises the interior districts of the State. This has not yet been thoroughly explored. Broadly speaking, it is an extension of the broken tableland. It possesses numerous isolated hills and ridges of granitic and metamorphic rocks which are often separated by sand plains. In the sand plains numerous salt-water marshes and brine lakes occur. This division contains no important rivers and has only a slight rainfall.

GENERAL VIEW OF THE GREAT BOULDER GOLD MINES SURFACE PLANT.

West Australia possesses many singular geological features. Three of these will be referred to—namely, the Archæan rocks, the amphibolites, and the laterites. These are prevalent on all the gold fields.

The Archæan rocks occur all over the State, and have a greater development there than in any other part of the globe. They are composed chiefly of granites, gneisses, and schists which generally run in parallel belts striking towards the north or north-west. The most valuable mineral deposits are found in, or closely associated with, these rocks. Six main belts of Archæan rocks have been mapped. The first, known as the western belt, extends from the Murchison River to the south coast and underlies the coastal plains.



DUMPING PLANT AT THE GREAT BOULDER MINES.

The problem of handling the immense accumulations of dump matter is at present an important one on the Kalgoorlie field.

The Darling belt underlies the Darling Mountains and extends northwards from the south coast to the Murchison River, and thence north-eastwards to the Robinson Range. The third belt, measuring over 100 miles in width and composed mainly of granite, is known as the well belt, owing to the numerous natural reservoirs found in its depressions. The next parallel belt is the auriferous belt. This has an average width of about 35 miles. The Southern Cross, Mount Magnet, Cue, and other prominent Yilgarn and Murchison gold mining centers are situated on this belt.

The fifth, or Pilbarra, belt is also granitic. It is extensively exposed on the Pilbarra and other north-western gold fields. The remaining belt extends northwards from the Dundas Hills, traverses Coolgardie and Ularring to Nullagine, Egina and Mallina. These extraordinary Archæan belts are of great interest to petrologists and stratigraphical geologists. They, however, have not been scientifically investigated.

The amphibolites, called by the miners greenstones, are the principal ore-bearing rocks on the south-eastern fields. They consist of much green hornblende and feldspar, and pass imperceptibly from red greasy clays into chlorite, hornblende and serpentine schists.*

The laterites are detrital deposits which cap the hills and ranges. They form prominent features in the landscape owing to their richness in iron oxides and their consequent coloration. These deposits are found all over the State. In some places they are auriferous and in others they are sufficiently rich in iron to be worked as iron ores.

Gold Production.

The gold production of West Australia from 1886 to April 30, 1908 amounted to 18,920,143 ounces fine, valued at $378,403,740. Of this amount 9,628,741 ounces, valued at $192,574,820, were exported, and 9,291,402 ounces valued at $185,828,040 were coined.

Table I. West Australian Gold Production, 1886 to April 30, 1908.

Year.	Fine Ounces.	Value.
1886	270.17	$5,400
1887	4,359.37	87,180
1888	3,124.82	62,500
1889	13,859.52	277,200
1890	20,402.42	408,040
1891	27,116.14	542,320
1892	53,271.65	1,065,420
1893	99,202.50	1,984,040
1894	185,298.73	3,705,960
1895	207,110.20	4,142,200
1896	251,618.69	5,032,360
1897	603,846.44	12,070,920
1898	939,489.49	18,789,780
1899	1,470,604.66	29,412,080
1900	1,414,310.86	28,286,220
1901	1,703,416.52	34,068,320
1902	1,871,037.35	37,420,740
1903	2,064,801.40	41,296,020
1904	1,983,230.07	39,664,600
1905	1,955,315.88	39,106,320
1906	1,794,546.60	35,890,940
1907	1,697,553.59	33,951,060
Total	18,363,787.07	367,276,620
1908, to April 30	556,355.59	11,127,120
Total	18,920,142.66	$378,403,740

The annual yields since 1886 are given in Table I. The proportional contributions of the leading gold fields, and the importance of West Australia as a gold producer as compared with the other States of Australia are graphically illustrated in Figures 1 and 2. West Australia now produces about $37,000,000 worth of gold annually.

* See the "Goldfields of Australasia" by Schmeisser and Vogelsang for an interesting account of the amphibolites.

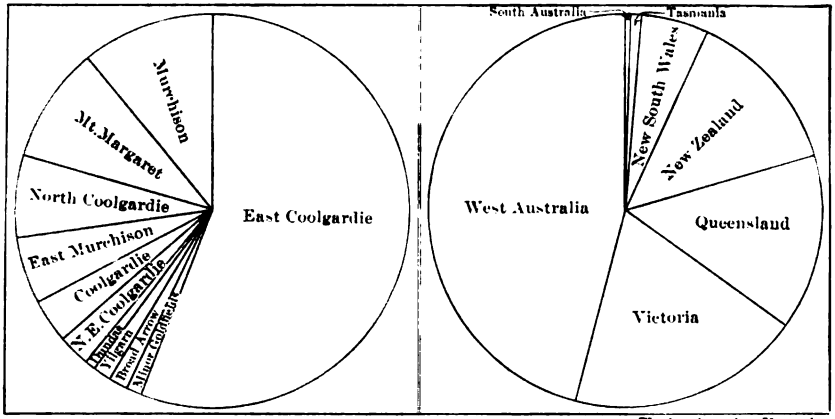


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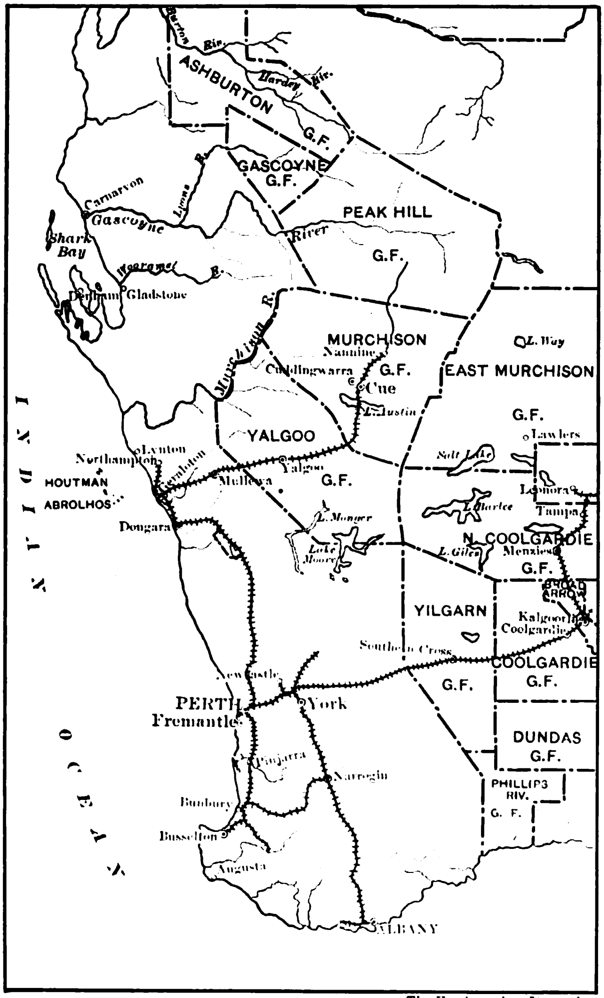
FIG. I. CHART SHOWING COMPARATIVE PRODUCTION OF THE PRINCIPAL GOLD FIELDS OF WEST AUSTRALIA.
FIG. 2. CHART SHOWING COMPARATIVE GOLD PRODUCTION OF THE AUSTRALASIAN STATES.

Characteristics of the Principal Fields.

The State has been divided for administrative purposes into numerous mineral districts which include twenty gold fields. The principal gold fields will be briefly described.

Kimberley.—The first payable gold strike in West Australia was made on one of the branches of the Elvire River. Later similar finds were made near the head waters of the Ord and Margaret Rivers. This is the most northerly of the gold fields. It is situated about 200 miles due east of the port of Broome, Roebuck Bay. It embraces an area of 33,000 square miles reserved for gold-mining purposes on May 20, 1886. Archæan crystalline schists, granites, and more recent volcanic rocks occur throughout this field. There are also many representatives of the Cambrian, Devonian, and Carboniferous systems. Very little mining is being carried on at present, but the field is exceedingly rich in minerals and at some future date will possess extensive mining industries.

Pilbarra.—The Pilbarra gold field was opened in 1889. It comprises an area of 9,480 square miles, situated on the north-west coast. Starting from the Fortescue River, its southern boundary, the field extends up the coast a distance of 250 miles. Granites and gneisses are the principal gold-bearing formations. Vast masses of sandstones, grits, conglomerates, and volcanic rocks overlie the Archæan rocks on the field. These recent rocks are known as the Nullagine beds, taking their names from the Nullagine River around which they are prominently developed and form remarkable scenery.



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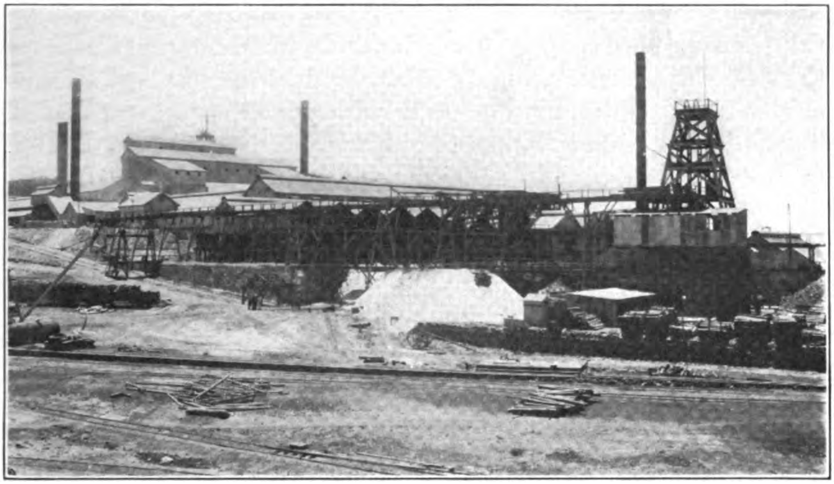
OUTLINE MAP OF THE WEST AUSTRALIAN GOLD FIELDS.

Quartz veins occur in great abundance all through the granitic and schistose rocks wherever they outcrop. The veins are usually small in width and of lenticular form. The field produced, between 1889 and 1907, 215,306 ounces of gold valued at $4,306,120. Pilbarra, Marble Bar and Nullagine are the leading gold-mining centers.

Gold occurs, and is being profitably mined, in conglomerate deposits of great extent, which bear a strong resemblance to the banket deposits of the Transvaal, in South Africa, at a point on the Nullagine River about 90 miles above its junction with the Oakover River. When mining costs are reduced, these deposits will be extensively mined.

Ashburton.—This field is situated along the Ashburton River. Commencing at a point on the river about 150 miles inland from the sea, it extends inland about 150 miles to the boundaries of the Gascoyne and Peak Hill gold fields. This field was proclaimed in 1890 and has an area of 15,000 square miles. It was famous early in its history for its alluvial workings. It gives promise now of becoming an important producer of vein gold. Auriferous veins are being developed in a belt of country running from the junction of the Hardy and Ashburton Rivers south-easterly for a distance of 170 miles.

Peak Hill.—The auriferous territory lying at the head waters ot the Gascoyne and Murchison Rivers was proclaimed the Peak Hill gold field in March 1897. It has an area of 12,194 square miles. This country embraces a portion of the coastal plateau. One of its singular geological features is a series of quartzite dikes, which are often of large size, trending in a north-easterly direction throughout the field. These dikes are auriferous in places. Many of them could be mined as low-grade ore bodies.

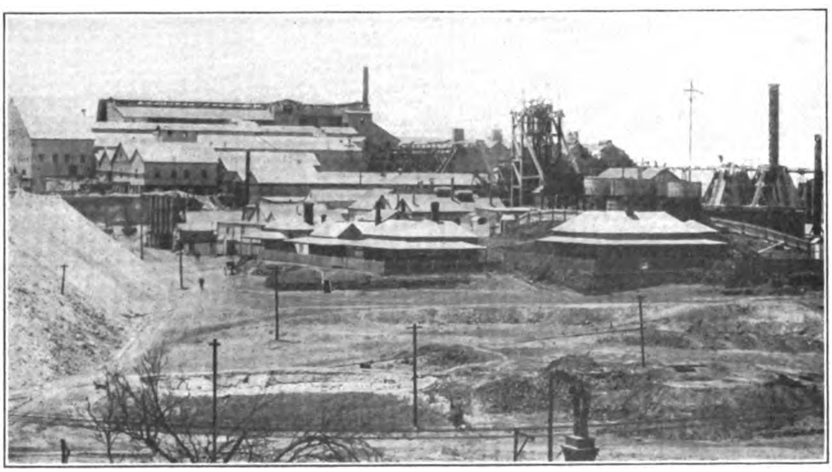


ASSOCIATED GOLD MINES, SHOWING SHAFT AND MILL BUILDINGS.

Murchison.—The Murchison gold field adjoins the southern boundary of the Peak Hill field, and contains an area of 20,000 square miles proclaimed in 1891. The geological structure of this district is remarkably uniform. A noticeable feature is the frequent occurrence of belts of banded hematite-bearing quartzites. These extend in a roughly parallel series many miles in length which outcrop in rough serrated ridges in a diorite formation. These great lodes are generally auriferous. Some day, doubtless, they will be mined very extensively. At the present time the Great Fingall mine, which has produced over 1,000,000 ounces of gold, is the largest property in operation. A number of large mines are being developed in the Cue and Day Dawn districts. In the immediate future the Murchison promises to become one of the largest mining fields in Australia.

East Murchison.—This field was opened in 1895 and has an area of 25,420 square miles. Up to date it has produced $16,000,000 worth of gold. Granites are the prevailing rocks, and these have been greatly intruded by mineralized dikes. Lawler's, Lake Darlot, and Mount Sir Samuel are its most active mining centers.

Mount Margaret.—A large tract of country east of the East Murchison gold field consisting of 45,000 square miles was proclaimed the Mount Margaret gold field in 1897. Most of this field is covered by detrital accumulations which hide much of its mineral wealth and render prospecting difficult, but in many places the detrital formations are auriferous. The most common ore-bearing rocks here, as in so many of the other fields, are granite, gneiss, diabase, and pyroxenite. Mining is chiefly confined to the gold veins occurring in a series of schists similar to those successfully mined westward in the Murchison field. Large auriferous quartzite lodes are frequently met with on this field. The quartz-veins are chiefly of the lenticular type so common in West Australia. The veins occurring along the junction of the diorite and diabase formations with the Archæan rocks are often of great richness. The most famous mine on this field is the Westralia Mount Morgans, at Mount Morgan. The Sons of Gwalia, in the Mount Margaret district, and the Ida H. and Lancefield, at Laverton, are also large producers. Erlistoun, Laverton, Mt. Margaret, Mt. Malcolm, and Leonora, are important mining centers.



LAKE VIEW CONSOLS, KALGOORLIE.

North Coolgardie.—The North Coolgardie gold field, also known as the Menzies field, consists of an area of 30,609 square miles proclaimed for gold-mining purposes in 1897. Originally it formed an outlying part of the Coolgardie field with which it is geologically associated. The principal veins conform to the lenticular type, but irregular segregation veins are numerous. Some of the richest gold ores have been obtained from the peculiar segregation veins known as the "Coolgardie type," which are either pipes or irregular lenses whose axes follow the cleavage planes of the country rocks. In the oxidized zones the veins are exceedingly rich, but as they are sunk upon they diminish in gold contents. The Queensland Menzies, Lady Shenton, Crusoe Gold Mines, Menzies Mining and Exploration Companies, all English corporations, are largely interested in developing mining properties on this field. In the past twelve years over 1,300,000 ounces of gold have been won from the North Coolgardie mines. Menzies, Malline, Niagara, and Gooncarrie are its most active mining centers.

Coolgardie.—Few mining districts have such a romantic history as Coolgardie. The leading mining center, Coolgardie, from which the field derives its name, lies about 270 miles due east of Perth in the center of a tract of country, which was for many years traversed by explorers on their trips overland to South Australia and elsewhere. Lefroy in 1863, Hunt in 1864 and 1866, Forrest in 1871, and Giles in 1875 all traversed portions of Coolgardie without recognizing its immense mineral wealth. This remained to be discovered by two prospectors who strayed there by chance in August 1892.

In April 1892, Messrs. Bayley and Ford, two prospectors on the Murchison, after selling the alluvial gold they had won on that field, decided to invest the proceeds in prospecting the interior districts eastward. They outfitted at Perth and after numerous adventures approached the Marring field, which was discovered several months previously by Speakman. They met several parties of prospectors returning from the field, however, who reported it to be of no great promise. Bayley and Ford then returned to Southern Cross to refit for a more extensive trip eastwards. They then set out on the old track of the explorer Hunt. When in the vicinity of the native well called Coolgardie they were compelled to return to the Gnarlbine wells for water. They again set out and struck the Coolgardie well where good grass was found. As the explorers reported the land eastwards very dry with long stretches of Spinnifex and sand, they decided to rest and feed their horses well for a few days. While doing so they prospected the water channels around the well. In a few days they collected 200 ounces of gold. Then they sought its source and within a day discovered a vein carrying very rich gold. In a couple of days they broke 500 ounces from the outcrops, located a prospecting claim, and returned to Southern Cross to record their claim and publish their discovery. This news started a wild stampede of miners from every part of Australasia. In the next few years English capital was attracted to the field, and hundreds of prospectors went farther out into adjacent districts and made fresh gold discoveries, and still continue doing so. This has resulted in bringing West Australia to its present eminence as one of the most important gold producers in the world.

The Coolgardie field was proclaimed in 1894 and has an area of 11,974 square miles. Many of the rich veins belong to the type known as gash veins. In 1907 the Coolgardie mines produced 60,810 ounces of gold valued at $1,216,200. The total production of the field to the end of 1907 was 1,197,353 ounces valued at $23,947,040. In the past few years there has been a slight decline in the annual gold yield, due to the fact that capitalists are turning their attention to the alluring prospects of newer fields and are not giving much attention to the development of new mines on the Coolgardie field. This field, however, is highly mineralized and must soon become a great producer.

East Coolgardie.—Ranking next to Broad Arrow as one of the smallest gold fields in the State, East Coolgardie contains some of the richest gold mines in the world. Its famous Kalgoorlie district contains in its remarkable "Golden Mile" the richest belt of gold-bearing formation hitherto discovered. The area of the field, which was proclaimed Sept. 21, 1894, is only 632 square miles.

The largest portion of this field is covered with a deposit of reddish loam and other detrital matter which hides the country rock. The exposed rock formations are chiefly amphibolites, recent eruptives, and sedimentary rocks.

The great mines at Kalgoorlie are operating lodes consisting of a series of banded schistose formations derived from the alteration of amphibolites by dynamic and hydrothermal metamorphism. The lodes belong to the lenticular type. Some of them are half a mile in length and as much as 80 feet in width. They have been developed to a depth of 2,000 feet and at that depth still carry rich gold. This is one of the few fields yielding rich gold tellurides. In the past twelve years East Coolgardie mines have yielded the magnificent total of 9,660,638 ounces of gold valued at $20,000,000.

Conclusion.

Space will not permit of reference to the remaining gold fields or a fuller discussion of those already referred to. Sufficient, however, has been said to indicate the marvellous mineral wealth of West Australia. The wonderful returns already yielded on the comparatively small amount of capital invested in its mining industries, and the remarkable results obtained over practically the whole of its area, assure the future supremacy of West Australia in gold production.

SYSTEMATIC FOUNDRY OPERATION AND FOUNDRY COSTING.

By C. E. Knoeppel

II. THE IMPORTANCE OF CORRECT BURDEN APPORTIONMENT.

Mr. Knoeppel's series began in the issue of The Engineering Magazine for October. His discussion next month will take up the elements entering into production costs. An outline of the scope of the entire scheme was given on pages 96 and 97 of our preceding number.—The Editors.

IN the foundry business, as in almost every other branch of endeavor, the margin between success and failure is indeed narrow, often so narrow as to make the foundryman feel like giving up what seems to be an up-hill struggle. In many cases, however, when the fight is hottest and the odds most discouraging, additional information directed along proper channels would assist materially in turning a possible defeat into a victory. That knowledge, however, is the fundamental requirement in inaugurating a campaign of betterment, will be apparent when one considers that the successful man of today is he who acts with force and dispatch; whose action is guided and directed by experience; whose experience is the outcome of this knowledge of the results taking place all round him, secured through the instrumentality of a carefully worked plan whereby pertinent information is automatically and promptly recorded.

Action, then, without which no concern can ever hope to measure up to the limit of its possibilities, is directly traceable to a full knowledge of the important details, perhaps of no real consequence when considered by themselves, but in the aggregate or when compared with other details of like nature, assuming a position of significance. To put it another way, we might state that the results of action vary directly in proportion as *knowledge* increases or decreases, and that knowledge in its turn, is proportionate to the *dispatch* with which results are made known.

Have you ever stopped to consider what is really involved in finding your costs of production, or appreciated the true significance of the word "costing"? If you are keeping costs as a means—cost reduction and increased production being the end in view—then you are (or should be) getting results. If, however, you look upon the work as a "fad" or necessary evil, using the information at your disposal to no real purpose, you are losing the earning power of money which might be expended to advantage in other directions, and the only consistent advice is either to throw it out altogether, or begin all over again with the determination to make your methods count for something as a result producer.

We are told that "art" is *doing,* while "science" is *knowing;* and on the assumption that this statement is correct, we can only conclude that costing as an art cannot and does not accomplish what is possible if treated as a science, which (to put it another way) is "organized knowledge" and as such must and does get down to the principles involved. The term "costing", considered in the abstract, falls far short of conveying the full meaning, and here is perhaps the reason why so many fail to appreciate its dormant possibilities. To clothe it in its proper aspect let us define it as—

> A science, which has for its purpose to give to the executive an organized knowledge of all pertinent details, that he may be in a position to plan for maximum efficiency. It demands first of all a search for the underlying or basic principles which affect the success or failure of the enterprise, in order to get at the *why* or reason of things. This once established, facilitates the consideration as to *how* things should be done—the *product* or result being proportionate to the excellence of the art or *doing,* upon which depends the *application* and practical use of this product to specific ends.

A great deal has been said, comparing the foundry business with other lines, concerning the simplicity of foundry costing and the ease with which production costs can be determined. Without much consideration this might seem to be the case, especially if we consider foundry costing as an "art," the doing; but considered as a science, it is far from being the case. Put these same men, who scoff at the idea of foundry costing being anything else than a simple process, right in the midst of the fight—as foundry managers with instructions to secure a maximum production at the greatest margin of profit—and it will be only a matter of time when their views will undergo a pronounced change. Inasmuch, however, as any particular science is nothing but organized knowledge in one special field, why is it not possible to make our foundry costing more scientific and in this way perhaps more simple?

Getting back to our definition, we find that we must search for the basic elements that we may start right and at the beginning, for once we build a solid foundation, we can start the construction with the expectation of erecting a permanent structure. In the first place every foundryman will agree with the statement that a business is conducted for profit, and that while it is one thing to dispose of something, it is quite another to dispose of it at a margin over and above total cost, knowing that you have made it and how much. Here we have two elements:—

Disposing at a profit.

Disposing at a loss.

Naturally, if you have the interests of your business at heart, you will want to know:—

Where you have made or lost.

How much you have made or lost.

Why you have made or lost.

How do you know but that you may be losing money on some lines of work, bringing your net profits down to a figure that might have been increased had you known where the losses were, the amounts, and the why? Why is it important to know where and why you have made? Simply because nothing is so good but that it can be bettered by persistent effort; and if you have made something on one line of work, keep after it—better the conditions and make more money.

The basis of the sale is what is produced, which as far as this series of articles is concerned will be *castings*. Therefore to find the true condition of affairs, we must determine what the profits or losses are, which cannot be done until *costs* are ascertained. It has long been taken for granted that costs could not be determined until the completion of the work, but the foundryman should have some means of knowing about what the costs are going to be *before the work is even started*. The importance of this will no doubt appeal to every foundryman, and this point will be considered by this series of papers.

The next consideration is the elements entering into the cost of producing good castings, which can be divided into three general classes:—

1.—Materials { Direct or productive—A.
Indirect or non-productive—B.

2.—Labor { Direct or productive—A.
Indirect or non-productive—B.

3.—General Expenses.

No argument is necessary to show that if the three elements with their subdivisions could be charged to the production direct, the determination of costs would be a simple matter; but a glance at the table just shown will convince the reader that direct charging is possible in two cases only:—

Direct material—1A.

Direct labor—2A.

and this fact makes it necessary for the production to absorb the other three items in some just and equitable manner to be decided upon, the sum of these three items being, in the majority of cases, a large one; so that upon the correctness with which these items are spread over or apportioned to the production, depends more than is usually conceded. We can therefore safely say, in our search for principles, that the matter of properly handling these three items is of the utmost importance and can be really classed as our basis or foundation.

Direct or productive materials comprise the various pig irons, scraps, fluxes, coke or coal, the total cost for any period being a *direct* charge against whatever is produced.

Indirect or non-productive materials comprise incidental stores, supplies, etc., which are used in order to facilitate the manufacture of the product; the total cost for any period, although a charge against what is produced, cannot be charged direct but must be apportioned to it.

Direct or productive labor is the money paid to those who actually produce or directly assist in producing something having a *commercial value,* which can at all times be charged direct to specific production.

Indirect or non-productive labor is the money paid to those who, while they do not actually produce or assist in producing anything of value, are absolutely necessary in order that production may be facilitated and carried on to the best of advantage; this expenditure constitutes a charge to production by apportionment, owing to the difficulty in attempting to charge to product direct.

Expense is the expenditure entering into the general administration of the business, the securing of a finished product as well as the marketing of this product to the best of advantage, which on account of its very nature cannot be charged to production direct but must be absorbed by it by apportionment.

In this series of articles, the three items—

Indirect materials.

Indirect labor.

Expenses

will be classed as "burden"—aptly styled by one as "unseen dollars"; and as was before stated, the amount of this burden is usually a large one, so that apportionment must be as correct as possible, otherwise total costs are bound to be misleading. We can get at this matter of apportionment easier by looking at it as if a month's production consisted of *one* casting, in which case the entire burden would be charged direct to it. If the production consisted of ten castings, however, each weighing the same, with the material and labor costs the same for each of the ten castings, then each would absorb one-tenth of the burden; and when the cost of the last casting was ascertained, it would be found that the entire burden had been absorbed in a just and equitable manner. If, on the other hand, we substitute, as the production, one-thousand castings of different shapes and weights with absolutely no relation existing between the cost of the direct labor or direct material, how are we going to make these castings absorb the expense item so that each casting or class of castings will be charged with an equitable amount?

If one-thousand tons of good castings are produced in a certain period and the total burden for the same period is $10,000, we can make the production absorb this burden by charging $10 to each ton of castings produced—this being one method which we will term *tonnage apportionment.*

If on the other hand, one-thousand tons of castings are produced in a certain period and the direct-labor cost of producing these castings is $5,000 with a burden against this production of $10,000, we can make this production absorb this burden by adding 200 per cent to the direct-labor cost of any casting or class of castings, or $2 in expense for every $1 in direct labor—another method which we will term *direct-labor apportionment.*

It stands to reason that both methods cannot be right, although each seems to have its defenders. If one method is correct, then there is some reason *why* it is right and the other wrong, and this "why" must appeal to you, from a *dollar and cent* point of view. To show it all up in a way that will be clearly understood, it has been deemed advisable to submit several cases, showing the difference between the two methods; and while at best figures are dry and uninteresting, a quiet hour, plus a careful study of the figures which are to follow, will make the deductions surprisingly interesting.

We will suppose that in a certain period of time, your foundry produced 2,500,000 pounds of salable castings, your direct or productive pay roll (moulders and coremakers) being $15,000; the burden amounting to $22,500, and your rates for apportionment, in order to make the 2,500,000 pounds absorb the $22,500, being:

Tonnage basis—90 cents per 100 pounds.
Direct-labor basis—150 per cent.

Case No. 1—Light and Heavy Work.
Different Weight—Same Labor.

You make two castings, in this period, one being a small complicated affair, weighing 250 pounds, which we will call a gas-engine cylinder; the other being a small flywheel weighing 2,000 pounds, each on account of its nature requiring the entire time of a moulder for a day. Figuring material at $1 a hundred pounds for melted iron and labor at $3 per day (30 cents per hour), we have costs as follows:—

	250 lb.			2000 lb.	
Tonnage Basis.	$2.50		....Material	$20.00	
	3.00		....Labor (10 hours)........	3.00	
	$5.50		....Prime cost	$23.00	
	2.25		....Burden (90c. per 100 lb.).	18.00	
		$7.75 (A)	....Total cost		$41.00 (C)
Labor Basis.	$5.50		....Prime cost	$23.00	
	4.50		....Burden @ 150 per cent...	4.50	
		$10.00 (B)	....Total cost		27.50 (D)
		$2.25	....Difference		$13.50

Cost A is	$3.10	per 100 lb.	Cost C is	$2.05	per 100 lb.
" B "	4.00	" " "	" D "	1.37½	" " "
Difference	.90	" " "	Difference	.67½	" " "

A study of these figures will show that in the case of the 250-pound casting, the cost B is $2.25 ***higher*** than cost A, while in the case of the 2,000-pound casting, cost D is $13.50 *lower* than cost C. Looking further, it will be found that cost A is $3.10 per 100 pounds, while cost B is $4 per 100 pounds, the cost B being greater than cost A by 90 cents per 100 pounds, *only* a difference of $18 per ton. Cost C figures out at $2.05 per 100 pounds with cost D at $1.37½ per 100 pounds, the latter being less than the former by 67½ cents per 100 pounds, or $13.50 per ton. As the intention of this article is to show that the tonnage basis of burden apportionment is incorrect, this can best be proven by showing that direct-labor apportionment is correct. In the first place, we have a small casting weighing only 250 pounds and taking the entire time of a moulder for the day, while a casting eight times as heavy was produced in the same length of time so that the *productivity* (relative amount produced per man per day) of the latter is eight times greater for the particular case than that of the former. If, for the sake of argument, we assume that the tonnage basis is correct, giving the preceding statement the consideration it is entitled to, we find that the tonnage basis as compared with the labor basis forces the costs per 100 pounds to *decrease* as productivity *decreases* and to *increase* as productivity *increases*. Does this strike you as being logical? On the other hand, we find comparing labor apportionment against tonnage apportionment, that the former forces costs to *increase* as productivity *decreases* and to *decrease* as productivity *increases*, which is as should be. Looking again at case No. 1, it will be found that in cost B, the burden of $4.50 is really $1.80 per 100 pounds instead of a flat rate of 90 cents per 100 pounds, and in cost D, the burden is 22½ cents per 100 pounds instead of the 90-cent rate. In this way you are making the light, complicated cylinder cost the most per 100 pounds to produce ($4 instead of $3.10), and the heavier but easier to make wheel cost considerably less per 100 pounds ($1.37½ instead of $2.05)—which are things which the tonnage basis of apportionment ignores altogether. Putting it still another way, would you rather accept cost C as the correct cost, add 10 per cent as profit, and run the risk of losing the order through what is in reality an overestimation of $13.50 per ton; or take cost D as your basis, add your profit, which with other things being equal would land the order? On the other hand, would you rather take $4 per 100 pounds as your cost for the 250-pound casting, which in making cost you $1.20 per 100 pounds, add your profit and *make it*, or use $3.10 per 100 pounds as the cost—90 cents per 100 pounds less—add your profit, and get the work—but lose money on it?

CASE NO. 2—HEAVY WORK.
Same weight—Different labor.

In this case I assume that in your foundry you have made two castings, each weighing 10,000 pounds, one taking 60 hours to make, while the other was made in 20 hours. As the productivity of the man who made the one piece in two days is greater than that of the man who made the other piece in six days, it is logical to expect that the piece which took the least time to make—where the productivity was greatest—would cost much less than the piece taking the larger amount of time with a smaller productivity.

Let us see, however, how it works out, placing the six-day and ten-day jobs in parallel columns:

	10,000 lb.			10,000 lb.	
Tonnage Basis.	$100.00		..Material	$100.00	
	18.00 (60 hrs.)		..Labor	6.00 (20 hrs.)	
	$118.00		..Prime cost	$106.00	
	90.00		..Burden (90c. per 100 lb.)	90.00	
		$208.00 (A)	..Total cost		$196.00 (C)
Labor Basis.	$118.00		..Prime cost	$106.00	
	27.00		..Burden @ 150 per cent.	9.00	
		145.00 (B)	..Total cost		115.00 (D)
		$63.00	..Difference		$81.00

Cost A is	$2.08 per 100 lb.		Cost C is	$1.96 per 100 lb.	
" B "	1.45 " " "		" D "	1.15 " " "	
Difference	.63 " " "		Difference	.81 " " "	

A study of these figures will show, in the first place, that cost B is less than cost A by $63, while in the case of the casting where the elements are greater productivity and lower labor cost per 100 pounds, cost D is $81 less than cost C, a net decrease of $18. Also that cost C is less than cost A by $12, while cost D is less than cost B by $30. Looking at it still another way, we find that cost A is $2.08 per 100 pounds while cost B is $1.45 per 100 pounds, a difference of 63 cents per 100 pounds or $12.60 per ton. Cost C is $1.96 per 100 pounds with cost D $1.15 per 100 pounds, a difference of 81 cents per 100 pounds or $16.20 per ton, showing that the decrease is greater in the latter case, *as it should be*. By this method we are making the casting in which the elements are high moulding cost and low productivity, cost the most; and instead of charging a flat rate of 90 cents per 100 pounds, we make cost D bear 9 cents per 100 pounds and cost B 27 cents per 100 pounds—the increase being a logical one, as reflection will show, yet both rates are much less than the 90-cent rate. It should be plain that if costs A and C are used as a basis, they are overestimated to the tune of 63 cents and 81 cents per 100 pounds respectively—large enough to make any foundryman "sit up and take notice" inasmuch as there cannot be an *everestimation* in one place without *underestimation* in another, neither of which elements should be allowed to creep into any business. The advantages of using costs B and D in bidding for heavy work, instead of the prohibitive figures shown in costs A and C, are no doubt apparent without any explanation.

Case No. 3—Light Work.

Same weight—Different labor.

In this case we have two small castings, each weighing 150 pounds, one taking 7 hours to make, the other 3½ hours—low productivity in both cases, one being even lower than the other. As direct-labor apportionment makes costs increase over tonnage apportionment as productivity decreases, we naturally expect to find that costs under the former will be higher than under the latter, which the following figures will show to be the case:—

	150 lb.			150 lb.	
Tonnage Basis.	$1.50		....Material	$1.50	
	2.10 (7 hrs.)		....Labor	1.05 (3½ hrs.)	
	$3.60		....Prime cost	$2.55	
	1.35		....Burden (90c. per 100 lb.)...	1.35	
		$4.95 (A)	....Total cost		$3.90 (C)
Labor Basis.	$3.60		....Prime cost	$2.55	
	3.15		....Burden @ 150 per cent......	1.58	
		6.75 (B)	....Total cost		4.13 (D)
		$1.80	....Difference		.23

Cost A is	$3.30 per 100 lb.	Cost C is	$2.60 per 100 lb.
" B "	4.50 " " "	Cost D "	2.80 " " "
Difference	$1.20 " " "	Difference	.20 " " "

From this case, it will be seen that through the labor basis of apportionment cost B is $1.80 greater than cost A, while cost D is 23 cents higher than cost C. Comparing A with C, we find the former greater by $1.05, while B is $2.62 greater than D. Consideration will show that once more we get our greatest increases where they should be, costs B and D being greater than A and C by $24 and $4 per ton respectively. In this case instead of using a flat rate of 90 cents per 100 pounds, we have the burden $3.15, amounting to $2.10 per 100 pounds and the item of $1.58 amounting to $1.06 per 100 pounds.

Comparing all of the three cases, we find that in every case the burden cost on the tonnage basis was 90 cents per 100 pounds, while on the six castings of the three cases cited, we get rates, in cost per 100 pounds, on the direct-labor basis, as follows:—

$1.80 per 100 lb.
.22½ per 100 lb.
.27 per 100 lb.
.09 per 100 lb.
2.10 per 100 lb.
1.06 per 100 lb.

We find that the lowest rate is 9 cents per 100 pounds (cost D, case No. 2). Here we have an hourly product of 500 pounds—*high* productivity, and a labor rate of but 6 cents per 100 pounds, consequently the cost should be low and reference will show that through direct-labor apportionment, the cost was $115 instead of $196. Is not the low rate of 9 cents instead of 90 cents justified, when the facts in the case are considered? We also find that the highest rate is $2.10 per 100 pounds (cost B, case No. 3). Here we have an hourly product of about 21½ pounds instead of 500 pounds—*low* productivity, and a labor rate of $1.40 per 100 pounds instead of 6 cents per 100 pounds; consequently to take care of yourself properly, you must have a higher cost than tonnage apportionment would give you, for by means of it you get a cost of $3.30 per 100 pounds, while through direct-labor apportionment your cost is $4.50 per 100 pounds.

The only logical conclusion from the figures heretofore shown is, first, that through the tonnage method of apportionment, the cost of heavy work is made too high; and second, that the cost of light work is made too low. We also get a rule from direct-labor apportionment, that *burden costs are inversely proportional to productivity,* which the tonnage basis does not recognize. Now then, as the tendency in commerce is to lose in bulk of sales as price increases, it should be evident to every foundryman, that making the cost of heavy work too high is sure to result in lost sales in the case of the jobbing foundry, or an excessive cost of the foundry production to the machine shop in the case of the specialty foundry. On the other hand, by making the cost of light work too low the tendency is to get plenty of light work at prices which are in reality less than cost. The result is that both jobbing and specialty foundries are hurt alike.

Getting back to productivity, we may state the fact that the more a man produces in a given time, the less should be the cost of what he produces, and *vice versa.* If, then, the tonnage basis of apportionment as against the labor basis does not take this fact into consideration (and the figures heretofore shown clearly indicate that it does not) then the method has absolutely no merit and is consequently worthless from a commercial standpoint. To demonstrate its inaccuracy clearly, it was decided to show the difference between the two methods graphically.

Chart 1 shows amounts produced per man per day, from 200 pounds to 2,000 pounds, at different costs per 100 pounds, line 1 showing burden apportioned to direct labor and line 2 showing burden apportioned to tonnage. In plotting this chart, the rates heretofore mentioned were used, namely 90 cents per 100 pounds on tonnage, 150 per cent on the direct labor, and a daily labor rate of $3, so in order to arrive at our values for line 1, we take $4.50 as the burden, which is divisible by whatever weight is produced per man per day. A glance at the chart will show that there is a vast difference between costs of $18 and $22.50 per ton, on a production of 400 pounds for a man in a day on the one hand, and $18 and $4.50 per ton, if the same man can produce 2,000 pounds in a day, on the other.

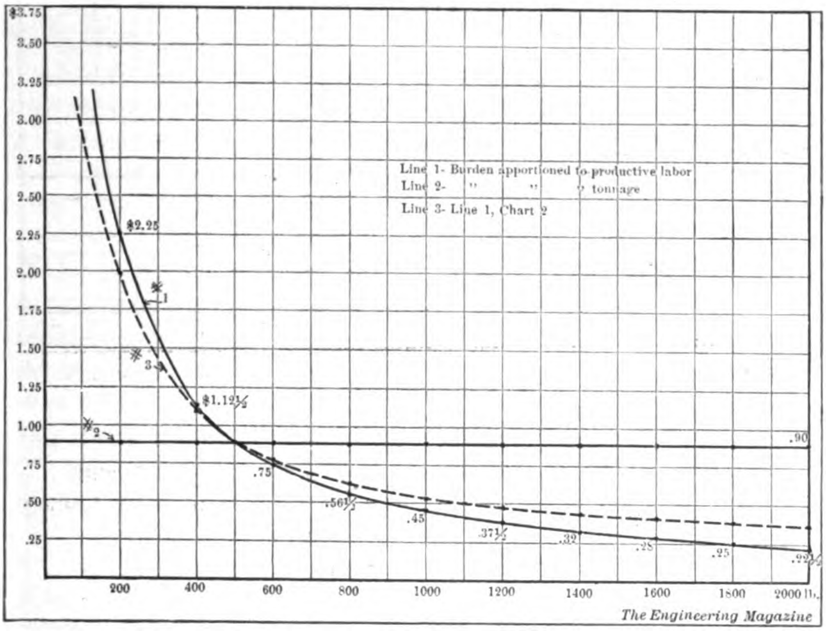


CHART I. BURDEN COSTS PER 100 POUNDS FOR DIFFERENT WEIGHTS PRODUCED PER MAN PER DAY.

A foundryman is likely to bring up the point, at this time, that certain items of expense are proportionate to the increase or decrease of the amount produced which a uniform basis of labor apportionment would fail to consider. That such a point would be well taken can be seen when it is considered that in a large number of cases, the more a foundry is able to produce, the greater would be such items as foundry, core-room and cupola supplies, cupola labor, repairs to flasks, yard labor, handling materials, and perhaps a few other items. A compromise, then, which will enable tonnage to absorb a certain proportion of the burden, and productive labor the balance, is perfectly logical—the result of such a combination method being shown by Chart 2, the same expense item being used as in the case of Chart 1.

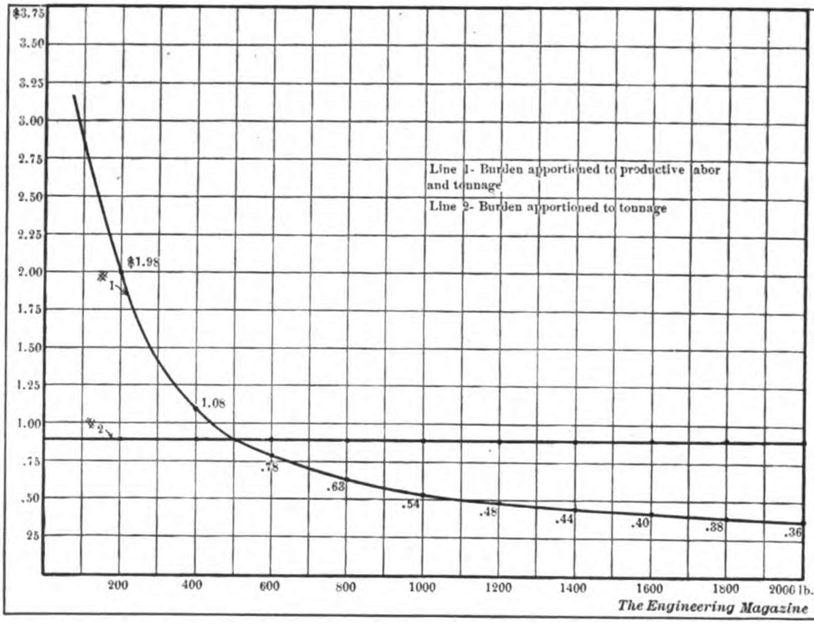


CHART 2. BURDEN COSTS PER 100 POUNDS FOR DIFFERENT WEIGHTS PRODUCED PER MAN PER DAY.

with the exception that we assume that $4,500 of the $22,500 is proportionate to tonnage, the balance to direct labor, the rates being:

Line 1—Compromise basis { 18 cents per 100 pounds on tonnage; 120 per cent on direct labor.

Line 2—Flat tonnage basis—90 cents per 100 pounds.

To show the comparisons properly, line 1, Chart 2 has been carried to Chart 1 as line 3, the following illustration serving to show the difference between burden apportionment—one case being a large production per man per day and the other a small production. Taking the case of large production per man per day first, we have:

CASE No. 4.

2000 lb. Casting.

	Tonnage Basis.		Labor Basis.		Tonnage and Labor.	
Material	$20.00		$20.00		$20.00	
Labor (10 hrs.)	3.00		3.00		3.00	
Prime cost...	$23.00		$23.00		$23.00	
Burden	18.00	(90c. per 100 lb.)	4.50	(150%)	3.60	(18c. per 100 lb.)
					3.60	(120 per cent)
Total	$41.00		$27.50		$30.20	
Per 100 lb...	2.05		1.37½		1.51	

Examining now the figures with small production per man per day, we find:

400 lb. Casting.

Material	$4.00		$4.00		$4.00	
Labor (10 hrs.)	3.00		3.00		3.00	
Prime cost ..	$7.00		$7.00		$7.00	
Burden	3.60	(90c. per 100 lb.)	4.50	(150%)	.72	(18c. per 100 lb.)
			....		3.60	(120%)
Total	$10.60		$11.50		$11.32	
Per 100 lb...	2.65		2.87½		2.83	

After considering all that has gone before, Chart 3 will no doubt prove of particular interest to foundrymen, in that it shows *total costs* for different weights produced per man per day by the various methods of apportionment. Moulding cost has been taken at $3 per day of 10 hours, with material at $1 per 100 pounds of melted iron, burden on the tonnage basis being 90 cents per 100 pounds, on the direct-labor basis 150 per cent, and on the tonnage and labor basis, 18 cents per 100 pounds on tonnage and 120 per cent on labor—these rates being the same as used in previous illustrations. The labor of making cores is not included in the figures, as for the purpose of illustration it was deemed advisable to consider simply the work of moulding, which would include the work of setting the cores, making it an easy

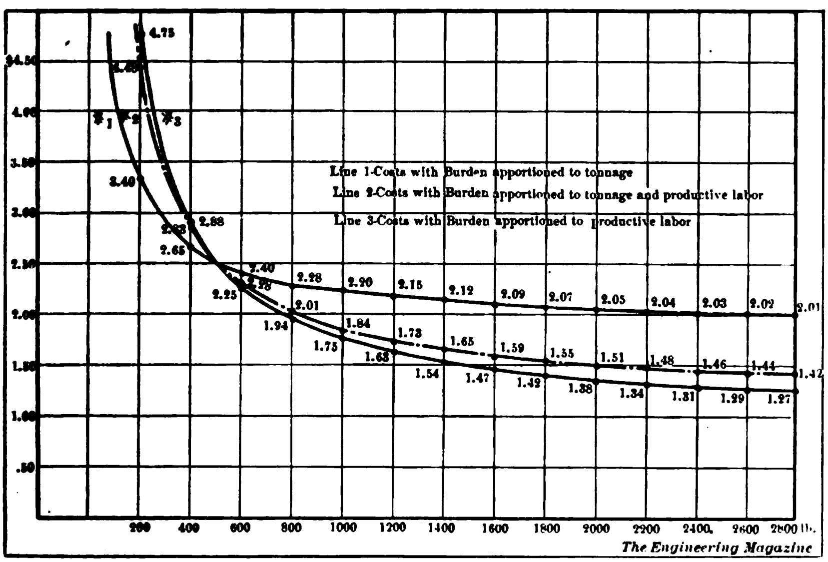


CHART 3. TOTAL COSTS (MATERIAL, PRODUCTIVE LABOR, AND BURDEN) FOR DIFFERENT WEIGHTS PRODUCED PER MAN PER DAY.

matter, in using charts of this nature, to add the core labor to any of the total costs.

The conclusions that can be arrived at from a study of these charts are, first, that ***the various methods are correct at the point where the lines cross;*** but that to the right of the intersection, the burden and total costs, per 100 pounds, on the direct-labor or direct-labor and tonnage methods of apportionment, decrease as the amount per man per day increases; while to the left of the intersection, the costs increase as the product per man per day decreases, while it will be seen that from Charts 1 and 2, the burden costs on the tonnage basis are the same ***regardless*** of whether 200 pounds or 2,000 pounds are produced per man per day; this explains the slight increase and decrease of the cost as shown by line 1, Chart 3. The direct-labor or the compromise method considers that the direct labor is in a sense the ***real investment*** on which success or failure depends, for the reason that, as a rule, the more producers there are at work, the greater will be the production and the lower the costs, while costs increase and production decreases as the number of producers decrease. Consideration is given to the great variety of work in a foundry, making the costs of both light and heavy work about what they should be, instead of too low in one case and too high in the other.

The value of Chart 3, to those who desire to know instead of guess, will be apparent after due consideration, and as it is possible to plot such a chart from the records of any foundry, the rules given in Chart 4 may be found of interest as well as of assistance in determining the values for charting. With figures from your own records, substituted for the values shown in 3, you will be surprised, at the margin of difference between the three methods. The costs of good castings at 2,200 pounds per man per day, from 3, are shown as $2.04, $1.48, and $1.34 per 100 pounds, while at 200 pounds the costs are $3.40, $4.48, and $4.75 per 100 pounds, while further all three lines cross at $2.50 per 100 pounds for 500 pounds per day per man. ***What does the chart covering your own work show you?*** From 3, or from your own chart, it is evident that all three methods cannot be right; and as the inaccuracy of the tonnage method of apportionment has been demonstrated, it leaves only two others to choose from. Eliminating from our burden those items which are more proportionate to the increase or decrease in the production, we have left those items which are proportionate to direct labor; so that we have by this process also demonstrated that direct-labor apportionment is incorrect, although it would be far better to use this method than tonnage apportionment—leaving only one method, *apportionment to tonnage and direct labor.*

TONNAGE BASIS.

$$\frac{\text{Expenses}}{\text{Weight of Castings Produced}} = \text{Rate per 100 lb.}$$

DIRECT LABOR BASIS.

$$\frac{\text{Expenses}}{\text{Productive Payroll}} = \text{Rate in Per Cent.}$$

TONNAGE AND DIRECT LABOR BASIS.

$$\frac{\text{Expenses Proportionate to Tonnage}}{\text{Weight of Castings Produced}} = \text{Rate per 100 lb.}$$

$$\frac{\text{Expenses Proportionate to Direct Labor}}{\text{Productive Payroll}} = \text{Rate in Per Cent.}$$

RULES FOR APPORTIONING BURDEN AT THE RATES ABOVE.

W = Weight produced per man per day.
M = Metal cost.
L = Amount paid to moulder per day.
B_1 = Burden on tonnage.
B_2 = Burden on direct labor.
B_3 = Burden on tonnage (A) and direct labor (B).
C_1 = Cost per 100 lb. on tonnage apportionment.
C_2 = Cost per 100 lb. on direct labor apportionment.
C_3 = Cost per 100 lb. on tonnage and direct labor apportionment.

TONNAGE BASIS.

$$\frac{(W \times M) + L + (W \times B_1)}{W} = C_1.$$

DIRECT LABOR BASIS.

$$\frac{(W \times M) + L + (L \times B_2)}{W} = C_2.$$

TONNAGE AND DIRECT LABOR BASIS.

$$\frac{(W \times M) + L + (W \times B_3A) + (L \times B_3B)}{W} = C_3.$$

CHART 4. RULES FOR ARRIVING AT BURDEN RATES.

As the purpose of this article was to start our foundation before commencing the structure, we can with safety decide on this latter method as being the basic element about which a system of foundry costing can be created; and with the matter of burden *apportionment* disposed of, knowing that we are right in principle, we can take up the elements entering into burden *construction,* which will be the purpose of the paper to follow.

RECENT DEVELOPMENTS IN MOTOR VEHICLES FOR INDUSTRIAL PURPOSES.

By Harry Wilkin Perry.

In a series of two articles, of which this is the first, Mr. Perry summarizes the most interesting features of recent progress in adapting the motor vehicle to industrial purposes. This first section deals chiefly with mechanical improvements and with wagons for ordinary transportation. The following portion is concerned more particularly with applications to quasi-public service, and vehicles for various specialized uses.—THE EDITORS.

THERE has been a marked awakening of interest of late in the self-propelled vehicle for industrial purposes, and it is thought by those best qualified to judge that in the near future the production of such vehicles will outrank in importance the manufacture of pleasure automobiles. The commercial motor vehicle had its beginning in America about ten years ago, almost simultaneously with the advent of the light steam runabouts and surreys which had a great vogue; but its development was retarded by the concentration of effort upon the pleasure car, which appealed more to popular interest and realized more prompt and liberal returns to experimenter and builder. Now that the touring car and runabout have been brought to approximate standardization, much more of the attention of engineers and constructors has been devoted to the motor truck and delivery wagon during the last two or three years.

Although steam vehicles predominated in America eight years ago, the steam delivery wagon and steam wagonette for public stage lines are practically non-existant and steam machines are no longer a factor in the situation, with the exception of a very few steam ambulances and patrol wagons. Heavy steam trucks, such as are common in England, have never met with success on the western side of the Atlantic, and are built now only in an experimental way or to special order.

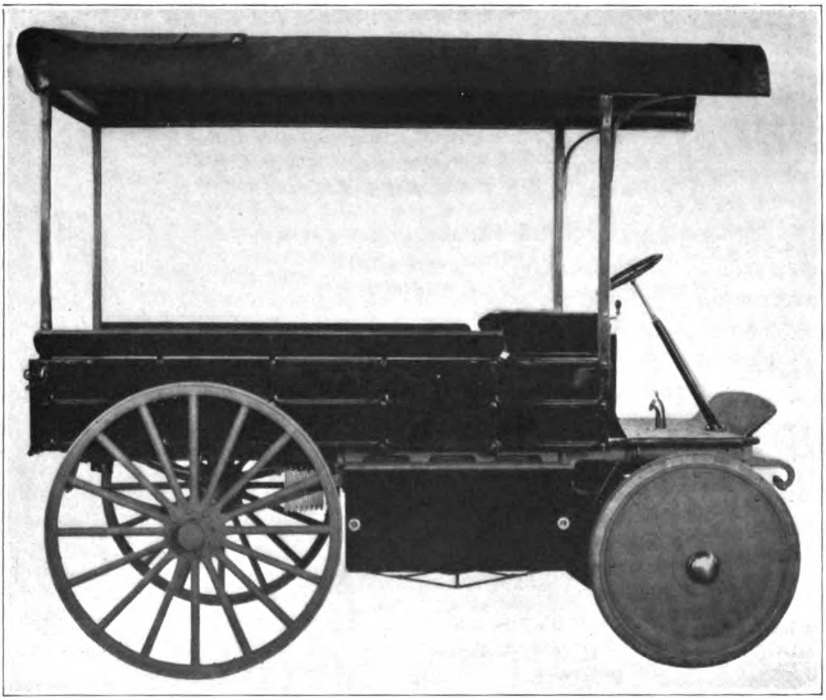
The day of the steam vehicle was succeeded by a period of considerable activity in the manufacture of electric delivery wagons and heavy trucks. Hundreds of these were bought by retail merchants, brewers, telephone and electric-light companies, and others having much heavy hauling to do. America quickly took the lead of all nations in the manufacture and use of electric vehicles, both for business and pleasure purposes, and she still holds this premier position. In the meantime, however, great progress has been made in studying out the problem of the so-called gasoline or internal-combustion-engine vehicle, both in Europe and at home, and there can be little doubt that this type is fast taking the lead both in number and importance. Obvious reasons why it should do so are the economy of burning the fuel inside the engine cylinders, thereby utilizing the maximum of heat units, the lighter weight of vehicle in proportion to load carried than with the great majority of electric vehicles, and the ability to travel indefinitely over ordinary country roads so long as gasoline—and in some cases kerosene—is available.

Vehicles for Private Commercial Work.

Although many of the earliest electric trucks and delivery wagons are still in service, many improvements have been made since they were built. Notable tendencies during the last year or two have been in the direction of decreasing the weight of the vehicle in proportion to its load capacity; increasing its radius of action on one charge of the battery by fitting anti-friction bearings to the wheels and motors, and employing improved batteries having a greater or longer output of power relative to size and weight; prolonging the life of the running gear by suspending the motors from the main frame which is carried on the springs; reducing the noise by driving with side chains instead of gears and enclosing the reducing gears; decreasing wear by better protection of wearing parts and more thorough lubrication. It can be affirmed without prejudice in the light of exhaustive trials that a very marked advance in the electric field is shown by the combination of the Lansden wagon and Edison nickel-iron battery, as now used most extensively, perhaps, by the Adams Express Company, which has supplanted its former horse service in New York, Buffalo, New Haven, Indianapolis, and Washington with electric vehicles and will make similar changes in its service in all the large cities.

Four-Wheel-Drive Electric Trucks.

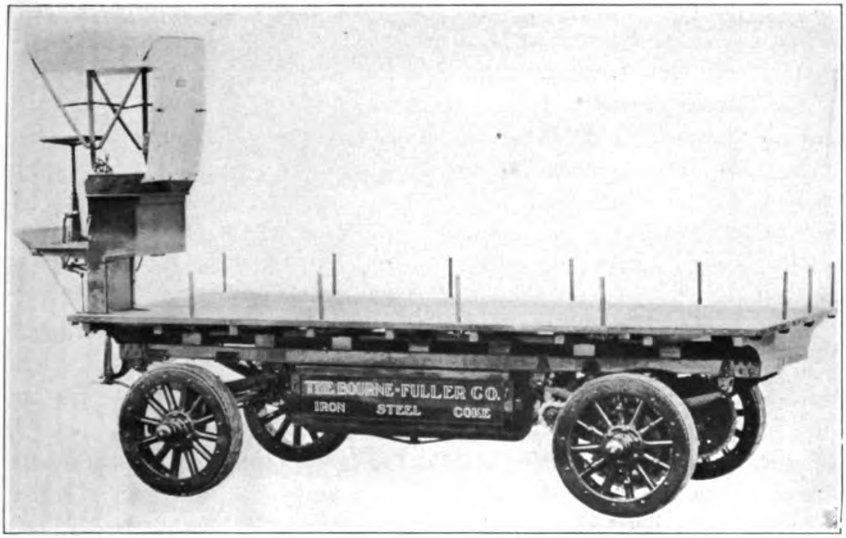
Because of the flexible transmission of power possessed by the electric vehicle, the advocates of front-wheel drive and four-wheel drive have found concrete expression of their ideas most easy in vehicles utilizing the electric current for propulsion. To the engineer the most interesting development along this line is the couple-gear freight wheel truck which is now made in 1-ton, 3-ton and 5-ton models in Grand Rapids, Mich. The striking feature of these machines is the housing of the electric motors within the wheels, which are formed of two opposed rings having teeth cut in their opposed faces, a steel tire encircling them and two steel discs bolted to their outer faces. The builders claim to have determined by Prony brake test that with this construction 97 per cent of the energy developed by the motor at full load is transmitted to the periphery of the wheel.



COUPLE-GEAR ONE-TON ELECTRIC EXPRESS WAGON WITH FRONT DRIVE.

Speed 9 miles an hour; two 3 horse-power motors concealed in front wheels; battery, 40 cells W. B. plates; wheel base 82 in., tread 53 in.; tires, front 36 by 3 in., solid; rear 48 by 2½ in., steel.

While the larger couple-gear trucks are built with motors in all four wheels, the 1-ton express wagons have motors only in the front wheels, which are also the steering wheels. In one model dummy metal wheels are fitted in the rear, and in another a pair of steel-tired wagon wheels are fixed to the rear axle. This vehicle has a speed of 9 miles an hour, with load, and a radius of action of 40 to 50 miles on one charge of the 40-cell 11-plate battery. The two motors are of 3 horse-power each and can be overloaded momentarily to 200 per cent, or will sustain an overload of 100 per cent for 15 minutes.



STUDEBAKER 5-TON ELECTRIC TRUCK FOR RODS AND ANGLES.
Driver's seat arranged to give unobstructed platform and allow load to project in front. Wood tires, underslung battery box, and double motor drive through side chains.

An electric vehicle excels all other classes in the matter of available load area. This is clearly illustrated in the photograph of the 5-ton Studebaker truck supplied to the Bourne-Fuller Company for hauling iron and steel. The driver's seat is mounted, with all control mechanism and folding top, on a small pedestal at the extreme left front corner of the platform, leaving the platform otherwise unobstructed. Extra long rods and angles can be loaded to project both fore and aft. The battery is underslung, as in practically all new electric business vehicles, and the double motors drive by side chains to the rear wheels. Wood tires are used on this vehicle, as they are on many other heavy trucks built to carry loads of 5 tons or more. They are made of wood blocks set with the grain radial to the hub of the wheel.

NEW GASOLINE TRUCKS BY LEADING AUTOMOBILE CONCERNS.

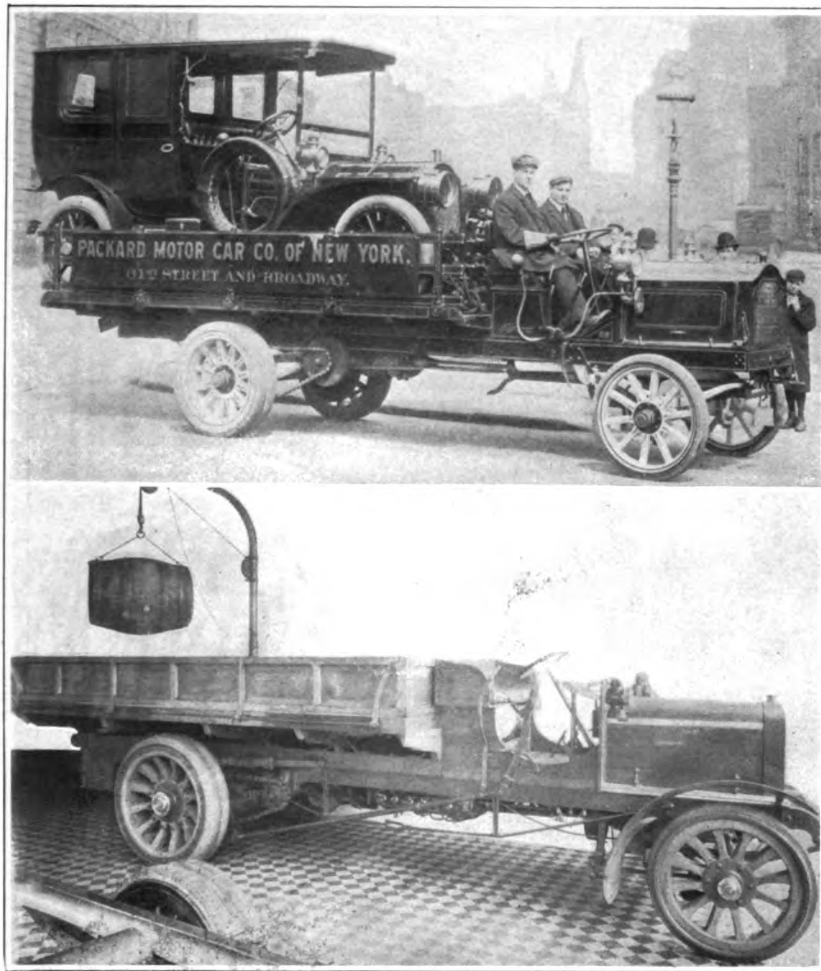
While electric vehicles are conceded to have many advantages for use in the city, particularly for short hauls with frequent stops, the truck or wagon that is driven by an internal-combustion motor is best adapted for long hauls over country roads, particularly with loads up to 3 tons. While apparently devoting all of their time and energies to the production of pleasure cars to meet the constantly growing demand, the foremost automobile-building concerns in America have been experimenting quietly with the manufacture and testing of such trucks. Among these may be mentioned the Winton, Packard, Peerless, Pierce and Autocar companies, the American Locomotive Company, Corbin Motor Vehicle Corporation, H. H. Franklin Manufacturing Company, and Matheson Motor Car Company. These makers have been holding back the manufacture of commercial cars until they could privately test their experimental machines sufficiently to feel safe in backing them with their established reputations in the pleasure car field or until market conditions should warrant diverting capital and effort to this branch of the industry.

The Packard company has during the past summer, put through a lot of twenty-five 3-ton gasoline trucks similar to that illustrated in one of the accompanying engravings showing a limousine car on the platform.

The power plant is carried over the front axle under a protecting hood of pressed steel. The driver's seat, as in touring cars and most of the European motor trucks, is back of the dash behind the engine. This brings the center of the "paying load" well over the driving wheels while the front wheels carry the weight of the engine and driver. The engine is of the standard 40 horse power touring-car type, having four vertical cylinders cast in pairs with integral water jackets.

Driving connection between the engine and the running gear is effected by an expanding clutch that operates within the recessed flywheel. The action of this is controlled by a pedal in front of the driver and also by the emergency brake lever. The speed-changing gear set is combined with the differential gearing in a single rigid metal housing on the countershaft or jack shaft which is suspended from the main frame in front of the rear wheels. Final drive is by side chains from sprockets on the ends of the countershaft to large sprocket wheels on the emergency brake drums bolted to the inner side of the drive wheels. Service brakes of the expanding type act within drums on the ends of the countershaft and are operated by a pedal. The hand lever that sets the rear wheel brakes has a notched quadrant for locking the brakes when desired.

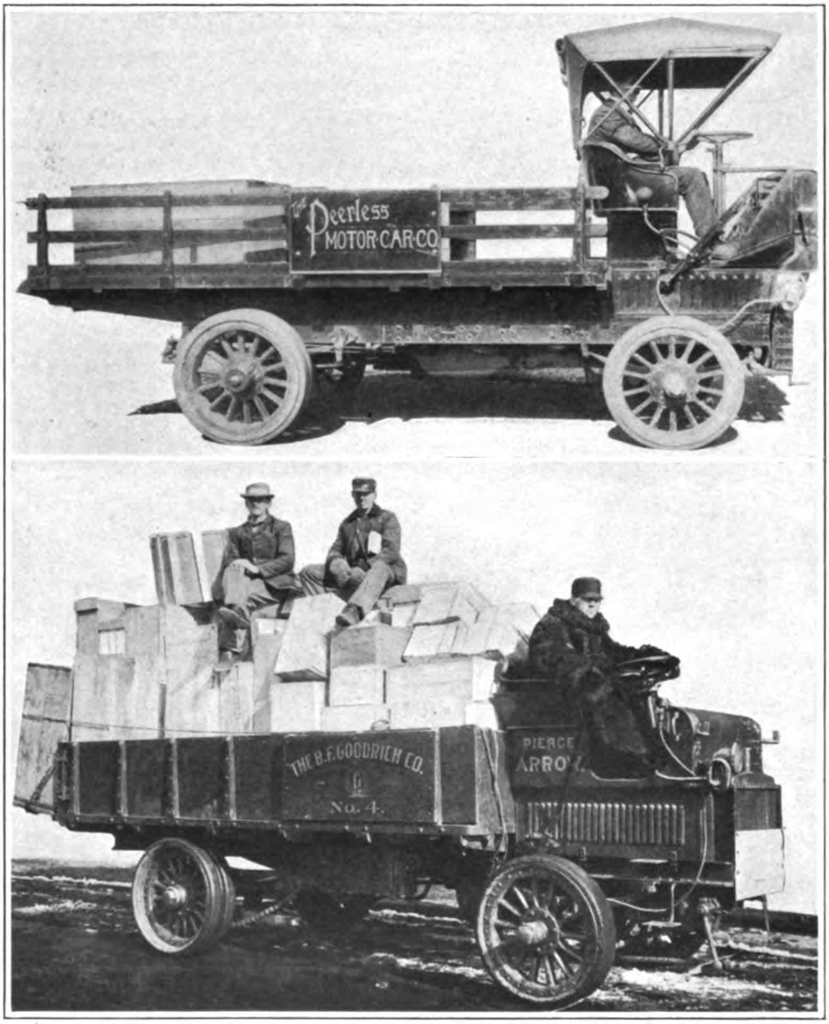
In its general features the Packard truck is typical of many of the best makes of European trucks and for this reason it has been described at some length. A close similarity may be noted between it and the new "Commer car lorry" built by Commercial Cars, Ltd., of England, for brewers' work. This lorry has a capacity of 4 tons, and is fitted with a swivel jib crane operated by the engine. This crane has a capacity of 10 hundred-weight (1,120 pounds) at a speed



ABOVE, PACKARD 3-TON GASOLINE TRUCK WITH BODY FOR GENERAL PURPOSES.
BELOW, COMMER CAR GASOLINE 4-TON ENGLISH LORRY FOR BREWER'S WORK.

The Packard car weighs 5,000 lb. without body, and has a maximum speed of 12 miles an hour; 40 horse-power four-cylinder vertical engine. The Commer car lorry is fitted with swivel jib crane, hoisting 1,120 lb. at 80 to 120 ft. per minute, and operated by the truck engine.

of 80 to 120 feet per minute. The Commer car "lorry" was one of the notable exhibits at the Second Annual Commercial Motor Car Exhibition held in Olympia Hall, London, March 27 to April 4 last. Special features of construction that will be observed at a glance are the use of truss rods with turnbuckles for giving vertical strength and rigidity to the frame, the use of a heavy external emergency brake rod, massive steering arm and joint, and hinged sides on the



ABOVE, PEERLESS 3-TON GASOLINE TRUCK; BELOW, PIERCE 5-TON EXPERIMENTAL GASOLINE TRUCK.

The Peerless truck was built for private work and tests in actual service. The Pierce truck weighs 7,290 lb. and has an average speed of 15 miles an hour; driven by 50 horse-power four-cylinder vertical engine.

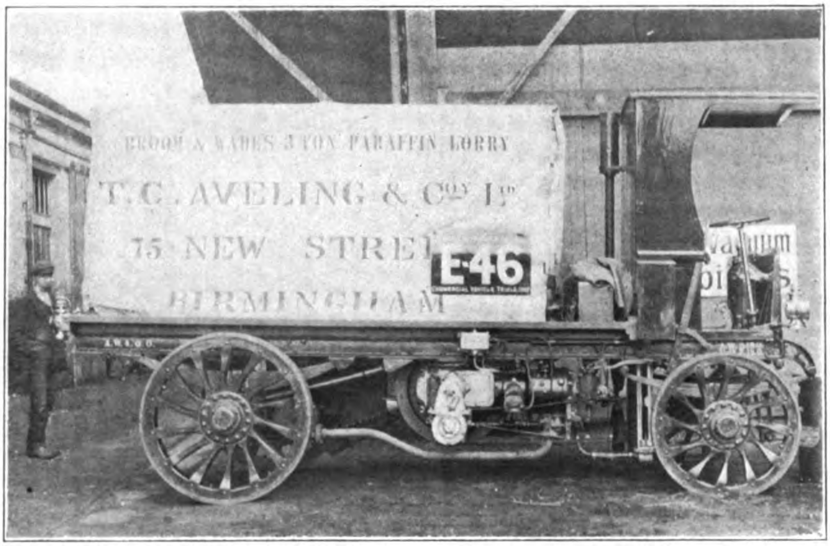
body. The Commer car was designed after the Saurer truck built in Switzerland, with the exception that the change-speed gearing is an English invention and affords four forward speeds; it is of the selective gear pattern, the gears being always in mesh and any pair engaged at will by jaw clutches that slide on squared portions of the primary shaft. The main characteristics of this lorry are so nearly like those of the Packard truck that the student cannot fail to observe how close together are leading constructors in Continental Europe, England, and America in the matter of design for vehicles of this type and capacity, and to surmise that they are fast approaching a standard of construction.

Data from Seven-Months Work by a Truck.

The trucks produced for experimental work by the Pierce and Peerless companies represent a type that is more distinctly American than the Packard, with the driver's seat built directly over the engine space above the front axle, thus shortening the overall length and the wheel base, which facilitates turning in narrow streets, permits of a slightly longer load platform with less overhang at the rear, and brings the center of the load well forward of the rear axle. The steering columns are vertical, or nearly so, and the fuel tanks are in front of the dash above the radiators. The Peerless truck, which has a load capacity of 3 tons, is driven by a four-cylinder 45-horse-power gasoline engine. Side driving chains are eliminated by the use of a driving shaft from the change-speed gear box to differential gearing on the "live" rear axle. The Pierce truck is built for loads of 5 tons and is driven by a 50-horse power four-cylinder engine. With the object of giving it a thorough test in actual service, it was placed in the service of the B. F. Goodrich Co., rubber goods and automobile tire manufacturers of Akron, Ohio, who have kept careful records of the performance and cost of operation and maintenance. Since last November it has hauled all of the product of the company's very large plant from the factory to the railroad station 1.3 miles away, displacing three two-horse teams and wagons that were kept constantly busy and which cost for maintenance, together with drivers' wages, $15 a day. The average daily cost of operating the truck, everything included except tires, has been $9.35. During the first seven months of service the actual cost of replacements of defective or worn parts has averaged $1 a month. An average of 85 tons of goods is hauled daily, single loads ranging from 11,000 to 15,000 pounds; on one occasion the truck carried more than 100 per cent overload—20,960 pounds, to be exact. The average speed is about 15 miles an hour, notwithstanding Akron is both hilly and badly paved.

Five-Months Motor Coal Delivery.

Various attempts have been made to design a type of motor truck with special body for coal delivery. One of the latest and it is be-



BROOM & WADE 3-TON KEROSENE LORRY.

Single-cylinder 26 horse-power horizontal engine underneath body. Single-chain drive to live rear axle; two-speed planetary change-speed gears.

lieved the most successful results is found in the Hewitt 6-ton coal trucks with side-dumping steel bodies. Although following accepted practice in such matters as vertical four-cylinder gasoline engine, sliding-gear change-speed mechanism, differential countershaft and side chain drive, the designer has made interesting departures in placing the steering wheel and control lever on the left side and suspending the radiator on helical springs to prevent the development of leaks in this delicate organ. The truck not only carries its own load but hauls a trailer loaded with 4 tons more, bringing the hauling capacity up to 10 tons. The amount of work which such a truck and trailer can do is shown by the record of five-months work for Herbert Bros., coal dealers, of New York. From October 30, 1907, to March 28, 1908, the truck was in service 105 days, some of the time with and part of the time without trailer. In the 105 days 623 trips were made, representing a total distance of 2,775 miles, and an aggregate of 3,618½ long tons of coal was delivered. This makes the average tons hauled per day 34. A total of 925 gallons of gasoline and 56 gallons of lubricating oil was consumed. The work of the truck was greatly hampered by delays in loading and unloading, which became so unsatisfactory that it was taken off this service and put on other work. A single example will suffice: On January 14 the time required for loading eight loads comprising 88,600 pounds was 118 minutes, and for unloading the same 353 minutes, or a total of 7 hours 51 minutes, while the total time consumed in going and returning was 4 hours 18 minutes.

Trucks with Horizontal Engine Under the Body.

Practice differs materially in the design of trucks to carry from one to three tons. Use of the double-opposed horizontal engine disposed underneath the body is common in America, and the merits of the construction involving its use, especially for certain classes of work, were given recognition by the British engineers who acted as judges in the Commercial Vehicle Trials conducted in England by the Royal Automobile Club from September 9 to October 12, 1907. Referring to the Broom & Wade 2-ton platform truck having a 26 horse-power single-cylinder horizontal motor, 8 by 8 inches, suspended underneath the body and using kerosene for fuel, and single chain drive to the real live axle from a two-speed planetary gear, the judges, in the course of their report on the trials, made the following observations:

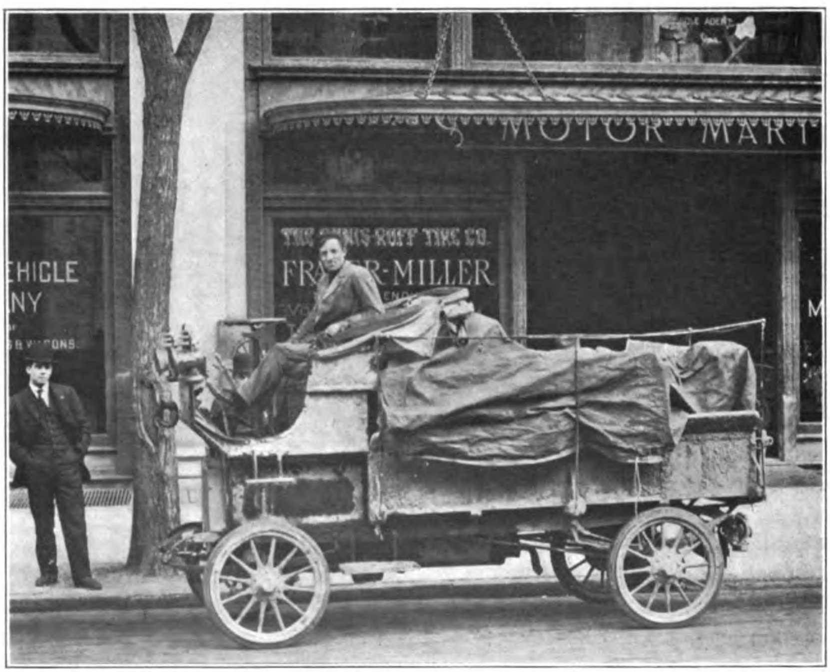
"There would appear to be a future for a type of vehicle suited for delivery work in the country in cases where speed on the road is of secondary importance, where capital outlay and running costs are required to be reduced to a minimum, and where the loads to be carried would not exceed three tons. The majority of petrol lorries (gasoline trucks) being a very high-class engineering product, do not fulfil these conditions, and manufacturers might well turn their attention to a cheaper and slower class of vehicle, an excellent example of which was submitted which, though capable of improvement and simplification, is worthy of special commendation."

Long-Distance Road Performance.

Difficulty of access to the engine and its attachments for purposes of cleaning, adjustment and repair in the type of car having the engine under the middle of the body, has recently turned the course of development noticeably in the direction of the vertical-motor-in-front construction which has become the standard in pleasure-car manufacture. An example of this in light trucks is seen in the Mitchell 1½-ton truck, which is worthy of mention because of a long overland trip that one of these trucks made from the factory in Racine, Wis., to New York City last November, with a load of 3,400 pounds—representing a considerable overload. The distance covered was 1,168 miles, with the roads in miserable condition because of many successive days of rain. Consumption of fuel and lubricants on the journey was: gasoline, 132 gallons; oil, 16 gallons; hard grease, 10 pounds; aggregating an outlay of $39.40. The largest items for repairs on the trip were: resetting a tire, $5; repairs to transmission, $18. This is one of the longest and most arduous demonstrations of the reliability of a motor truck ever made on the road. The engine develops 20 horse power and drives through a sliding gear "transmission" giving three forward speeds and reverse. A very unusual feature is the employment of worm drive to the differential on the rear axle. A worm of coarse pitch is secured to the end of the driving shaft in place of the customary bevel pinion and engages a worm gear on the periphery of the differential group.

Novel French Light Delivery Van.

Much attention has been attracted of late to a novel little gas-engined vehicle with a carrying capacity of 1,000 to 1,500 pounds designed especially for the quick and economical delivery of small parcels in large cities. This is the Roval light delivery van built in Paris and exhibited for the first time at the Paris Automobile Salon



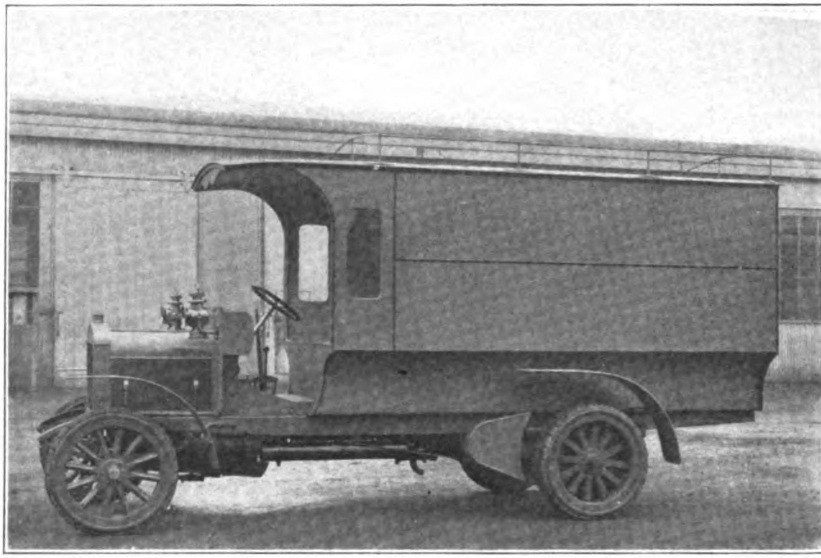
MITCHELL 1½-TON AMERICAN GASOLINE TRUCK, AFTER ROAD TRIP FROM RACINE TO NEW YORK.

Weight without load, 2,300 lb.; 20 horse-power four-cylinder vertical engine; wheel base 110 in., tread 56 in.; body, inside, 8 ft. by 3 ft. 7 in.; tires, front 30 by 3 in., rear 30 by 3½ in., solid.

ROYAL LIGHT VAN FOR QUICK DELIVERY OF SMALL PARCELS.

Capacity, 1,500 lb.; speed 18 miles an hour; 6 horse-power single-cylinder vertical engine; wheel base 8 ft., tread 4 ft.; width of frame, 2 ft. 4 in.; wheels, tires all 27½ by 3 1/3 in.

last December. The driver sits above the rear axle and has an unobstructed view over the top of the body, which is set on a pressed-steel frame of channel section filled with wood to stiffen it. The center of gravity is so low that great stability is assured, although the tread is only 4 feet between wheel centers. This arrangement also permits of the use of a 6-foot body on an 8-foot wheelbase without any overhang. The pressed side members of the frame are formed in one piece with the sides of the seat support and the web to which the dash is secured, a design that contributes to rapidity and economy of manufacture. All the mechanism is placed at the rear, with the single-cylinder, vertical water-cooled motor and its attachments, such as carbureter and magneto, under a metal cover at the left of the seat pedestal where they are almost as accessible as when on the block, and where the heat and odor can have no effect upon the contents of the van. The fuel tank is attached to the rear of the dash at the left of the steering post. A speed-changing gear set affords three forward speed ratios, while the engine, which develops 6 horse power, is provided with an exhaust-valve control by which its speed can be regulated within the limits of 500 and 1,500 revolutions per minute. The engine and speed-changing gear set are built in a unit with a differential countershaft which is parallel to and in the same horizontal plane with the crank shaft, and drive is from the ends of this to the rear wheels by chains. The body is loaded and unloaded conveniently through doors in the front.



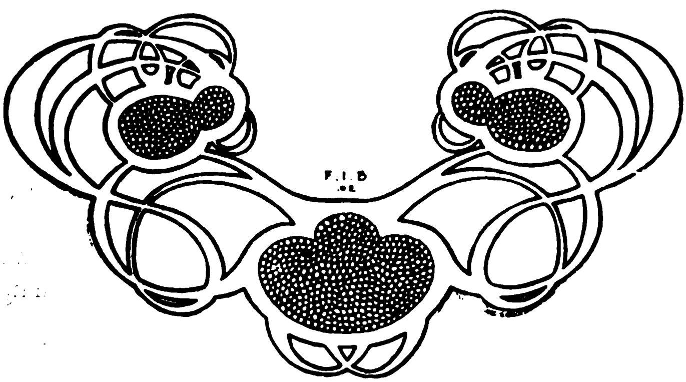
THORNYCROFT 16 HORSE-POWER 1½-TON BOX VAN FOR DELIVERY WORK.

English Box Van for Delivery Work.

A good example of the English type of box van for loads of medium weight is seen in the new Thornycroft 1½-ton van. As high speed is detrimental to commercial vehicles, this wagon has an engine of but 16 horse power and is geared low so that it will have no difficulty in surmounting hills. The two cylinders of the engine are cast together side by side and stand vertically. Inlet and exhaust valves are on opposite sides of the T-shaped cylinder heads. Since delivery wagons are commonly placed in the hands of former horse drivers, the Thornycrofts have endeavored to simplify the construction and operation as much as possible. This is evident in the employment of the natural or thermo-syphonic cooling system, which requires no pump that can get out of order and cause overheating; the use of low-tension ignition which obviates battery troubles and needs no attention; of an oil pump which supplies lubricants to the main bearings and cylinders automatically; and a single engine-control lever that acts simultaneously on the gas throttle and ignition advance. Even a driver having no knowledge of the fundamental theory of the gas engine can have no trouble in regulating his engine with but one lever to manipulate, since movement of the lever in one direction for increased speed or power both opens the throttle and advances the time of ignition. It is not desired that a driver should try to rush an ascent on high-speed gear, opening the throttle wide to give full charges of gas and retarding the spark to allow the engine to run slowly.

The keynote of simplicity is also evident in the Thornycroft carbureter, which has no float for maintaining a constant level of fuel to give uniform feed at all times, and no jet. The design is very simple, comprising a U-shaped tube to which the fuel is admitted through a valve. This tube is heated by exhaust gases from the engine which circulate within a jacket, and as the fuel and air commingle in the tube they are heated to assist vaporization. After the engine has been started on gasoline and run until the carbureter is hot enough to vaporize kerosene, the lighter and more expensive fuel is shut off and the car run on kerosene. There is no reservoir for fuel in the device, as in the usual float-feed carbureter, and changes from one fuel to the other can be made quickly, so that if it is found that the heavy oil has been turned on too soon, the driver can return to the use of gasoline.

For changes of vehicle speed, selective type gearing is used, which has the advantage of not requiring the passing through intermediate gears in dropping say from high speed directly to low. All forward changes and reverse are obtained by one lever operating in an H-shaped gate on a quadrant. Side chains are used for final drive to the rear wheels, and the front part of the chains and the sprocket wheels on the countershaft are protected by metal chain cases. The single front and twin rear tires are of a type largely used in England, having transverse slots or grooves in the rubber tread to prevent slippage on wet and "greasy" pavements.



A CHARACTERISTIC RAILWAY CONSTRUCTION CAMP; CHAMBERS' NO. 5.

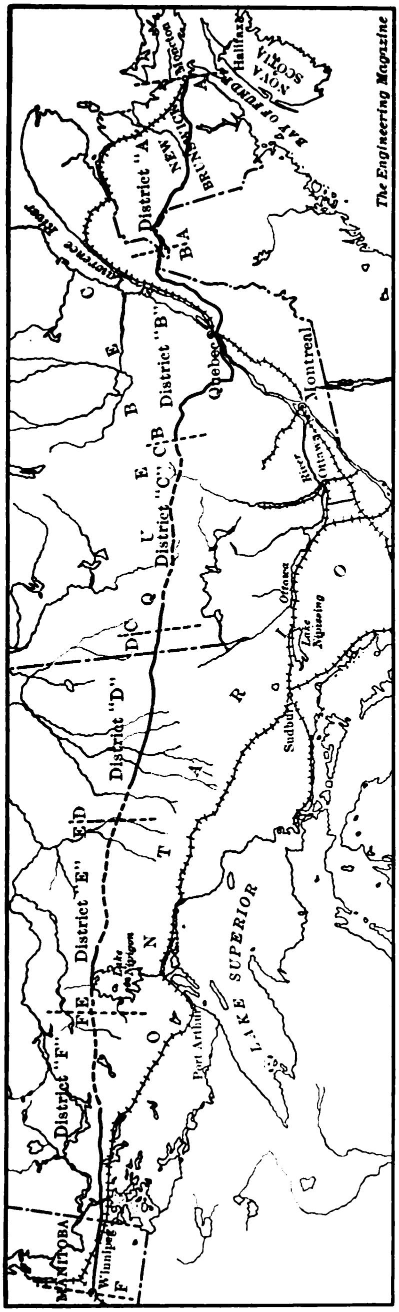
THE BUILDING OF THE NEW CANADIAN TRANSCONTINENTAL RAILROAD.

By George C. McFarlane.

Mr. McFarlane's article throws a vivid light on the difficulties encountered in constructing the Grand Trunk Pacific through the wildernesses of northern Ontario and Quebec. A four-hundred mile section west of Winnipeg has been open for traffic for some weeks, but, despite the vigor and efficiency with which Mr. McFarlane shows the work on the eastern section to be prosecuted, the completion of this great work must still be a matter of years.—The Editors.

THE new Transcontinental which will be known as the Grand Trunk Pacific stretches across 65 degrees of longitude and 8 degrees of latitude, from Moncton, N. B., on Bay of Fundy, to Prince Rupert on the Pacific, the total length of the main line being 3,400 miles. The eastern division, of approximately 1,770 miles, extending from the Atlantic Ocean to Winnipeg, is being built by the Dominion Government, and will be leased and ultimately purchased by the Grand Trunk Co. Construction work, which began in 1906, is being actively prosecuted all along the line; 1,200 miles of the Government section is now let, and on the western division 400 miles across the prairie is practically complete; last spring contracts were let for a hundred miles running out of Edmonton toward the Rockies, and for another hundred-mile section extending east from Prince Rupert along the cañon of the Skeena River.

The eastern division, from the valley of the St. Lawrence to the western prairie, traverses an unsettled wilderness; crossing the Laurentide hills that outline the St. Lawrence valley on the west, the line for 500 miles passes through a fairly well timbered rolling plain,



MAP SHOWING PROGRESS ON THE MONCTON-WINNIPEG GOVERNMENT SECTION TO MARCH, 1908.
The dotted portions indicate located line; the full portions, sections under contract.

which stretches southward from the shores of Hudson's Bay to the height of land; then it passes through 500 miles of rocky Archæan highlands lying to the north and west of Lake Superior, then across 60 miles of prairie to Winnipeg.

It is evident that a private corporation could not afford to build a railroad across 1,200 miles of wilderness, so the Government, after making a comprehensive investigation of the resources of this region, determined to undertake the building. The idea was to build a first-class railroad which should be a direct line from the wheat fields of the west to the seaboard, and with the Grand Trunk Pacific form a short line for "trans-Canada" mail and traffic between England and the Orient, and which in time of need would furnish a military highway, well within the confines of Imperial domain, for the quick despatch of troops and armament from coast to coast. It will open up for settlement a large tract of fairly good agricultural land in northern Ontario, will tap great pulpwood forests, and as it crosses at Lake Abittibi and also near Lake Nipigon wide belts of mineral-bearing

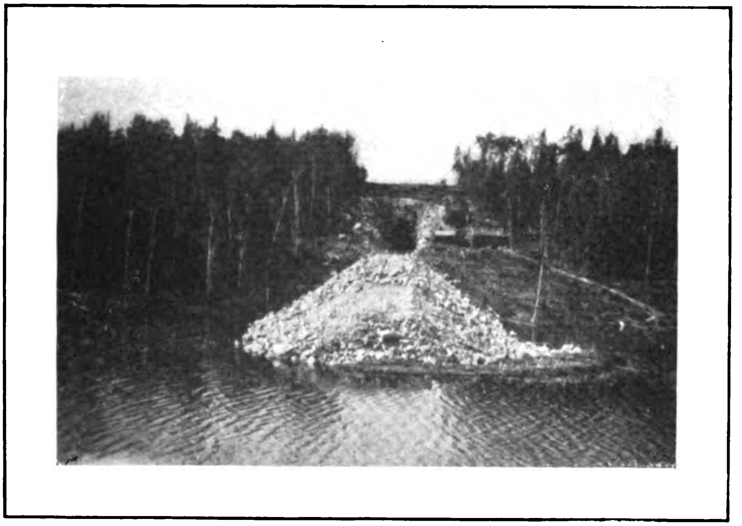
Huronian rocks, it will probably open up valuable mineral deposits.

Topographically the whole country is a vast, rolling plain broken up by numerous rocky ridges and bosses, and drained by rivers which are a series of lakes connected by short, river-like stretches. North and west of Lake Superior the country has been ground down to the bone by the glacial ice cap, the rock surface polished and rounded, and some glacial *débris* left in the hollows and depressions. In the basin of Hudson's Bay the rock is pretty well covered with a heavy mantle of marine sediments, which forms a good soil, only occasional rocky ridges projecting above the general level. In the depressions gouged out by the glaciers are myriads of lakes usually connected by shallow streams. These lakes and their connecting waterways furnish routes for reaching all parts of the region, by canoe in summer and by sleigh teams over their frozen surface in winter.

ONE MODE OF TRANSPORTATION USED BY THE RAILWAY BUILDERS.

Owing to the peculiar topography, the engineers experienced innumerable difficulties in getting a fairly direct line through this maze of lakes. From five to ten well equipped parties were in the field for nearly three years before the general route was decided upon. These parties were out winter and summer from fifty to two hundred miles from civilization; in summer supplies were brought in by canoe and left in caches at designated intervals along the route; in winter dog-teams, of which each party had several, furnished the only means of communication with the outside world. Between snow and bitter cold in winter, and mosquitos, black flies, rain, and muskegs in summer, the lot of a locating engineer was far from a pleasant one.

When the location work had progressed far enough for construction work to be started, the line was divided into six districts each in charge of a district engineer; each district was subdivided into ten divisions, each in charge of a division engineer, and the divisions were partitioned into ten- or twelve-mile residencies. When a section of the line was let to a contractor, engineer camps were built on the residencies within the section; these camps consist of a number of small but exceedingly neat and well built log houses; they are put up by the staff assistants, who as a rule are expert axemen. The residency force consists of an engineer, transitman, three assistants, a force accountman, chore boy, and cook.



TUNNEL AND FILL. SHOWING CHARACTERISTIC TOPOGRAPHY.

Usually the locating engineers are appointed division engineers of construction, and the instrument men of the locating parties are given charge of residencies. Besides the regular engineering work incident to construction, the engineers assist in enforcing the Government regulations for the exclusion of liquor, the prevention of forest fires, the sanitary regulations regarding the building of contractors' camps, and the food supplies furnished the men, and they also see that the contractors' employees receive fair treatment and are paid no less than the minimum wage scheduled by the Government.

When the Government was ready to begin the construction of the road in the spring of 1906, there was an abnormal shortage of labor caused by the railroads in the Canadian northwest, which were gridironing the prairies with branches and extensions. Under these circumstances the commissioners decided to extend the construction over a period of six years; by letting the work in short sections, starting at convenient points, the completed section would give access to adjacent portions of the line, and these adjacent portions would be let to contractors in sequence. During the flush years of 1906 and 1907, not over nine thousand men were at work on the road; during the present depression double that number of men are given employment at fair wages. It is interesting to note that while wages are 20 per cent lower than they were a year ago, the average efficiency is fully 30 per cent greater. During the good times, when the laborers were being paid as high as $2.25 and $2.50 per day, they seldom staid over a month in one camp, quitting them to find a better job at higher wages; after reaching town and "blowing in," the employment agent would ship them back to another camp at the same wages and in debt for railway fare and employment fee. Some of the laborers would even throw away their blankets and working clothes when they quit a job. As long as the good times kept up and there were more jobs than men, they kept up these tactics; with the coming of hard times in the beginning of the year all this was changed; wages were cut to the base scale, work being scarce men quit shifting around, and now the average laborer stays over six months on a job without going to town and is saving more money than in the so-called good times.

The first section of the line to be let was the 275 miles running from Winnipeg to Superior Junction, where it connects with a branch now being built by the Grand Trunk from Fort William; it was desired to have this section in operation as soon as possible in order to give the western wheat another outlet to the Great Lakes. This 275-mile section has the heaviest stretch of rock grading on the Continent. After crossing 60 miles of prairie, lying east of Winnipeg, the line traverses a region of lakes and low granite hills, and the road, particularly for the first hundred miles, is a continual succession of deep rock cuts and heavy fills over the intervening shallow lakes, swamps, and depressions. It was estimated that this section would cost about $13,000,000 to build, but this estimate will be greatly exceeded, because there has been a great deal of overbreak in the rock cuts and heavy settlements have taken place where the fills cross muskegs and the shallow arms and bays of the lakes skirted by the line; it is therefore probable that this section will cost between $16,000,000 and $17,000,000.

In May, 1906, the commissioners awarded the contract for this section to J. D. McArthur, of Winnipeg, who was obliged to furnish a cash bond of $1,300,000 for the carrying out of the work. For the purpose of rapidly organizing a working force and carrying on the work as expeditiously as possible, Mr. McArthur sublet the grading of the entire section in small blocks; his field manager, W. A. Dutton, to whom the successful outcome of the contract will be largely due, personally took 58 miles of the heaviest rock work. According to this arrangement the general contractor was the financial backer of the sub-contractors, furnishing them the money for purchasing equipment, paying all the payrolls, furnishing all supplies for boarding and clothing the men and laying down explosives, etc., at convenient points on the Canadian Pacific Railway. All supplies were furnished at cost plus 10 per cent; payrolls were charged up net with 1½ per cent added for indemnity insurance; the general contractor also maintained a field-hospital service for which the subs were charged $1.00 per man per month.

THE FACE OF A 50-FOOT CUT.

The powder men are blowing out the two blast holes in the bottom with steam, preparing to put in the blasting charge—in this case 100 lb. of dynamite in each hole.

All the sub-contractors used the same general methods in carrying out the work. Camps for feeding and housing 80 to 125 men and from 10 to 20 teams of horses were established at intervals of 2 or 3 miles along the line. These camps consisted of log buildings, the logs being laid up in the round, spotted and chinked, and then plastered inside and out with a mixture of clay and lime, and the roof being a single thickness of boards covered with rubberoid paper. The regular camp consists of an office and store building, a warehouse, powder magazine, blacksmith shop, cookhouse, three bunkhouses, and two barns, and costs from $3,000 to $4,000. In order to get in supplies at all seasons of the year, small steamboats were built on the Winnipeg River and on the larger lakes along the line, the portages between these lakes were cut out, and tramways were built on some of the main portages. Winter sleigh roads running south to stations on the C. P. R. were cut from each group of camps.

A HEAVY SHOT.

Most of the work of camp building, road cutting, and right-of-way clearing on the McArthur contract was completed by the end of 1906, and the actual work of rock excavation commenced early in 1907. The organization of the working force was about as follows: the force of each sub-contractor was under the general charge of a walking boss; each camp was directly in charge of a "camp-walker," who divided his force into gangs of ten or twelve men. Each gang was in charge of a gang foreman and was assigned to a cut, which it usually held until finished. The gang foreman is the powder man as well as boss of the gang in a rock gang. One of the men is a teamster, and drives the stone-boat team or car horse; three of the men are drillers, and the remainder of the gang load out the broken rock and trim the dump.

The rock is first broken with heavy blasts. For this purpose a centre hole is drilled back of the face of the cut; in the big cuts these holes are often drilled 30 or 35 feet deep and set back 25 or 30 feet from the face of the cut. After being drilled the gang foreman chambers the hole by springing it with repeated and successively larger charges of dynamite; starting with a single stick, the springing charges will be doubled or trebled, until, in the case of a 30-foot hole, the final springing charge might be 200 pounds and the blasting charge 800 pounds of dynamite. When such a shot is detonated with a battery the ground quivers, and instantly and almost noiselessly a big haystack of rock rises above the ground level, opens out like a lily, and falls with a clatter into the cut. Possibly 1,500 cubic yards are thrown out, and some of the pieces will be as big as a house and weigh a hundred tons; all these big pieces are broken by block holes or loose dynamite packed tight in a depression of the rock and covered with a mud cap.

MUCKING OUT FROM A HEAVY CUT.
The tripod in the background is over a blast hole, and is used to steady the long loading stick.

Several methods are used for loading out the rock and hauling it to the dump. Stone-boats running on pole tracks and hauled by heavy two- and three-horse teams are used on short hauls, and in winter when they can be run on iced poles or on the frozen lake surfaces they are used in nearly all the borrow pits and cuts not equipped with derricks and cars. In nearly all the long cuts low platform cars running on 20-pound steel rails are used; these care are usually loaded with derricks, the small stuff being loaded by hand. Hand and horse-power stiff-legged derricks are commonly used, although a few steam derricks are in use.

As the work progressed, steam-drills were gradually introduced for drilling the big blast holes; they were also used in the tunnels, except in the tunnel near the Winnipeg River crossing, where the Temple-Ingersoll electric air drill is being used with good success. In this tunnel the heading was driven from an incline cut sunk on the east side of the ridge; the east approach proved to be a great mass of quicksand and boulders in an irregular basin-shaped depression of the bed rock.

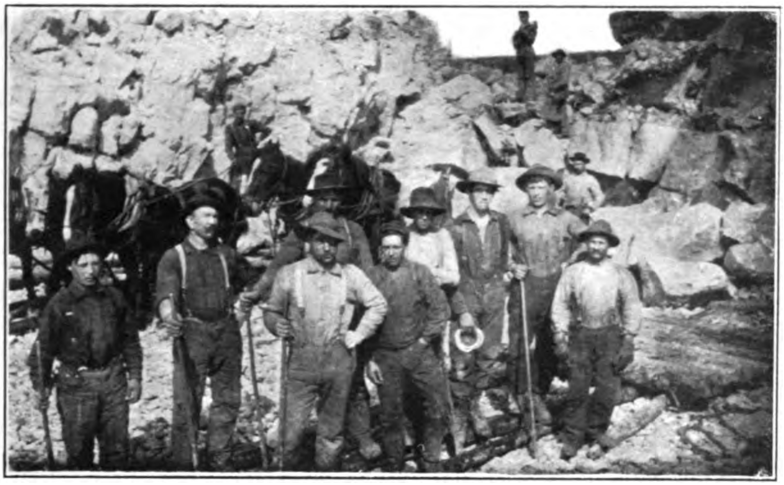
From the start of the work, the contractors have been replacing the day gangs with gangs of station men, as it has proven by far the most economical method of handling rock. According to this system ten or twelve men band together to take out a cut or borrow pit by the yard; while carrying out the work, they are furnished with all necessary equipment, such as horses, cars, and rails, at a very nominal rental. The station men do not draw any wages, however; they are furnished all supplies, necessary to carry on the work, as well as board and clothing, all of which are charged up at a slight advance over cost prices. When their cut or station is completed, it is measured up by the engineer and the station gang given a prompt cash

ROCK WORK IN WINTER.

A DERRICK FOR LOADING BLASTED ROCK ONTO CARS. DRILL AT WORK IN THE BACKGROUND.

settlement. The prices received by the station men average 15 per cent lower than the sub-contractors' prices, who in turn receive 10 per cent less than the general contractor receives from the Government. Sometimes three or four extra good men are given a cut and allowed to hire day hands, receiving regular day wages from the contractor, to assist them. The advantage of working station men is that once the work is let, the contractor is sure of making a reasonable profit on his job; because no matter what difficulties or squabbles a station gang may have, they have to stick it out and finish in order to get any money. Occasionally a station gang may not do enough to pay their expenses; this may be caused by dissensions among themselves, poor judgment in blasting, or the work itself may be poor. Scratch-cuts, clay-cuts, or mixed dirt and rock are considered to be hard propositions for station gangs. As a rule this work must be taken out by day gangs of Austrians, Galicians, and Italians. For the most part, the station gangs are composed of Swedes, with a sprinkling of Norwegians, Finns, and native Canadians; men of other nationalities, while often individually first rate rockmen, do not seem to be able to put up the team play or to exhibit the knack of handling rock to advantage. As a rule a Scandinavian station gang uses very little machinery in taking out rock, preferring to break up the rock by mud-capping and block-holing and loading on the car or stone boat by hand. On the average the station gangs get out more rock in this manner than the day gangs, who are provided with steam drills for drilling the rock and derricks for loading the big chunks. Even among the station gangs the efficiency varies enormously; some of them do not average $1 a day over expenses; the majority average $2.50 per day, and a few clear $7 a day.

One of the most distressing features of the work is the great number of fatal accidents that are continually taking place, both on the McArthur work and on the rock sections through Quebec and New Brunswick. Of course on this class of work, a good many accidents are to be expected; men loading in the cuts are liable to pick into unexploded pieces of dynamite; they are liable to be caught by rocks or boulders rolling down the slopes; and they are often struck by flying fragments of rock when apparently standing a safe distance away. About half the accidents are caused in this manner and from the careless handling of dynamite; the other half are the result of premature explosions of the big blast holes, when being loaded with heavy springing charges or being tamped up with the blasting charge. These latter accidents are, in a sense, the direct outgrowth of the station-gang system. The rock is nearly all the hardest kind of syenite and granite; hand drilling blast holes in this rock is tedious and expensive; to save expense and get out a lot of rock at one shot, station men will put down one deep hole and keep springing it until they can get in enough dynamite to tear out the rock in front and for per-



A STATION GANG.

They are nearly through their cut, and are mucking out the last big shot.

haps 20 feet behind the hole. This excessive springing in hard, tough rock splinters the hole above the chamber; now in shoving hundreds of sticks of dynamite down the small jagged and splintered hole leading to the bottom chamber, some of the dynamite is bound to lodge in the crevices; the tamping stick, probably jammed by a splinter of rock in one of its numerous trips up and down the hole, might be given an involuntary jerk by the most careful loader, and the loose splinters striking together might detonate the entire charge. I believe this is the true cause of nearly all the bad accidents; my observations lead me to believe that the commonly accepted theory that these premature explosions are caused by loading before the holes have cooled off from previous chambering blasts is absolutely false; neither are they caused by reckless handling of explosives, except in rare instances; the men handling the explosive, almost without exception, along the whole line are intelligent and understand thoroughly all the precautions to be used in handling the stuff. In the more or less decomposed and softer rock usually met with in railroad cuts, the explosive used in chambering a hole pounds the rock around the chamber and along the walls of the hole over the chamber into an inert punky mass and it would be manifestly impossible to rub fire by churning a wooden tamping stick in the hole. The highly elastic crystalline rocks along the line of this road splinter into sharp, angular slivers, and when loose dynamite sifts among these particles and they are agitated by churning a tamping stick up and down, it is no wonder they rub fire and detonate the charge. Again, the mineral crystals composing these

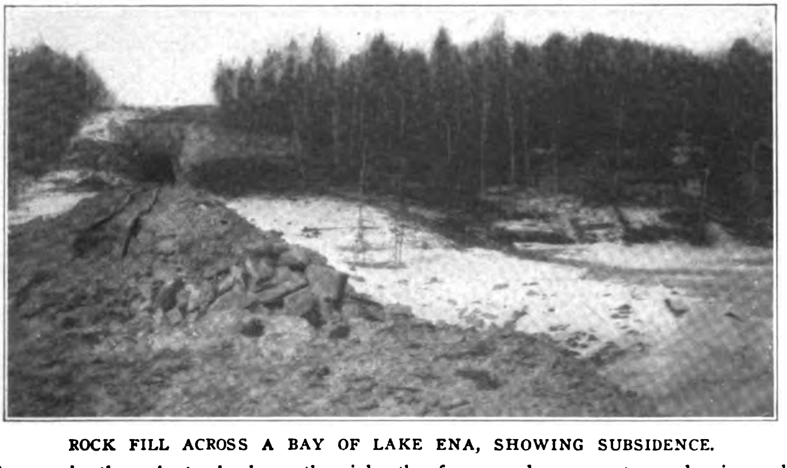
A ROCK CUT NEARLY FINISHED.

rocks often contain microscopic inclusions of gas blebs under high pressure; under certain circumstances the bursting of these gas blebs would cause detonation. After a heavy springing charge is exploded, enormous stresses are developed in the surrounding rock; at times the rock will grind and crackle several minutes after the explosion; it is possible that the rock sometimes does not adjust itself to these stresses for several days—that at times microscopic movements take place in obedience to these stresses after a long interval of time. Supposing such a movement should occur while a hole was being loaded; loose dynamite and angular mineral particles would be scattered along the cracks and crevices radiating around the chamber; some of the mineral particles would be cracked, and the bursting of a microscopic gas bleb might be the locus of a detonation that would extend through the entire charge.

An accident that must have been caused in this manner occurred in one of the big cuts last winter; two holes were placed in the bottom bench of the cut, being fired together with a battery; before the muck was cleared, a squaring-up shot was blasted down from the upper bench. The men after inspecting the shot for a few minutes, started back toward the mouth of the cut to get the tools and rail; before they had gone back two hundred feet, the west bottom hole, which was supposed to have exploded three days before, let go; kicking sideways, it demolished the hoist-engine house on the east bank of the cut. If this shot had thrown ahead it would have mown down every man in the cut.

In the future a good many accidents can be avoided by the contractors adopting a system of machine drilling the rock cuts and letting the blasting and mucking to station men. The machine holes can be spaced so close that it will not be necessary to load more than one or two boxes of dynamite in any one hole. As the machine holes are much larger than the hand-steel holes, they are much easier to load and there is little danger of the loading stick jamming in the hole.

The only dispute that has arisen so far between the commissioners and the contractors has been over the engineers' classification of the hard, tough clay met with in the approaches of the rock cuts as "common excavation." The rock work so far has been vigorously prosecuted in winter time and nearly all this clay was frozen and had to be blasted; even in summer this clay is so tough and full of roots and rocks that the contractors cannot handle it at a profit. Finally the commission made a ruling that in certain cases the engineers might classify common excavation as loose rock. This ruling has subjected the commission to considerable criticism from the opposition press of the Dominion. Some of these papers have represented that the increased cost of the road over the estimates was caused by over-classification of material. This is a rank injustice to the members of a commission which has directed the carrying out of a great Government enterprise with such signal ability. Practically all the increased cost is accounted for by the overbreak in the rocks cut and the sinking of the grade. The rock is free from cleavage planes and fractures but possesses a large irregular jointing; in order to get solid walls for the cuts, the sides have to be taken back to these joint faces; and when the cut is scaled and trimmed up it will usually show 25 per cent overbreak. On the other hand, while nearly all the lakes had a



ROCK FILL ACROSS A BAY OF LAKE ENA, SHOWING SUBSIDENCE.

The sag in the pole track shows the sink; the foreground was up to grade six weeks before the picture was taken. The lifting and breaking of the ice by mud squeezed up from the bottom is seen on the right-hand side.

fairly hard clay bottom, the 30- and 40-foot fills have sunk anywhere from 10 to 50 feet into the mud and clay.

These fills have taken the over-break, and in many places thousands of yards of rock borrow has been used for bringing them up to grade. The sinking of the fills has been very gradual; most of the sinking takes place under the centre of the dump, and the clay heaved up forms a wide ridge along the sides of the fill. I have noticed places where the centre has gone down 50 feet and big stones along the edges of the embankment would be heaved up 5 or 6 feet out of water. Across most of the bays, before settlement stopped, there was as much rock under as above the original bed of the bay.

For the 200 miles of rock grading between Rennie and Superior Junction the general contractor will receive about $11,000,000; at the average prices paid station men, which is also approximately what it costs to take out the cuts with day gangs, the work will cost the contractors for labor and supplies $8,250,000. Besides this the camps and roads cost $600,000 to build; the horses, cars, rails, derricks, drills, and miscellaneous equipment represent an initial investment of $1,345,000; as all kinds of contractors' equipment depreciate very rapidly, it is probable that all the contractors' plant will not be worth over $600,000; of this the horses will be the principal item. The contractors' administration expenses, which include the salaries of general foreman, walking bosses, shipping clerks, and clerks in the main offices, will amount to $675,000. This makes the total cost to the contractors for executing $11,000,000 worth of rock excavation $10,-270,000, leaving a profit of $730,000 or 6.6 per cent. I believe the profit made on supplies and clothing sold to the men would pay the interest on the cash bond, indemnity insurance, and incidentals. The salaries and expenses of the Government engineers in charge of this $11,000,000 worth of grading, by the end of November when the work will be completed, will amount to $370,000, or 3.4 per cent. The preliminary and location surveys for this portion of the line are said to have cost nearly $200,000.

Analysis of the above gives the following sub-division of costs for grading the Transcontinental through 200 miles of heavy rock section:

Engineering, preliminary and location surveys, superintendence of construction	5	per cent.
Contractors' profits	6.25	" "
Contractors' expenses of administration	5.75	" "
Preliminary construction of camps and roads	5.5	" "
Depreciation of contractors' equipment	7	" "
Labor, explosives and supplies	70.5	" "

FUEL FOR POWER GENERATION.

By Edward C. Warren.

In a preceding article Mr. Warren suggested the very attractive—and as he believes, practical—possibility of providing a fuel for internal-combustion motors which should (so to speak) contain its own oxygen and dispense with the now limiting necessity of air supply and compression. In this paper he conducts a radical attack upon the other element of combustion, proposing to replace the common "combustible," carbon, by hydrogen. He admits that this possibility depends upon some new short-circuiting of the cycle of dissociation, by which Nature will restore the combustible to a free state as it restores the flowing water to higher mountain levels; but he believes a way to the solution of this problem can be indicated, and therefore offers his suggestions not merely as interesting, but as potentially of great use and importance.—The Editors.

DURING the month of May of the present year there was convened at Washington, by manifesto of the President of the United States, the most remarkable congress of which American history bears any record. By direct personal invitation of the President the governors of the States of the Union were assembled in conferense with the Nation's Chief Executive to consider what has become a momentous question of immediate vital importance to the whole people—the conservation of natural resources.

Prominent among the gravely threatening aspects of the situation as pictured by the learned investigators loomed the all-important question of an impending famine of fuel substances for the maintenance of the myriad industrial and power-using operations forming the substructure of our civilization. Prominent among the prophets of disaster in his scathing arraignment of national extravagance and indifference to rapidly disappearing resources was Prof. I. C. White, State geologist of Virginia, whose remarkable array of facts and figures proved beyond cavil that, at the present rate of reckless expenditure, our coal measures—those marvelous, Providentially provided deposits of carbonaceous power-wealth—will surely be exhausted within the short space of some 75 years from date. Likewise the oil wells, already falling far behind the demand in the rate of production of their priceless hydrocarbon compounds, must soon be exhausted and the Standard Oil Company close its refineries and pipe lines and turn its attention exclusively to railroads and politics as a source of dividends. Same thing with natural gas, and nothing else in sight to burn.

Now this is, of course, the phase of the question that particularly concerns the power engineer, since he is, collectively speaking, responsible for the existing status and future of the fundamental science of energy-conversion upon which practically all industrial advancement depends.

Prof. White pertinently and forcefully inquires: What are we to do for fuel substances and how are we to generate the mechanical power so universally required to keep in motion the wheels of civilization when the coal and oil and gas are gone? A pertinent question indeed, and one demanding an early answer if there is to be no break or interruption in the onward march of scientific achievement. For there is no questioning the conclusions of Professor White and other investigators on this point, that the visible supply of the universally used fuel substances is diminishing at a rapidly increasing rate and the time is near at hand when a change must be made if disaster is to be averted.

It is of small avail to urge that a huge, almost incredible, proportion of the fuel taken from the earth is wasted through inefficient methods of utilization, that the best steam-power plants realize hardly 10 per cent of the heat energy of the fuel in the form of useful work on a rotating shaft, that the giant Mauretania with her marvelously complex and highly refined propelling machinery actually realizes in propulsive effect in her progress across the Atlantic a beggarly 5 per cent of the actual power-value of the 5,000 tons of selected coal consumed under her twenty-five boilers in the five-day trip across the ocean. It is quite beside the question to argue that if some of this prodigious waste could be stopped the date of exhaustion of the coal measures might be deferred. The fact is a large part of this wasted fuel could and certainly should be utilized by the employment of improved processes and mechanisms even now available. There is today no valid scientific justification for thermal efficiencies so absurdly low as those quoted, for by the utilization of existing improved systems of generating an expansive motive agent from the combustion of carbonaceous fuels, thermal efficiencies double or triple those now commercially realized may certainly be attained.

This may all be readily conceded by advanced students of engineering science, and yet the fact remains that commercial application must apparently forever lag far in the wake of scientific progression and we must face the fact that any practical material reduction of the rate of dissipation of the fuel supply is, under the circumstances, a remote contingency. Furthermore, the important fact must be considered that any economies effected in the generation of power must inevitably react in an increased use and demand for power, and the cheapening of power simply means a demand for more power, so that it might easily be that the only effect of an application of economy would be an increased demand which would absorb the portion of fuel so saved, and thus the actual date of the extinction of the fuel deposits be unaffected or, possibly, through an over-reaching effect of the stimulating of power consumption, be even brought nearer.

How then is this vitally important problem to be met? Man must use power. Mechanical power, the harnessing of Nature's forces to supplement man's puny physical potential, is the key to all material advancement. Our aim has been and should continue to be to encourage by every possible means the use of mechanical power. A limit to the available supply of power means a limit to human achievement. Yet if the use of power is to continue unchecked and the extension of the application of power in the advancement of man's conquest of the earth is to go on indefinitely, the supply of power must know no limitation.

Generally speaking, the idea of power presupposes fuel; for although it is possible to generate power, theoretically in any quantity, by utilization of solar energy direct by focussing the sun's rays for the concentration of heat, by utilizing the stored energy of the waves of the sea and the rising tides and the moving winds, and while a certain definitely limited although large amount of power may be derived from the natural water powers of the land—still, for the vast field of generally diffused power application, an inexhaustible supply of fuel must ever continue to be regarded as the grand desideratum for the fullest and unretarded extension of the principle of power for performing the work of the world and the lightening of the burden of mankind.

Fuel—the grand desideratum! But the visible supply is strictly limited and going fast,—according to these learned statisticians. But stay! What is it that is going so fast? Coal, oil, and gas. Fuels. But are these the only fuels that Nature has provided? What is fuel, and what is the nature or composition of these substances the deposits of which are stated to constitute practically our sole source of power for general purposes?

Quoting from a recent volume from the pen of Robert Kennedy Duncan, professor of industrial chemistry at the University of Kansas, entitled "The Chemistry of Commerce," the following is of particular interest: "The industries of the world use for fuel only carbon and the compounds of carbon, but other substances may be used instead. This was discovered by Prof. H. Goldschmidt, of Essen, in the use of aluminium for the production of heat."

This is indeed interesting and the "discovery" of Prof. Goldschmidt is indeed most timely and valuable. Fuel then as commonly understood, and those disappearing deposits of coal, gas and oil, are carbon and compounds of carbon; but other substances may be used instead of carbon and carbon compounds! What other substances, and where and how may we perhaps obtain and utilize them?

Let us get down to business, for this is serious business. Of course we all know perfectly well, when we really stop and take stock of our store of facts, that fuel substances are substances capable of uniting with other substances in the phenomenon of combustion. We know, of course, when we refer to carbon as fuel, that carbon is simply a substance capable of uniting with oxygen in combustion with the evolution of heat. That the oxygen which combines with the carbon and without which no combustion of the carbon is possible, is as much a fuel as the carbon. That, as a matter of fact, fuel strictly speaking involves the idea of two or more elemental substances mutually attracted by the mysterious force of chemical affinity which, under certain conditions, causes them to unite in the phenomenon of combustion.

It may be well to mention in passing that we also know that these elemental substances do not lose their elemental character by this process of combustion or union in a new chemical compound, but that carbon is still carbon and oxygen is still oxygen. The process of combustion has merely changed the physical form of one or all and united the atoms of the two or more substances in a new arrangement of molecules. Therefore when we are called upon to consider the question of a fuel supply, the problem before us must be, broadly speaking, to determine upon the elemental substances best adapted by Nature to produce the phenomena we desire, to consider the various involved problems of accessibility, or cost of getting, adequacy of supply, and adaptability to handling, storage, and transportation.

We have observed that carbon and compounds of carbon are universally employed as fuel substances, and it is readily understood why this is so from the fact that the element carbon is one of the most abundant and widely diffused substances in nature, existing in all three of the physical forms of matter—solid in coal, charcoal, and various organic compounds, liquid in the numerous hydrocarbon compounds, and gaseous in carbonic-oxide gas, marsh gas, etc. Its actual availability for fuel purposes is obvious, but for this purpose it appears to possess one serious inherent defect—that when combined with oxygen in combustion it retains the gaseous form acquired in the process, and the cycle by which it is freed from its union with its affinity and returned by Nature to its previous concentrated solid or liquid condition, so as to be again available as fuel, is so slow and complex that the restitution by Nature's own process of the stored deposits of the element in these forms bears no calculable relation to the present or prospective rate of dissolution of these deposits by the demands of civilization.

It is apparently in recognition of these facts that certain, I might say many, of the leaders of thought in this field are today urgently advocating the manufacture of alcohol for fuel and power purposes and are predicting freely that in this direction lies the solution of the fuel problem. The merits of alcohol as a fuel are fairly well understood by combustion engineers. Its manufacture may be considered as a sort of process of "short-circuiting" of the slow cycle of Nature, by which the carbon and hydrogen dissipated into the atmosphere in gaseous form by process of combustion are seized upon in transit, as it were, soon after their divorce from the affinity element oxygen, and hauled ruthlessly back to again be put through the fiery crucible of marital union.

In the issue of THE ENGINEERING MAGAZINE for August, 1908, Mr. Thomas L. White sets forth very clearly the relative advantages of alcohol as a fuel substance and describes an improved process for its production. The significant point is well made that alcohol fulfils at least one essential requirement of a permanent fuel supply. It is theoretically possible to produce it in unlimited quantity and it will therefore be perpetually available. So far so good. We have at least found one source of fuel supply—and a carbon compound too—upon which we may rely to the extent of its adaptability to our needs, with the assurance that the well is not going to "run dry" some time, stop our precious wheels and leave us to freeze. As to the cost per B.t.u of this particular fuel, and the unfortunate fact that we must handle double the weight and bulk of it to develop the same heating power as of the products of natural petroleum, these are quite secondary considerations. The main point for the present is the inexhaustibility of the supply.

But how about other possible sources of fuel? This idea of "short-circuiting" a slow natural process and so establishing an unfailing supply is certainly fascinating. Alcohol is good, but is it the only or the best fuel of which a permanent supply may be thus assured? Going through the list of substances known to be "combustibles" (and the list is long) we find many, nearly all, obviously quite unsuited to general use as fuel substances. We find, in fact, that the two familiar elemental substances, carbon and hydrogen, through their wide diffusion and universal availability and affinity for the oxygen of the air, represent practically the only available substances for general use.

How, then, about hydrogen? We have considered carbon and find that its one grand defect from the fuel standpoint is that when we burn it, it gets away from us in the form of gas and the best we can do is to win it back through the elaborate "short-circuiting" alcohol process. But, it will be said, alcohol actually contains hydrogen as well as carbon. True enough, but its manufacture, none the less, is a short-circuiting of the carbon cycle. The presence of the hydrogen is incidental, though exceedingly important.

We are familiar with the use of compounds of carbon with hydrogen, but while we deal constantly with carbon as a fuel in itself, while we are familiar with this element in a practically pure state as in anthracite and charcoal, we never hear hydrogen suggested as an independent fuel substance, to be burned as carbon is burned without admixture of any other combustible.

True, it is employed in the oxy-hydrogen blowpipe for the production of extremely high temperatures, and its gas has been used in many and various ways from the filling of balloons to the illuminating of interiors by the hydro-platinum lamp. But as to using this well-known and powerfully combustible element as a substitute for carbon fuels for general power and heating purposes, I cannot find that it has ever to date been suggested. And it is to lead up to and prepare the way for just this revolutionary suggestion that all the foregoing has been laboriously evolved and written.

Hydrogen for Fuel! And why not!

Let us investigate. "Its symbol is H. Its chemical equivalent is 1. Its heating value in combustion with oxygen is 60,000 B.t.u. per pound." So runs the familiar cyclopædic description of this strangely neglected fuel element. But what are the special qualifications of hydrogen as a fuel? Certainly we know it will burn, and we know its heating value per pound is four times that of the best coal; but where are the natural deposits or supplies of hydrogen? How is it to be obtained in any volume commensurate with the enormous demands for fuel, and further, how are we to deal with, handle, store, and transport such a volatile, elusive element? Pertinent questions all; and prompt, sufficient, and conclusive must the answer be if this proposal is to be taken seriously and this paper and the author preserved from the indignant denunciation meted out to hopeless fatuity.

Here are the answers, submitted in all humility but with the confidence born of a conviction that the conclusions herein set forth will be recognized by the profession as clearly and legitimately deducible from long-established facts of engineering and chemical science.

The first and all-important qualification of hydrogen for general use as a fuel substance is that the supply is inexhaustible.

The second and equally important qualification is that its natural cycle through the processes of isolation, combustion, and re-isolation is so short as to render feasible the continuous re-use of the same volume of fuel substance. It is an ideal "short-circuit."

A third important qualification is the practicability of absolutely perfect combustion. There can be no ash, no smoke or soot, no vitiating gases, for the sole product of combustion is water.

The fact of extremely high heating value per pound of combustible is interesting but relatively unimportant. The commanding merits of hydrogen as a fuel rest wholly upon other grounds.

But the source of supply! Granting the possession of these exceedingly important qualifications, how is an adequate supply of this most volatile of elements to be obtained, and how controlled, transported, and applied? And how about the cost of production? Let us refer for a moment to the second above described "qualification."

Suppose it be suggested that, "the continuous re-use of the same volume of fuel substance" materially alters the aspect of the question of supply. And this brings us to the necessity of enunciating the new conception as to fuel and power—new only in the sense that a theory may be new because never before formulated and put into words though the facts upon which it is based may long have been of common knowledge.

Professor Robert Kennedy Duncan calls it "the new knowledge" —this wedding of science with industry, this application of the newly appreciated but long recorded facts of physical chemistry to the actual work of the industrial world. And it is this "new knowledge"—or rather, in the particular case of power production, this belated application of old knowledge—that is to lead us out of the present existing "chaos of confusion and waste" into a more orderly and rational condition of affairs, whence we may look to the future with confidence, fearing not that our progress may be halted and the very existence of our treasured industries threatened by the exhaustion of some definitely limited natural resource.

The new thought or theory—there is no pretense that it involves new or even special *knowledge*—concerning power and its concomitant commodity, fuel, which constitutes the actual inspiration and foundation of this article, may be embodied in a brief statement conveyed by three words: Power Costs Nothing!

A startling statement, more startling even than the proposal to employ hydrogen for fuel. In fact, the suggestion that this element be used for fuel purposes is merely a corollary of the main proposition.

Power costs nothing! Literally true, though apparently at odds with the most obvious facts of human experience. Power is free.

It is only the harnessing that costs. Obviously true, on reflection, in the case of abstracting power from a water-fall; but when we burn fuel and generate steam to drive engines or when we consume hydrocarbon liquids in an internal-combustion engine, then does not Nature exact an equivalent in fuel consumed for every foot-pound of mechanical energy yielded us, and are we not compelled to expend and exhaust the natural deposits of fuel in order to generate power? Only in the most superficial sense does Nature exact an equivalent, and we laboriously extract and expend these definitely limited and ill-adapted fuel elements purely as a matter of empirical choice and not at all from necessity.

We burn coal, oil and gas simply because some one, a few years ago, observed that they would burn and because certain individuals for their individual benefit exploited these substances as fuel. Is carbon or any available compound of carbon a better fuel substance than hydrogen? Is such material more suitable in any way for the production of heat, light or power? Are such substances more universally available, more readily obtained, stored, transported or applied?

What would be the answer of the physical chemist to such a question? Have the users of fuel, the users of power, ever *asked* the chemist—the only person who has actually any means of knowing—any such question, or has the chemist on his own motion ever considered the problem and offered a suggestion? If so it is not recorded in the history of modern industry. We have simply accepted blindly, unquestioningly, the fuel thrust upon us by those who had it to sell, have paid the price and endeavored with all the cunning of skilful mechanics to devise mechanisms and methods to extract the available heat energy and convert it to our uses. And so long have we pursued this unthinking course, and so schooled have we become in this idea that Nature is niggardly in the matter of her boundless resources of energy and demands that something be destroyed, consumed, or irrevocably offered up as the price of utilizing for a moment the smallest unit of her everflowing cycles of force—something which we call fuel, for which we must dig and pay and which when once "consumed" is gone forever and cannot be replaced—that the very thought or suggestion of free power, costing nothing for fuel substance, exhausting no physical resource or store of material, is only receivable as relating to the accidental and occasional opportunity offered by a flowing stream, a water-fall, the moving wind, or some such manifestation of Nature's restless elements in motion.

Yet it is the purpose of this discussion to insist and demonstrate that power for general purposes, *fuel power*, generated through combustion of fuel, may be and shall be universally obtained henceforth as free of actual power cost, *fuel cost*, as is the case where we harness the energy of Niagara and capture thousands of horse power of energy at the mere expense of the harnessing.

The cost of harnessing is the sole legitimate cost of power. Nature does all the work. Man never "generated" or "took from" Nature a single horse power of energy. When we place a water wheel in the path of a flowing body of water we are simply interposing in the cycle of a natural manifestation of energy. Some well-intentioned but misinformed poet once sang, "The mill will never grind with the water that is past," and we have taken his word for it ever since, though any ancient physicist could have written that the mills of the earth may and do grind over and over again with the water that has passed them many times. The fact is, as we well know, that the mills may go on forever using the same water over and over again, for kindly Nature is continually busy gathering up the spent water and restoring it to its higher level so that its potential energy is again available for man's use for power.

And in precisely the same way is Nature constantly at work restoring to their original form the elements metamorphosed by man's operations in the harnessing of the potential energies of fuels. In the case of "carbon and the compounds of carbon," those fuel substances which are now being "wasted" at such an alarming rate, the impending shortage is due solely to the fact that the "carbon cycle" is a very slow, long, and complex one. The carbon we burn today will be again available as fuel some time in the dim future after it has served its purpose in the evolution of plant life. The only trouble is that when we have caused an atom of carbon to unite in combustion with its two atoms of oxygen, the subsequent natural dissociation of the two elements and the restoration of the carbon to an available concentrated form is such an exceedingly deliberate process, and the intermediate diffusion of the element is so great, as to render the fact and process of such cycle and restoration of no practical benefit to the present generation.

We have already observed how, in the manufacturing of alcohol, this cycle may be "short-circuited" and the carbon recovered long before it has completed the natural cycle which would restore it to the form of coal. And we have observed how the first and most important effect of this is to place in our hands the key to an inexhaustible source of fuel.

Let this then be regarded as the prime requisite of a universal and scientific fuel substance; a short natural cycle. For it must now be plain that if a fuel be employed capable of passing quickly through its cycle of combustion, rarefaction, condensation, and dissociation, we have reduced the question of a source of supply to an absolute minimum; since, as the fuel may thus be immediately recovered and re-used, a supply merely adequate to "stock the cycle" or reach around the circle is all that is required.

Here then, we have the answer to the question as to a supply of the proposed new fuel and the key to its adaptability above all other known fuel substances, for the natural cycle of hydrogen is an ideal "short-circuit." We burn it. It combines with eight times its weight of oxygen. The combustion is perfect and the product of combustion aqueous vapor, immediately condensable and susceptible to ready decomposition and yielding ready to hand not merely our original volume of hydrogen but the oxygen requisite for its immediate recombustion. Is the inference plain? Does not every reader know these facts? and does not every possible question find here its answer —that we shall derive our supply of both hydrogen and the oxygen needed for its combustion from the waters of the earth, that we shall simply insert or interpose our mechanisms or harness in a natural *fuel cycle* and derive unlimited supplies of power by intelligently "short-circuiting" a naturally simple and expeditious cycle of one of Nature's elements.

As to the important question of the particular mechanical or chemical means to be employed in bridging the one natural gap in the hydrogen cycle, the decomposition of the water, this must be regarded as a purely manufacturing operation. That it can be readily accomplished is, of course, as well known as are all the other facts entering into the composition of this new theory of power production. The details of a practical process adapted to the particular requirements of any particular field of power development may well be left for elucidation at another time and place.

It is, however, desired at this time to present only the suggestion that the threatened "fuel famine" is in the nature of a purely imaginary disaster, since we have but to turn from the curiously purblind policy of "seeking afar at great labor and pains" a supply of something which, in far more adaptable form, lies in measureless abundance at our feet, to be had for the taking without labor and without price.

EDITORIAL COMMENT

Panama in Washington.

THE recent domestic aspects of the Panama Canal affairs (as distinguished, that is, from anything contained in an actual survey of the field work) have been marked principally by further investigations and renewed criticisms. The investigations this time are of alleged irregularities in the award of contracts, and the criticisms are a revival of the attack on William Nelson Cromwell as the evil genius of the Administration at Washington. In the former we take no stock whatever. The evidence, the appearances, and the traditions of the military service now in control all lead to the belief that the work is being managed in a fair, straightforward and honorable manner. Of William Nelson Cromwell's relations with the great national undertaking we expressed our opinion four years ago. Whatever his motive or his methods, he succeeded, in a time of great stress and danger, in securing ends most desirable for the nation, but with the acquisition of the Panama Canal from the French company a point was reached where the path of Mr. Cromwell's advantage and that of the country's best good began to diverge

Some of the charges now revived are amusing. Mr. Cromwell, for example, may have used, but certainly did not create and could not have created, the weight of professional opinion before the societies and in technical magazines in favor of the Panama route. That he had any other than proper and permissible interest in the sale of the French property to the United States, is speculative. The price was regarded by unimpeachable appraisers as being very advantageous to the United States, and this judgment has been endorsed by the most impartial judges abroad. If, however, there was any arrangement by which Mr. Cromwell and his associates received much of what was supposed to have gone to the unfortunate French investors, we feel quite sure the facts can not be discovered. But that Mr. Cromwell had a close personal interest in certain claims additional to the $40,000,000, we have strong reason to believe; and we have strong reason to believe, also, that Mr. Cromwell's displeasure fell upon those who opposed the admission of these claims, and that through influence upon the Administration (which influence we consider malign) he succeeded in breaking and sweeping from his path those who advised the Administration against paying for the items in question. Because we believed it to be improper for Mr. Cromwell to be both adviser to the Government and a strenuous advocate for claims adverse to the Government we said in March, 1905: "We seem to have reached the point where the ways fork, and where the interests of Mr. Cromwell and the interests of the country follow different paths. For our part we are unfalteringly loyal to the welfare of the United States, and to the best of our ability we shall endeavor to advance it, wherever that course may lead us. At present, it seems to lead directly away from Mr. Cromwell."

It still seems to us to lead away from him.

Progress on the Isthmus.

THE reports of progress of work in the field at Panama have become less specific during the past year, but general figures of excavation suggest that the maximum possible under the present plan of steam-shovel work has been reached in the attack on the Culebra cut. During 1906 the monthly total of earth removed in the Culebra section rose from 120,000 cubic yards to 307,000 cubic yards; during the twelve months of 1907 it climbed to 1,025,000 cubic yards; in March, 1908, the climax of the curve apparently was reached at 1,290,000 cubic yards—the dry season this year thus showing a very much smaller proportionate increase than was exhibited last year. In September the total is back to 1,122,000 cubic yards; the average for the year has been barely above the figures for December eleven months ago. According to competent authorities, this is far below the results which should be obtained by a carefully worked out scheme for arranging and advancing the steam shovels and for moving the dirt trains between the shovels and the spoil banks or other points of disposal. If, as has generally been accepted, the time required for the Culebra cut is a key to the time required for the Canal, a higher rate of progress here would mean earlier completion of a serviceable waterway.

Railroad Rates and Efficiency.

IT would be curious and interesting—and also very satisfactory—if, when the excitement of the campaign is over, and public attention returns to the freight-rate question, that question should be found to have disappeared with the disappearance of the deficit which supplied the leading if not the only argument for the proposed advance. In many directions there is already distinct enlargement in production and manufacture, and hence in traffic; and in some of the grain-raising States traffic has already increased to the car-shortage point. It will probably soon become clear to all that the conditions from which the railroads argued the necessity of a substantial advance in freight charges were but temporary and such as they must be expected to endure as part of the common lot.

If this is made manifest the impropriety of raising rates as a remedial measure should be convincingly apparent. It would be less reasonable, indeed, than it would for the steel maker or the copper producer to raise prices when demand fell off.

The question is a large one. The layman who approaches it is warned away with the admonition that he has not the wide and intimate knowledge necessary for its intelligent discussion; but most of those who have this wide and intimate knowledge are necessarily in the railroad service and committed to the railroad point of view. In general, however, typical returns from some of the larger railroads shows an almost level line for the average receipts per passenger mile and only a slight decrease in the earnings per ton mile for many years past, and against the decline in the unit of freight earnings must be placed the reduction in unit costs secured during the twenty-year period by revision of lines, improvement of equipment, increase of train loads, and all the other reforms in which the railroads have taken so much pride. Legislation, further, has protected the roads from the very heavy drafts once made upon them for free transportation, preferential rates, and concessions to large shippers. It is our belief, as we have heretofore urged, that the best and indeed the only course for the railroads to pursue is to push the policy of betterment in operation—of efficiency in every department—through all the broad fields in the railroad organization which are still open to improvement. The way has been pointed in the work already accomplished on some of the transcontinental roads, and recognition of it is apparent in the interest and attention with which the results are being examined by eastern lines. If the period of depression stimulates this movement it will have worked a permanent good for the railroads of the United States.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

SHIPBUILDING IN JAPAN.

A REVIEW OF THE PRINCIPAL FIRMS ENGAGED IN THE INDUSTRY AND THE EXTENT AND CONDITIONS OF GOVERNMENT ASSISTANCE.

Engineering.

IN last month's issue of THE ENGINEERING MAGAZINE we reviewed in these columns an article on the progress of ship owning in Japan, which appeared in a recent number of *Engineering*. We promised at that time similarly to review a paper on the Japanese shipbuilding industry which was announced to appear in the same journal as a supplement to the former article. This promise we now fulfil by the presentation of the following abstract of the comprehensive article on this subject which appeared in *Engineering* for August 21.

"The three principal private shipyards in the country are the Mitsu Bishi Dockyard and Engine Works, at Nagasaki, with a branch at Kobe; the Kawasaki Dockyard Company, at Kobe; and the Osaka Iron Works, at Osaka. There are besides the Uraga Dockyard Company, at Uraga, in Tokio Bay, and the Ishikawajima Shipbuilding Company, at Tokio. These have at certain periods shown signs of great activity, but have at present dropped somewhat out of the running, except for repair work, and for this purpose the former has two fine graving docks. In 1906 the Uraga Dock Company, however, built two torpedo-boat destroyers for the Japanese Government, and last year the Ishikawajima Works turned out three small steamers, the largest 917 tons gross. In the same connection the Yokohama Dockyard Company may be mentioned, a very enterprising and firmly established company, in possession of two good graving docks. Except small vessels, such as steam-launches and motor-boats, this company has not at present ventured upon new construction, although, with some developments, a larger policy would seem to be well within its scope. Scattered throughout the country there were, in all, in 1906, 214 private shipyards, the largest number being in the Osaka district, 38; Hiroshima, 31; and Yamaguchi, 38. Most of these shipyards are engaged upon small craft, in many cases of junk build and rig only; but some undertake wooden steamers, and a few, though furnished with but few machines, consider the building of a steel ship by no means beyond them, the limit of size being, perhaps, 1,000 tons. The engines for these steamers are not very difficult to obtain. General engineering shops of small size are fairly plentiful throughout the country, and any one of these will undertake to build a marine engine when called upon to do so. In some cases the shipyard has a small machine-shop in which to do its own work, obtaining only the castings outside; in others the obtaining of a satisfactory boiler is a matter of somewhat greater difficulty, and the shipyard builds its own boiler as well as hull, obtaining the engines only from outside. The special shipyards that may be mentioned in this connection are:

Oaki's, at Shinagawa, Tokio (which, however, builds only wooden vessels); Ono's and Fujinagata, at Osaka; and Chujio's, at Tosa."

The Mitsu Bishi works at Nagasaki were originally founded by the Imperial Government in 1857 for the repair of small ships of war; they were purchased by the present possessors in 1884. During the first few years following the latter date the output of the works consisted chiefly of small steel vessels ranging from 200 to 700 gross tons. Their most remarkable achievement was the construction in 1895 of the 1,530-ton Suma Maru, the largest steel merchant ship built in Japan up to that date. Following the passage of the Shipbuilding Encouragement Law in 1896 an era of rapid development began. In 1898 was completed the Hitachi Maru, the first steamer exceeding 6,000 tons built in Japan, and since that year progress has been uninterrupted. The output of the works since 1900 has comprised 47 vessels of 117,791 total gross tons and 149,039 total indicated horse power. In recent years this company has built the majority of the ships of the Nippon Yusen Kaisha. A number of the latest vessels turned out by the Mitsu Bishi works have been fitted with Parsons turbines, for the manufacture of which the company holds the sole right in Japan. The works now cover some 114 acres; they are well fitted with complete equipment for building hull, machinery and boilers, and with the special machines for producing turbines.

"The works at Nagasaki are also admirably suited for repairs, possessing three graving docks, with a length on the keel-blocks of 350 feet, 510 feet, and 714 feet respectively, and a hauling-up slip. A branch of the Mitsu Bishi Company was started in 1903 at Kobe, on a scale that will allow of very great developments in the future; at present this branch is laid out principally for repairs. A floating dry dock with a lifting power of 7,000 tons was inaugurated here in 1905. A second dock, for the same purpose, but with a lifting power of 12,000 tons, is at the present time under construction at the Kobe works."

The works of the Kawasaki Dockyard Company also were started originally by the Imperial Government about 35 years ago; the organization of the present company took place only in 1896. The output since that date has been 95 vessels of 55,913 total gross tons. The number of men employed has risen from 1,390 in 1897 to 8,135 in 1907.

"In these works the ships have been mostly of moderate (and even small) size; they have included a large number of gun-boats for the Imperial Government of China, and a steam-yacht for the Government of Siam. During the past year and more, however, two large steamers for the N. Y. K. have been under construction, each with a gross tonnage of some 8,700 tons, and three cargo-steamers of about 6,000 tons for the O. S. K.; the yard and shops are equipped for large work, and contain all the plant needed for the construction of hulls and machinery. There is also a very fine graving dock, 377 feet long on the blocks, besides two hauling-up slips for repairs."

The Osaka Iron Works, including dock and shipbuilding yard, were founded in 1880 and have progressed steadily ever since. "They are spread over various parts of the principal river at Osaka, and comprise engine and boiler shops and a dry dock on the original site, some two miles from the river mouth, a dry dock nearer to the mouth, and the new shipyard at Sakurajima, on the shores of the recently made, and still unfinished, harbor of Osaka." The output since 1897 has been 62 vessels of 31,493 total gross tons. In 1898 the company employed 1,860, and last year 3,282, men.

"Summarising the total shipbuilding output of the country from private shipyards for eight years past, and including sailing vessels above 100 tons, and practically all steamers, the following table may be given:

	Vessels.	
Date.	Number.	Gross Tons.
1900	21	10,768
1901	39	31,771
1902	34	24,769
1903	47	29,591
1904	62	32,612
1905	127	32,858
1906	127	44,452
1907	135	73,682

With regard to naval shipbuilding, to which considerable space is devoted in the article under review, it must suffice to say that the Imperial dockyards are four in number, situated at Yokosura, Kure, Sasebo, and Maizuru. New construction is at present carried out principally at the first two named but the increasing dimensions of warships are severely taxing the accommodations in these yards. The other two, now used principally for repairs, have greater potentialities for extension and they may be expected to assume a much greater importance in the near future. Since 1899 launchings from the Imperial dockyards have comprised 64 vessels of 122,250 total gross. tons displacement and 314,225 total indicated horse power.

"The first law for the purpose of assisting the building and owning of ships in 'foreign' style was passed in 1870. The law which is at present in force was passed in 1896, and is to expire in 1914. In its relation to shipowning, provision is made for a payment of 25 sen (6d.) per gross ton per 1,000 miles, to ships under the Japanese flag, engaged in foreign trade, of not less than 1,000 tons (gross) and 10-knots speed. The amount of payment varies with size and speed, reaching a maximum of 60 sen per ton for ships of not less than 6,000 tons (gross) and 17 knots. The amount also varies with the age of steamers, the full sum being due for the first five years after launching, it is then reduced 5 per cent per year up to the fifteenth year, when it is entirely withdrawn. Ships taking advantage of this provision are granted a certificate called the 'Navigation Encouragement Certificate.' For competition with foreign companies the encouragement thus provided proved insufficient, and in 1899 a very important new departure was made. Special contracts were entered into with various Japanese steamship companies to run regular services on certain definite routes. The routes and companies obtaining the advantage of these subsidies are the European, Seattle, and Australian lines of the Nippon Yusen Kwaisha, the San Francisco line of the Toyo Kisen Kwaisha, the more local lines of the Osaka Shosen Kwaisha, and two or three other less well-known companies. For the European line the contract calls for twelve vessels, each of 6,000 tons gross and 14 knots speed; for the Seattle line three vessels, each of 6,000 tons and 15 knots; for the Australian line three vessels of 3,500 tons and 16 knots; for the San Francisco line three vessels of 6,000 tons and 17 knots. The number of steamers possessing the Navigation Encouragement Certificate in March, 1907, was thirty-two, of an aggregate tonnage of 105,000 tons. The ownership of these steamers was divided as follows:

Nippon Yusen Kwaisha, fourteen, of 60,530 tons.
Mitsui Bussan Gomei Kwaisha, eight, of 25,114 tons.
Osaka Shosen Kwaisha, six, of 10,405 tons.
Mitsui Bishi Goshi Kwaisha, two, of 5576 tons.
Government railways, two, of 3359 tons.

"The payment under this head was 961,779 yen* in 1907-8, estimated to be increased to 3,483,955 yen in 1908-9.

"The number of steamers owned by the six subsidised companies under contract to carry out the above-noted services were (early in 1907):

	Number.	Gross Tons.
Nippon Yusen Kwaisha....	78	253,363
Toyo Kisen Kwaisha......	6	35,279
Osaka Shosen Kwaisha....	100	110,741
Konan Kisen Kwaisha......	3	3,329
Daito Kisen Kwaisha.......	15	884
Oya Shosen Kwaisha.......	2	3,215

"The amount of subsidies paid in this connection was 6,756,763 yen in 1907-8, and is estimated to be 6,886,300 yen in 1908-9.

"In its relation to shipbuilding the law of 1896 provided for a payment on both hull and machinery: for the hull, when the gross tonnage is between 700 tons and 1,000 tons the rate is 12 yen, and when the gross tonnage is above 1,000 tons the rate is 20 yen per ton; for the machinery the rate is 5 yen per indicated horse-power actually developed upon trial, no payment, however, being made for machinery unless the tonnage exceeds 700, and the hull thereby entitled to its share. Steamers claiming these subsidies must necessarily be constructed in Japan; they must, moreover, comply with the shipbuilding regulations of the Japanese marine bureau. Up to March,

* Yen = 2s. 0.583d., or 49.8 cents.

1907, sixty-seven steamers, of an aggregate gross tonnage of 138,900 tons, had been built to take advantage of this law. Sixteen of these vessels, with an aggregate gross tonnage of 65,436, belong to the N. Y. K., and twenty-one, with an aggregate gross tonnage of 27,572, to the O. S. K.. The payment under this head was 677,348 yen in 1907-8, and is estimated to be 1,995,440 yen in 1908-9."

Mild steel shipbuilding material is produced in Japan only at the Government works near Wakamatsu, which were established in 1901. During the late war all material produced by these works was requisitioned by the Government but recently private builders have been getting a share of the output. Enlargements now under way are expected to increase the annual capacity of the plant to 270,000 tons, two-thirds of which at least will be available for structural purposes. Cast steel is produced in considerable quantities in a number of works.

The keen interest taken in the development of the Japanese shipbuilding industry is attested by the number of students under training in this subject at the Imperial University of Tokio. These now number 115. The course of study extends over three years, and while the practical part of their training is insufficient it is good so far as it goes. The theoretical training is well conceived and adequate.

POWER FOR HARBOR WORK.

A DISCUSSION OF THE RELATIVE ADVANTAGES OF HYDRAULIC AND ELECTRIC POWER FOR PORT AND DOCK MACHINERY.

Brysson Cunningham—Cassier's Magazine.

IT is now about fifteen years since electricity first made its appearance as a serious competitor with hydraulic pressure as a motive agency and source of power for port and dock machinery. The pronounced success of the first experimental plants installed led to the prediction that electricity would in a short time entirely supplant the older form of energy. The field of electricity has been enlarged by great and frequent advances but for certain important classes of machinery the use of hydraulic power still persists and, according to Mr. Brysson Cunningham, who writes on the relative advantages of the two forms of energy in *Cassier's Magazine* for September, is likely to retain its position. We give below a few extracts from Mr. Cunningham's interesting paper.

After a general summary of the prominent characteristics appertaining to each kind of power and to the modes of generation and transmission, Mr. Cunningham considers their special application to port and dock work. "The working appliances of an ordinary port may be broadly divided into two classes, with an intermediate section formed by a few implements common to both. The first class includes all powerful machines for working heavy loads at speeds which are not required to be very great. Such are dock-gate machines, large sluice penstocks, massive swing bridges and coal elevators. The second class comprises light-running machinery, dealing with variable, small or moderate loads at a fairly rapid rate, such as quay cranes and warehouse jiggers, of powers ranging up to 10 tons, but lying generally between 10 and 30 hundredweight. The intermediate division embraces appliances difficult to allocate definitely to either of these, as capstans, winches and the lighter kind of moveable bridges.

"Characteristic of machines of the first-class is their heaviness and uniformity of effort, necessitating gear of considerable strength. Furthermore, they may be said to possess a special and trying environment. Dock gates have to be closed at times in the face of atmospheric conditions of an extremely adverse nature, when any failure of power would be a serious matter. And here lies the advantage of employing the agency of the hydraulic ram, which is exceedingly reliable and simple, without any complex or delicate mechanism to get out of order at a crucial moment. Moreover, gate and sluice machines lie almost universally below ground level, and in such damp situations, unless special precautions are adopted, there are possibilities of leakage and breakdown in electric cables. It may, therefore, be laid down as a safe and definite conclusion that, in all exposed situations necessitating powerful machinery of fairly uniform capabilities, and, in fact, whenever loads are heavy, constant and slow moving, hydraulic power can be utilized to advantage; and this despite many excellent performances standing to the credit of electric machines devised for these very purposes. The question is not simply one of economy. Considerations of reliability and control are of prior and, indeed, of paramount importance, and they should outweigh even adverse financial reasons, which will not necessarily nor probably arise. Most engineers are satisfied that hydraulic machines are best adapted to this class of work.

"It is in connection with the second class of port machinery that the contest for supremacy is mainly fought, and conditions here are favourable to a more equal and exact comparison. It is relatively a simple matter to set an electric and a hydraulic crane to do work side by side under precisely similar circumstances of service and supply, such as could not possibly be the case with gate or sluice machinery. This has been done in a large number of cases, and we have the benefit of the results recorded.

"But while the quantity of evidence thus collected is not inconsiderable, and while much of it is extremely valuable, it is not infrequently apparent that the whole circumstances have not been taken into consideration. Very often an imperfect comparison is based on actual power expenses without reference to maintenance, and more often still without reference to capital expenditure. It is, on the whole, easy to show a result in favour of electric cranes working under variable loads, if cost of power alone be taken into consideration, for the hydraulic ram is not, as has already been stated, an economical machine for variable loads. Quay cranes which lift up to 30 hundredweights are mostly occupied in dealing with loads much below this limit, and this condition tells enormously in favour of the electric crane. Taking any ordinary class of goods, it is doubtful whether the usual load of a 30-hundredweight quay crane would average more than a ton or 25 hundredweights at the outside. In many cases it is as low as 12 or 15 hundredweights. It may be urged, of course, that this is one of the elements of the situation, and must be acquiesced in accordingly. Admitting this, it may also fairly be contended that other elements favourable to hydraulic power, such as prime cost, should not be omitted. A hydraulic crane costs considerably less than an electric crane, and, therefore, the current amount chargeable to interest and depreciation will be correspondingly smaller. As will be seen, this item plays an important part."

A table is given showing the comparative cost of working an electric and a hydraulic 30-ton crane. The results show a very close approximation to coincidence. Power costs for the electric crane are lower but this advantage is balanced by the lower interest and depreciation charges of the hydraulic installation. Considerations other than actual operating cost, however, throw the balance of advantage in favor of electricity for light quayside appliances. As regards the intermediate group of machines, their motive power will be largely determined by circumstances, both systems being equally convenient.

"Summing up the whole matter, it can confidently be stated that there is still ample scope for the employment of both electric and hydraulic energy in connection with port and dock work, and while electricity seems to have been gaining ground rapidly at the expense of its rival, this is only due to the fact that it is taking up a position of equal importance which has rightly belonged to it from the very first. For the future, the field lies open to both systems to extend their influence along the lines of their natural development, and there is little present prospect of either of them gaining complete possession and control."

THE STUDY OF BREAKAGES.

THE SYSTEMATIC STUDY OF FAILURES AN IMPORTANT SOURCE OF KNOWLEDGE OF THE STRENGTH AND BEHAVIOR OF MATERIALS.

Walter Rosenhain—British Association for the Advancement of Science.

IN an interesting paper read at the recent meeting of the British Association for the Advancement of Science, and printed in *Engineering* for September 11, Mr. Walter Rosenhain, of the National Physical Laboratory, emphasized the importance of the knowledge of the strength and behavior of materials to be obtained from the systematic study of failures of machines and structures. Except in cases where the failure involves the loss of life or limb, such investigations are rarely undertaken, to the great detriment, Mr. Rosenhain thinks, to the progress of engineering knowledge. We give below a brief abstract of his paper:

"The principal argument in favor of the careful study of breakages by modern scientific methods lies in the fact that such study opens up a large amount of valuable knowledge of the properties of engineering materials which is not otherwise obtainable. While in no way underrating the immense importance of the experimental study of materials in our engineering laboratories, it must yet be recognized that such experimental investigations do not, and cannot, reproduce the conditions of actual practice; in fact, for the purpose of rendering the results of the experiments more definite and direct, specially simplified conditions are chosen. In applying the results of such experiments to actual practice, there is therefore a certain residuum of uncertainty which engineers are well accustomed to reckon with by means of factors of safety, or by modifications of design resulting from practical experience of how such things behave in practice. In the great majority of cases these methods succeed in avoiding failure, but, as is well known, this is frequently done at the expense of economy or efficiency. Consequently all fresh knowledge that tends to bridge this gap of uncertainty must represent an improvement of our knowledge of the behavior of our engineering materials, and it is just the study of those cases in which the very fact of failure has shown that not only our knowledge of a definite kind, but our factors of safety and "teachings of experience" together have been insufficient to avoid breakage, that will ultimately enable us to correct our views where they are erroneous or insufficient. This incorrectness of our views may relate to the quality of the material in question, or to its mode of treatment by the manufacturer or user; it may relate to the use of a material good in itself, but not well adapted to the purpose in question, or it may be concerned with the effects of faulty design, defective workmanship, or even of unsuspected or, at present, incalculable stresses. When a failure occurs it may be attributed, according to the ideas or interests of the person concerned, to any of these causes, but only if full investigation takes place and the true cause of the failure is ascertained can the information thus gained be properly employed for the prevention of similar failures in the future. Nor must the manufacturer of materials, be they iron or steel, or other metals, assume that the investigation of breakages will always, or even in the majority of cases, lead either to a condemnation of his product or to the enforcement of more stringent tests; actual practice has shown that in many cases failures result rather from unfair or improper use of material than from inherent defects of the material itself. These are necessarily the most difficult cases to trace, and the investigator naturally inquiries into the quality of the material in the first instance, but in many cases mechanical, chemical, and microscopical tests show that the material itself is of good average quality, and the cause of failure is to be sought elsewhere.

"Again, in another direction the study of breakages may be of direct service to the makers of engineering materials. A frequent, and indeed nearly always an advisable, method of studying failures is to compare the broken article with a similar one which has given good service—this not only gives the investigator the means of applying the test of actual service to his conclusions, but incidentally it also throws valuable light on the relative importance of the various factors that are insisted upon by various specifications—and the effect upon the specifications is not by any means always in the direction of increased stringency. It is not rare to find that material which from the point of view of the usual specifications would be regarded as superior has failed, while material lying nearer to or even beyond the limits set by the specification has given good service. Of course, it is not suggested that any conclusions as to the correctness of the specifications should be drawn from isolated or even from a small number of instances of this kind, but the accumulation of such data, only derivable from a systematic study of breakages, would undoubtedly lead to a sounder appreciation of the relative importance of the various clauses of our specifications.

"Before passing on to the consideration of the various examples of investigations of failures which are presently to be described in some detail, it will be well to consider some of the principal causes of breakages, and the manner in which they may be detected from a study of the facts and materials of the actual cases; it must, however, be premised that the classification of causes of failure here given is not intended to represent a complete or final analysis of this great question. It is, in fact, only possible, by the use of somewhat vague general terms, to cover the principal classes into which these causes may be grouped.

"According to the stage at which the defect which has ultimately resulted in breakage has arisen, the causes of failure may be classed into three large groups:

Group 1. Defects arising from the manufacture of the material.

Group 2. Defects arising from incorrect treatment of the material during the process of construction.

Group 3. Defects arising during the life of the structure or machine.

The first of these groups is a very wide one, but a few typical cases may be mentioned in connection with steel, the most widely used of engineering materials. Steel may be defective on account of the presence of undue quantities of impurities, but there is a wide difference of opinion as to the quantities which should be considered "undue." Further, the distribution of the impurities through the mass of the metal is of great importance and the systematic study of breakages will gradually elucidate the whole of the vexed question of segregation and its effects on the soundness of the metal. A good deal of information as to the nature of the material in this respect may be obtained by chemical analysis of samples taken from different parts of the broken object and microscopic examinations of sections cut from appropriate parts of the material throw further light on the purity and uniformity of the metal. Mechanical tests, such as tensile, impact, alternating-stress, or brittleness tests, are useful to a certain extent, but it must be remembered that mechanical tests, while accurate and convincing as far as they go, can only reveal the condition of the metal at the time of testing. They cannot be relied upon to determine whether the defect is due to an inherent property of the material or arose from some process or treatment the metal has undergone at a later stage.

The quality of material supplied by the maker depends fully as much on the treatment it has undergone, since its first manufacture into ingots as on its chemical composition. Overheating or even burning of steel are frequent causes of failure. The latter defect may be easily recognized by microscopic examination, although, in case the metal has been heated by the user as well as by the original maker, it will not always be possible to determine at what stage the damage has been done. Overheated steel is readily recognized in the same way. While the damage done by burning cannot be removed by subsequent treatment, that due to mere overheating may be undone by proper reheating. If this has actually occurred, it may happen that certain pieces or certain patches of a single piece have escaped the refining operation and a weak piece may have been incorporated in a machine or structure. Such weak patches may be very small in area and careful examination of the immediate vicinity of a fracture should be made to avoid overlooking such a point.

When steel is supplied to the user in a partially finished condition, such as forgings ready for machining, many other possible causes of failure may have been introduced. Among these may be mentioned insufficient working by press or hammer, finishing at too high or at an excessively low temperature, and imperfect welding; and unequal heating or cooling of large pieces of metal and insufficient or unduly prolonged annealing. Defects arising from these causes usually show great diversity of structure, sometimes apparent to the eye at the point of fracture and always revealed by mechanical tests and microscopic examination.

The defects arising from improper heat treatment to which reference has been made may also be included in the second of the above groups, which also includes the sources of ultimate failure introduced by the various mechanical processes to which the material is subjected in the workshop. Such processes as punching or shearing may give rise to unsuspected weaknesses. Cold working of mild steel, commonly thought to impair the material very little on account of its great ductility, may be an exceedingly dangerous proceeding, particularly if applied at all locally. Local cold working seems to destroy the ductility, and the resulting brittleness, though local, may cause the failure of the entire piece. Undesirable cold working may usually be subsequently detected by regions of severe deformation. These are readily detected by the microscope and local brittleness is revealed by mechanical tests.

Under the third group are to be found a certain number of cases of failure, in which there is no sign either of defects inherent in the metal or due to injurious treatment; in these cases the metal has been subjected to undue stresses while in actual use. Actual faulty design, in imposing known but unduly severe stresses on sound material, is a very rare cause; a much more frequent and serious one lies in the operation of not readily calculable forces, such as the effects of thermal expansion and contraction in steam boilers and heat engines. Bearings thrown out of line by this or any other cause may set up alternating stresses which may result in the fracture of one of the parts affected. Undue stresses may be thrown on certain parts also by small errors in erection. In the investigation of these cases the fracture itself gives most useful evidence, since the details of the fracture of steel under various types of loading show characteristic differences.

Mr. Rosenhain describes at length four examples of failures investigated after these methods by the National Physical Laboratory, in which definite causes of failure were ascertained: the first, the inner tube of a large gun which developed internal cracks and finally failed, the cause lying in the inclusion in the original ingot of undue quantities of slag; the second, a boiler plate weakened locally by cold working; the third, a locomotive crank pin which had been weakened by a too severe hardening; and last, a failed steel shaft to which an unsatisfactory structure had been given in the forging process. He concludes:

"The above four examples have been taken, as typical cases, from a considerable number of others covering such objects as rails, pump-rods, and other parts of machines. It is hoped that the description of these actual cases may prove of interest to engineers, and may serve to show the extent to which the application of modern methods renders possible the detection of causes of apparently mysterious failures. No doubt cases may arise from time to time which baffle the resources of the investigator, but under favorable conditions considerable insight into such cases can be gained. These favorable conditions, which can often be realised by careful attention on the part of those under whose authority the fracture has occurred, may be summed up as follows:

1. Full information as to the exact circumstances of the failure, the service already undergone by the part in question, its origin, and any special circumstances concerning it.

2. Careful preservation of the fracture itself and of all portions of the fractured part, in order to avoid the covering up of important facts by the rapid accretion of dirt and rust which so frequently occurs."

THE USE OF STEAM IN THE SUCTION GAS PRODUCER.

THE CHEMICAL REACTIONS INVOLVED AND THEIR INFLUENCE ON THE DESIGN OF A PRODUCER FOR BITUMINOUS COALS.

Philip W. Robson—British Association for the Advancement of Science.

THE discussion on gas-power problems in the Engineering Section at the recent meeting of the British Association for the Advancement of Science centered to a large extent around the suction gas producer. The leading speakers commented on the steady growth of the demand for producers of this type and emphasized the convenience and reliability of the anthracite producer as a source of cheap power supply. A most interesting suggestion was made by Mr. Philip W. Robson, who believes that by proper design and proper regulation of the steam supply the elimination of the tar distilled from bituminous coal may be accomplished in the suction producer without the use of special cleaning apparatus. We give below an extended abstract of his paper:

"The principle of working all suction producers is similar: the gas inlet valve on the engine cylinder is directly connected to the producer, which usually consists of the furnace or generator coupled to a cooling vessel or scrubber. During the suction stroke of the cycle the inlet valve of the engine is opened, and the gas accumulated in the intervening pipes between the engine and the producer is drawn forward into the working cylinder together with a proper proportion of air. A corresponding amount of mixed air and steam flows into the furnace of the producer and reacts there with the fuel, with the result that gas is evolved of an amount equal in volume (after being cooled in the scrubber) to that drawn away. Hence the yield of gas entirely depends upon the suction effect exerted by the engine through the gas inlet valve; the latter being in turn under the automatic control of the engine-governor in the extent to which it is allowed to open causes the amount of gas to be automatically regulated to suit variations of load. All the attention that is necessary, therefore, whilst the plant is working is to keep the generator charged with fuel—an operation occupying from two to three minutes every two hours."

To obtain the highest possible efficiency the gas must be produced with a minimum of heat loss in the producer so that as large a balance as possible may be available for useful work in the engine. The only combustible gas obtainable in ordinary practice, that is, by the partial combustion of the carbon constituents of the fuel, is CO, the reaction being

$$2C + O_2 = 2CO \qquad (a)$$

but the production of this gas is attended by the evolution of 30 per cent of the heat of the carbon reacted upon. To obtain a reasonable degree of efficiency and to prevent very high temperatures in the producer due to the cumulative liberation of heat, with consequent excessive production of clinker and other troubles, the greater part of this heat must be recovered. This is accomplished in a very simple and practical manner by wholly or partially saturating the air supply with steam. The steam reacts with the incandescent carbon in two alternative ways,

$$C + 2H_2O = CO_2 + 2H_2 \qquad (b)$$
$$C + H_2O = CO + H_2 \qquad (c)$$

and in each case a combustible gas results. In addition to utilizing the liberated heat, the use of steam has the advantage of enriching the gas by the addition of hydrogen produced entirely apart from reactions with air, which in all cases carries four times its volume of inert nitrogen.

The decomposition of the steam begins at a comparatively low temperature, 500 to 600 degrees C. Since it is accomplished by means of the heat resulting from the reaction of the atmospheric oxygen and carbon, it may be said that, in general, the degree to which the reduction of steam according to either equation *(b)* or *(c)* can take place with advantage depends entirely on the amount of heat liberated in the production of carbon monoxide according to equation *(a)*.

By neglecting the radiation losses and heat losses in the scrubbers it is possible to make a simple calculation of the conditions under which the whole of the heat of the fuel can be accounted for in the gas produced. Such is the case if equation *(a)* is combined with equations *(b)* and *(c)* in the following proportions:

$$\left.\begin{array}{c} 2C + O_2 = 2CO \\ 0.95C + 1.9H_2O = 0.95CO_2 + 1.9H_2 \end{array}\right\} (d)$$

$$\left.\begin{array}{c} 2C + O_2 = 2CO \\ 1.18C + 1.18H_2O = 1.18CO + 1.18H_2 \end{array}\right\} (e)$$

Assuming the relative weights to be taken in pounds and the volume of gas produced in cubic feet, the gases produced in these two cases will have the following compositions and properties:

"In making the foregoing calculations it is assumed that the heat required for steam-raising purposes is obtained from the fuel consumed in the generator, and hence in establishing a heat balance the amount of heat required to vaporise the water has been deducted from the left-hand side of the equation in both cases. The only apparent difference in the efficiency of these two systems, therefore, lies in the fact that in the first more steam is used than in the second. It will be noted that the gas produced in the latter case is considerably richer than in the former.

"It is found, however, that there are further considerations which influence the efficiency of gas producers. At temperatures of 500 degrees C. and over, it is well known that carbon monoxide and steam, and also carbon monoxide and carbon dioxide, may react with each other, such reactions being reversible and depending upon temperature. These reversible reactions are usually written as follows:

$$CO_2 + H_2 \rightleftarrows CO + H_2O \qquad (f)$$
$$C + CO_2 \rightleftarrows 2CO \qquad (g)$$

In both cases the reaction tends from right to left at temperatures under 800 degrees C., above which they take place in the opposite direction; in other words, the carbon monoxide tends to become destroyed in a certain degree as the temperature of the producer is lowered. Further, the combined reaction according to equation *(d)* also tends to take place rather than the alternative according to equation *(e)* as the temperature falls. It is obvious, therefore, that in order to get the highest working efficiency the steam supply should be

	(d)	(e)
Total volume produced.		
CO	715 cu. ft.	1136.8 cu. ft.
CO_2	339.6 "	———
H	679.25 "	420.25 "
N	1430 "	1430 "
Percentage by volume.		
CO	22.6	38.06
CO_2	10.725	———
H	21.45	14.06
N	45.2	47.88
Weight of steam per pound of carbon	0.965 lb.	0.577 lb.
Air required per pound of carbon	50.5 cu. ft.	46.8 cu. ft.
Total volume of gas produced	3163.875 "	2987 "
Calorific value per cubic foot	151.5 B.Th.U.	179 B.Th.U.

regulated so that the temperature of the fire in the producer is kept as high as possible without making excessive clinker, seeing that a richer gas thereby results, and the reversible reactions tending to the destruction of carbon monoxide are avoided Professor Bone and Mr. Wheeler recently demonstrated the truth of this statement in an exhaustive series of experiments on a Mond producer. The fuel used contained 78 per cent. of carbon, and by varying the amount of steam in the air-blast from 0.45 pound to 1.55 pounds of steam per pound of coal gasified, the efficiency of the producer, including the steam for blowing engine, was found to fall from 77.8 to 66.5 per cent. Similar comparative results may be expected from a suction producer, and this drop of efficiency would appear to be due chiefly to the influence of the reversible reactions referred to. The efficiency of a good suction producer varies from 85 to 90 per cent, according to the conditions under which it is worked.

"The importance of properly proportioning the steam supply will be appreciated; otherwise, the best results cannot be obtained, and this is one of the points to which further attention might with advantage be given by gas plant designers. Given a properly designed producer, however, the conditions of highest efficiency can be automatically and continuously obtained without the slightest trouble whilst the plant is being worked by an ordinary attendant.

In the suction producer successful working depends also on the absence of any restriction to the flow of the gas from the furnace to the engine. A restriction causes a reduction of the weight of the charge drawn into the cylinder and the loss of power may make all the difference between success and failure. Simplicity in all directions is the essential condition for successful working. It is, however, difficult to attain in a suction producer for use with bituminous fuels. The tarry matter in the volatiles distilled off, unless previously removed, condensing in the scrubber and mains, quickly clogs them up, and, in addition, sufficient tar may reach the cylinder to interfere seriously with the working of the engine. The introduction between furnace and scrubber of sufficient cleaning apparatus to extract the tar would greatly increase the frictional resistance to the passage of the gas and would otherwise destroy the essential simplicity of arrangement.

"Attention has naturally been turned, therefore, to various methods by which the tar trouble can be eliminated, with the hope that it might prove possible to transform the condensable tarry vapors into fixed gases in the generator, so that the difficulty of tar extraction and additional cleansing apparatus generally could not arise at all. Attempts have been made to decompose the tar by working the producer on the down-draught principle, which has the effect of compelling the volatiles to pass through the hot zone of the furnace before leaving the producer. By another plan the gas outlet is in the middle of the producer, and air is supplied both at the top and at the bottom, the action which is aimed at being to use the upper half of the producer as a down-draught furnace for distilling and fixing the volatiles, while the lower half is supplied with the residual coked fuel, and works as an ordinary up-draught furnace. It is, however, extremely doubtful whether a successful solution of the difficulty will be arrived at by either of these two methods. In pressure producers many plans for reducing the tar within the producer by passing the volatiles through the hot zone of the furnace have been carefully tried from time to time, but without a sufficient measure of practical success to warrant the permanent adoption of any of them for use with bituminous steam coal such as is available here. There appears to be no reason for thinking that modifications of these proposals when applied to suction producers will prove to be more efficacious.

"The calculations previously given in this paper would appear, however, to suggest a better method for attacking the problem. It has been shown that all the sensible heat liberated by the combustion of the carbon of the fuel with the oxygen of the air could be absorbed by the reduction of the steam passing into the furnace along with the air, and that the precise amount of steam which can be reduced depends entirely on the amount of heat which is so liberated. Further, when we account for the whole heat of the carbon in this way, and take into full consideration the diluent effect of the nitrogen which is unavoidably present, a gas of sufficient calorific value results for use in the engine cylinder.

"There would, therefore, seem to be no reason why the furnace of the producer should not be devised in such a way that the volatiles are absolutely burnt out after being distilled, the heat of this combustion being afterwards recovered by the decomposition of steam under the conditions already described. The final heat balance would be exactly similar to that established by the combined equations already given, and in practice a gas of about 150 British thermal units calorific value might reasonably be expected, and which is quite suitable for engine work. By such a method the tar would undoubtedly be eliminated, whilst the efficiency of the system would be high. There are several designers at work on producers of this character, and when the proper proportions and other practical details are understood a considerable measure of success may be hoped for; the simplicity of the cooling and scrubbing arrangements under this system gives good promise of the feasibility of evolving a practical suction plant for use with bituminous fuels. The ordinary plant, however, for gas coke or anthracite may still be expected to hold the field for units up to 100 brake horse-power."

A NEW METHOD OF EXTRACTING OIL FROM BOREHOLES.

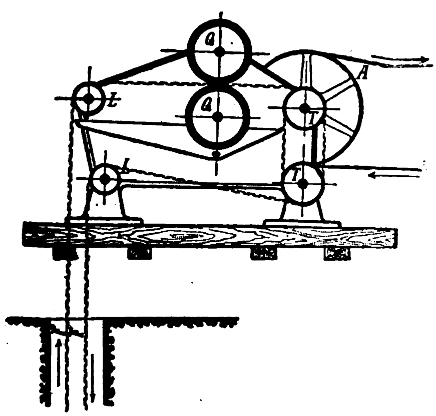
A DESCRIPTION OF THE LEINWEBER PROCESS FOR HOISTING OIL BY MEANS OF AN ENDLESS TRAVELLING HEMPEN BAND.

Scientific American Supplement.

A NOVEL process for extracting oil from boreholes to meet special conditions at the Kryg oil field of the Galicia-Carpathia Petroleum Company in Austria has recently been evolved and put into successful operation by Mr. Bruno Leinweber, an engineer of Vienna. This field, the wells of which belong to the "non-spouting" class, is situated in a very inaccessible part of the country, and the ordinary types of pumping machinery could be used only with considerable risk to the continuity of operation of the plant, owing to the difficulty of effecting repairs or renewals in its isolated situation. The laying down of elaborate pumping installations was avoided by Mr. Leinweber's simple process, of which we take the following description from the *Scientific American Supplement* for September 26.

"Briefly described, the Leinweber system consists of the lowering of a band of suitable material into the borehole and the passing of it through the liquid, whereby a certain quantity either becomes absorbed by the cable or clings to it, by which means it is hoisted to the surface and squeezed out by passing between rollers, the extracted oil falling into a suitable receptacle below. By connecting the ends of this band together an endless cable is procured, which, together with a continuous drive, enables extracting to be carried out uninterruptedly. The principal advantages of this system are that the band can be lowered into the narrowest fissures, the width of the band being designed to suit the conditions. The simplicity of the apparatus in both design and operation reduces the risk of breakdown to the minimum. Its applicability to the raising of any description of crude oil, whether thick or fluid, irrespective of the presence of sandy or other foreign substances which in a pumping plant are liable to cause clogging of the apparatus, is universal. Its highly efficient yield is secured with the minimum of expense.

"The general design of the apparatus may be gathered from the accompanying diagram. The endless band traveling up and down the borehole is represented by *F*, in the pit, the lower end passing through the oil deposit. The ascending cable after issuing from the borehole passes over the upper pulley leader *L*, then between the pressing rollers *Q*, round the winding sheave *T*, and thence into the borehole again over the lower pulley leader *L*, the mechanism being driven through the pulley *A*. In the case of the apparatus for the Kryg oil field, a few minor modifications had to be made in this design to coincide with local requirements, but fundamentally the principle is the same throughout. As will be seen, the whole of the apparatus is carried upon a timber frame, which can be placed at any desired height above the ground. The Kryg apparatus was constructed in the railway workshops at Reichenberg, Bohemia, under the superintendence of the railroad engineer, Mr. Oskar Forster, and was sent to the oil field ready for instant use upon arrival. The fact that the mechanism can be dispatched to any inaccessible point ready for immediate operation constitutes a prominent feature of the invention.



ELEVATION OF THE LEINWEBER APPARATUS.

"The endless band employed has flattened sides similar to those used on elevators, and up to depths of 1,640 feet is manufactured of hemp, being 3 inches wide by 0.31 inch thick, having a breaking strain of 9,240 pounds. This band is covered with carpet shag 2.36 inches wide by 0.078 inch thick, the pile of which offers a greater absorbing surface to the oil. For depths exceeding 1,650 feet a steel wire band is preferable to the hempen cable."

The first tests at Kryg were made under a number of disadvantages. The borehole at which the apparatus was first set up was nine inches in diameter and 2,000 feet deep, but owing to the severe cold the upper part only of the pit could be used and the band had to be considerably shortened. The carpet shag had become frozen and clogged with snow and considerable difficulty was experienced in lowering it into the pit, an operation which occupied about ninety minutes. The winding jack was operated by hand and the highest speed attained was 8 inches per second. The operations of carding out the carpet shag after passing through the mangling rollers and of removing the oil clinging to the edges of the band by means of scrapers were dispensed with. Despite these disadvantages, however, a yield of about 4.86 ounces per foot or 658 pounds per hour was obtained on oil rendered by the intense cold about the consistency of fruit jelly. "As the band became better adapted to the work, the yield increased to 6.13 ounces per foot or 763 pounds per hour. Subsequently steam power supplanted the manual labor, and at a speed of 3 feet per second the output at 6 ounces per foot rose to over 3,518 pounds per hour, giving a total yield per day of twenty-four hours of 84,432 pounds." The apparatus is now operating continuously at another borehole at a depth of 2,000 feet with entire success.

"It has been found necessary to reduce the absorbing capacity of the band, since when operated under the most economic conditions, the yield of the apparatus exceeds the capacity of the borehole. For instance, with a band approximately 5 inches in width by 0.5 inch thick, covered with shag having pile one inch in thickness and driven at 15 feet per second, the yield is 3.66 pounds of paraffin per foot per second, which is equivalent to approximately 396,000 pounds per hour. Since the construction of the machine above described and now in operation at Kryg, the inventor has considerably reduced the proportions of the band, and at the same time reduced the driving speed, so that the band may be rendered more durable with an added freedom from breakdown. Owing to the nature of the material used for the band, it can be lengthened or shortened according to requirements with facility and expedition, since the joints are effected merely by cobbler's thread sewn either by hand or by an ordinary saddler's machine. It has been found too that at no matter what speed the apparatus is driven, there is always a comparative absence of vibration, and that as the band becomes saturated with oil it runs still more smoothly, with an increased adhesion at the winding sheave, with less stiffness in the rope. Owing to the increased weight of the oil-charged ascending rope, it maintains an almost vertical line in the borehole, so that no losses are incurred by friction with the sides of the pit. The Kryg machine before being sent to the oil fields was submitted to severe tests with an overload of 2,500 pounds beyond the 550 pounds which was the stipulated weight of the ascending cable when charged with oil, and the band did not show the slightest signs of slipping or jerking during elevation to the surface at the highest speeds."

The Leinweber apparatus can be applied to any type or size of borehole by simply altering the dimensions of the rope. The presence of sand in the oil does not interfere with its operation in the slightest degree. Its efficiency can be regulated within wide limits by varying the speed, the width of the band, or the thickness of the pile covering, while the denser the fluid it has to raise, the greater the yield per foot at normal speeds. No part of the mechanism is liable to derangement, the only wearing part being the band, which can be repaired at any time without dismounting.

The withdrawal and insertion of the band are simply and easily effected, by securing the descending or ascending side of the band to the frame of the machine. Water in the borehole is drawn up with the oil and is easily eliminated, while sand suspended in the oil is removed by a steam or water flush. With the band running continuously there is no danger of the borehole becoming obstructed. The apparatus automatically locks the band in case of breakage and stops the winding sheave in case any undue strain is brought upon the rope. Once set in operation, the apparatus requires no further attention whatever beyond the periodical inspection of the cable, which can be followed while travelling, so that it can be run day and night without cessation.

AN ELECTRIC HARDENING FURNACE.

HARDENING IN A BATH OF A FUSED METALLIC SALT IN THE FURNACE OF THE ALLGEMEINE ELEKTRICITÄTS-GESELLSCHAFT.

C. R. Straube—Elektrotechnische Zeitschrift.

THE difficulties of hardening high-speed steels were very clearly summarized in Mr. O. M. Becker's article on the barium-chloride hardening process in the August issue of this magazine. The very important influence on their properties of small temperature differences in heat treatment was pointed out and it was shown that the method of hardening by means of a fused bath of barium chloride or other metallic salt offers greater opportunity for close temperature regulation than any of the older methods. Mr. Becker described a gas-fired furnace which, he says, is well adapted for use with this process. In the *Elektrotechnische Zeitschrift* for August 6, however, C. R. Straube describes an electric furnace controlled by the Allgemeine Elektricitäts-Gesellschaft of Berlin, which would seem to possess marked advantages for this work over the various types of externally fired furnaces. We give below a brief description of this furnace and its operation.

The bath of fused metallic salt is contained within a firebrick crucible, in two opposite sides of which are fixed electrodes of iron very low in carbon, the melting point of which is at 1,500 to 1,600 degrees C., higher than that of any steel. The crucible is entirely surrounded with a thick layer of asbestos which in its turn is imbedded in a layer of some refractory heat-insulating material, the whole being held together by a steel case. The walls of the furnace are built of such a thickness in relation to the dimensions of the crucible that after 10-hours' operation at a temperature of 1300 degrees C. the steel case may be touched with the hand without injury. Heat conduction is thus reduced to a minimum.

The soft iron supply conductors to the electrodes are connected to the secondary copper bars of a regulating transformer, which transforms the normal voltage (110 to 550 volts single phase) to the low voltage (5 to 70 volts) employed in the operation of the furnace. Auxiliary electrical apparatus consists of a controller attached to the transformer, a throw-over switch and a small switchboard. The latter carries a circuit breaker for the primary main, an ammeter and a voltmeter. A typical arrangement of the hardening equipment of a large works has the furnace, provided with a hood, in a central position, the auxiliary electrical equipment on the one side and the quenching tank immediately beside the furnace on the other. By this arrangement temperature change in carrying the pieces from the furnace to the tank is reduced to a minimum. Heating and cooling coils in the tank are supplied with steam or cold water so that the temperature of the quenching bath may be regulated at will.

A pure metallic salt or a mixture of several salts is placed in the crucible and fused by the passage of an electric current. The salt used is varied according to the nature of the steel to be treated, the desideratum being to employ a salt or a mixture with a melting point very close to, but below, the eutectic temperature of the steel. Thus, potassium chloride, fusing at 775 degrees C., is used for carbon steels, barium chloride, fusing at 950 degrees, for high-speed steels, and mixtures of the two give intermediate temperatures. For temperatures between 200 and 400 degrees potassium and sodium nitrates may be used, and for temperatures between 1300 and 1600 degrees, fluorspar and magnesium fluoride. The fusion of the salt is brought about with the help of a moveable electrode and a small piece of arc light carbon which is placed in the circuit between one of the fixed electrodes and the moveable one, the latter being connected to the other fixed electrode by a cable. Sparking between the carbon and the moveable electrode causes the salt immediately adjacent to melt and very soon a circuit is set up through a part of the salt. As the moveable electrode is gradually drawn away it leaves behind a streak of melted salt which is extended by degrees to the opposite electrode. When this point is reached the fusion of the remainder proceeds at a rapid rate.

The temperature produced depends, of course, on the voltage employed. While the bath is being melted a higher tension is required to overcome the higher resistance than during normal working. The temperature may be varied by altering the intensity of the current, and this is easily accomplished by means of the regulating transformer which is so constructed that a certain number of primary windings may be switched on or off. The regulating controller has two contact paths, each with five contact points. The gradations between the points on the lower path are subdivided through the whole of the upper path, so that 25 different intensities of current and degrees of temperature may be obtained by the use of the controller alone. This number may be doubled by bringing in another group of coils by the simple throwing of a switch. The 50 degrees of temperature available through manipulation of the switches may be varied through very small gradations by the use of various salt mixtures. Electrolytic effects are hardly perceptible at a frequency of 25, while they are practically absent at a frequency of 50.

Recently a new design of this furnace has been perfected which permits of the direct connection of the transformer to a three-phase system. In the transformer the three-phase current is changed by the Scott method into two-phase current. The latter is supplied to the bath through four electrodes, one on each side of the crucible, so that the three-phase furnace is really a combination of two two-phase furnaces. The temperature can be made practically constant throughout the bath. It is easily adjusted to within 10 degrees of that required by means of a suitable pyrometer, a piece of apparatus which is essential to the successful working of any hardening plant. A layer of about 10 millimetres below the surface of the bath is from 10 to 20 degrees colder than other parts but throughout the remainder no greater variation than 3 degrees has been found.

In externally fired furnaces the heat losses are always very large, particularly at high temperatures, and only a fraction of the total energy used in heating the muffle is utilized in raising the temperature of the metal. A further disadvantage of the gas- or oil-fired furnace is that when used at high temperatures the crucibles are rapidly destroyed. A temperature of 1350 degrees is attainable for laboratory tests but is not usually practicable for commercial hardening. Even at this temperature, however, the damage to the crucible of the electric furnace is very small. Working ten hours per day, the walls last for six months and at lower temperatures, for nine months or longer.

THE PROBLEM OF AERIAL NAVIGATION.

THE POSSIBLE UTILITY OF AERIAL FLIGHT AS AN AGENCY IN COMMERCE.

Prof. Simon Newcomb—The Nineteenth Century.

IN a long article in *The Nineteenth Century* for September, Prof. Simon Newcomb, President of the Astronomical and Astrophysical Society of America, discusses the possibilities of aerial navigation as an agency in commerce and for military purposes. It might be thought, he says, that there can be no better ground for now limiting what may be hopefully expected from the "conquest of the air" than there was a century ago for limiting what could be expected from the development of steam navigation. Reasoning from general principles only, he shows that the difficulties in the way of rendering aerial navigation of importance commercially are entirely dissimilar to those which have been overcome in perfecting the steam engine, the telegraph, or the telephone. His dispassionate conclusions as to the practical utility of aerial navigation, should the airship ever reach a stage of development approaching the limit of possible improvement, are in most refreshing contrast to the highly imaginative predictions indulged in by many writers.

In the first place Prof. Newcomb draws attention to the distinction between advance in knowledge and progress in invention. To the possibilities of the future of knowledge, or to the results which may be reached by its advance, no definite limit can be set. If some means were to be found for controlling or reversing gravitation, if radium could be produced for power purposes by the ton instead of by the milligram, if some metallic alloy could be found having ten times the tenacity and rigidity of steel, all our forecasts relating to future possibilities in the application of power would have to be revised. Inventors, however, are not seeking to discover new sources of radium, to find new alloys, or to bring out laws of nature hitherto unknown. They are accepting physical principles and the facts of engineering as they now stand. Forecasts of the possibilities of aerial navigation must be based, therefore, upon the present state of science, and can relate only to what is possible through invention being continued on the lines it is now following.

During the last century the application of power has been approaching fairly well defined limits which can never be extended except by some revolutionary discovery of which there is now not the slightest indication. There is a certain amount of energy stored up in fuel, which may possibly be utilized in the application of power. A great problem of invention has been to reduce to the minimum waste of this energy. There is a limit to the power which can be exerted by an engine of a given weight, a limit which is being approached in the light airship motors. The resistance and supporting power of the air are phenomena which no invention can change. No progress in invention will increase the weight which a given volume or surface of air will support at a given speed, nor can the resistance experienced by a surface in moving through the air ever be reduced below the point set by physical theory. Prof. Newcomb, however, presupposes an ideal vehicle, one in which every part is so nicely adjusted that the maximum of efficiency is reached with the least possible weight, and the best devices used to diminish friction and insure the application of all the power available in the fuel to the purpose of driving.

Two systems of navigating the air are now being developed, the one that of the flying machine, of which the only form yet found feasible is the aeroplane supported by a rapid movement of translation; and the other, the airship proper, floating in the air by its own buoyancy and not held up by propulsion. There are several drawbacks to every form of flyer which, taken together, would seem to throw it out of the field of competition. The greatest of these drawbacks is inherent in the theory of its support by the air. It must present to the latter a horizontal surface directly proportional to the entire weight to be carried, including motor, machine and cargo. Any enlargement of the machine must, therefore, be in a horizontal direction; a machine, for example, to carry two men instead of one must have its superficial extent doubled. It is readily apparent from the dimensions of the present successful flyers that any important enlargement would necessitate a practically unmanageable area of supporting surface with a consequent weakening of the machine. Fuhther, to secure the necessary strength, every extension must involve increased weight per square yard, which will be less and less compatible with its performance.

The flyer, supported only by its motion through the air, can never stop in flight to have its machinery repaired or adjusted. This disability constitutes a practical difficulty which seems insuperable. No engine built by human skill can be guaranteed against accident, much less the delicate motors necessary in the flyer; and a transportation vehicle, the slightest accident to whose propelling machinery involves in all probability the destruction of the vehicle, as well as danger to the lives of the passengers, can hardly be expected ever to prove of great practical utility. Another serious limitation upon the flyer is that it cannot be navigated out of sight of the ground, and must descend at once if enveloped in a fog, this necessity arising from the deviation of the apparent direction of gravity which must be produced by any change in the inclination of the supporting surface, through the consequent acceleration or retardation of the speed.

Neither of the first two drawbacks mentioned above is incident to the airship. As her buoyant power is proportional to her cubical contents and not merely to her superficial surface, she can be enlarged in thickness as well as in length and breadth. Further she may possibly stop for repairs while the flyer never can. This faculty carries with it a large range of possibilities which make the problems of airship navigation, neglecting the differences in the supporting media, to a certain degree analagous with those of steam navigation. In the latter it is axiomatic that the larger the ship the more economically can a ton of cargo be carried at a given speed. The same principle applies to the airship. The larger she can be built the more economically she can be driven when we measure economy by the ratio of carrying power to cost of running. The limits to her possible size cannot be set by any principles of physical science. The question is simply one of constructive engineering—how large can a manageable airship be built?

But it may be inquired whether the cheapening of transportation by steam power during the last century has not practically done away with all the supposed advantages of flight through the air, which appeared in so strong a light to former generations. Careful thought will show that, leaving aside exceptional cases, like that of striving to reach the Pole, the substitution of aerial for land and water transportation is at bottom the substitution for the solid ground of so imperfect a support for moving bodies as the thin air. In rail transportation the greater part of the propulsive power is expended in overcoming the resistance of the air. An airship of the highest possible perfection, if presenting to the air no greater surface than that of the train, would encounter a large fraction of the same resistance when traveling at the same speed. But, as a matter of fact, owing to the necessary size of the airship of equal capacity, the resisting surface would be vastly greater and the means of overcoming this resistance by adequate propulsive power would be more imperfect and expensive. In addition, fuel consumption would be greater in the airship capable of carrying the same burden as the train, on account of the increased propulsive power required.

This view may appear in conflict with the principle already mentioned, that increased economy will be gained by increasing the size of the airship, but it must be remembered that the economy is measured by the ratio of cargo carried to fuel consumed. It must always cost more to run a large ship than a small one. Economy is gained only when we increase the dimensions of the airship so that she will carry more cargo than the ocean steamer or the railway train. The projector of an airship who would successfully compete with the steamship in ocean traffic must not permit his modesty to suggest beginning with dimensions less than a length of half a mile and a diameter of 600 feet. His ship might then be able to carry some 10,000 tons of cargo or 15,000 passengers, and it would be only through these great possibilities that economic success would be reached.

In practical operation, the wind will affect the speed of the airship by the whole of its velocity, both in actual retardation and acceleration and in directions across the line of motion of the airship. Another difficulty will be the difficulty of finding the destination and effecting a landing in foggy weather. None of these drawbacks arises merely from imperfections in the present development of the airship, but they are inherent in any form of aerial vehicle, no matter how perfect.

There may be exceptional cases in which the airship will supply a more effective means for attaining an end than any other at our command, as for instance for reaching the Pole. She may also be of some value in warfare. Her possible usefulness in reconnaissance, though easily exaggerated, is obvious, but she can never be made an effective fighting machine or means of transportation. Her vulnerability, her great size, the impossibility of operating at night or in a fog and thus concealing her operations, the difficulty of navigating in a wind, all combine to make the idea of using the airship for invasion quite chimerical. If the airship is used at all for military operations it must be at such a height above the ground as to be outside the range of bullets or machine-gun projectiles, which can easily be fired directly upwards to a distance of at least two miles. The only rational fear is that airships may be able to drop explosive bombs into fortifications or upon the decks of warships. At a height of two miles the air is rarer by about one-fourth than at the earth's surface and this reduces in a still greater proportion the weight of projectiles the airship could possibly carry. Every ton of projectiles carried to a height of two miles would require more than 5,000 cubic yards of gas in the balloon and the task of seriously injuring a modern fortification by dropping explosives into it will be at least an expensive one. As for the danger to ships of war, the difficulty of striking a rapidly moving target with a projectile dropped from so unstable a platform as that of the airship renders it practically negligible.

SULPHUR DIOXIDE FOR FIGHTING MINE FIRES.

A STATEMENT OF ITS ADVANTAGES OVER THE COMMONLY USED CARBON DIOXIDE.

Walter O. Snelling—American Institute of Mining Engineers.

CARBON dioxide has been frequently used, and with considerable success, in combating mine fires by the production of an atmosphere incapable of supporting combustion. The gas for this purpose is produced by the reaction in large wooden boxes of sulphuric acid and limestone and it is led in large pipes to the location of the fire which is entirely closed off by tight brattices. Though simple and effective the method is expensive, and the high cost coupled with the risk of producing an explosion by the reduction (by the heated carbon) of the carbon dioxide to carbon monoxide has prevented its general application. Mr. Walter O. Snelling in a paper recently communicated to the American Institute of Mining Engineers suggests that a much more cheap and safe method may be found in using sulphur dioxide instead of carbon dioxide. We quote at length from this paper which is published in the *Bulletin* of the Institute for September.

"The use of sulphur dioxide in combating mine fires has not, I believe, been previously suggested or tried, and yet the method presents such decided advanmay be found in using sulphur dioxide that it seems proper to suggest the advisability of considering it as a cheap, convenient and safe means of fighting stubborn mine fires.

"One ton of brimstone, costing from $20 to $30, will produce about 25,000 cubic feet of sulphur dioxide gas, and allowing for all sources of loss it is probable that sulphur dioxide gas can be produced for about $1,300 per 1,000,000 cubic feet. For carbon dioxide gas, produced by the action of sulphuric acid on limestone, a good estimate would be $4,000 per 1,000,000 cubic feet, provided that sulphuric acid and limestone could be obtained at a small cost. Even under these favorable conditions it will be seen that carbon dioxide is about three times as costly as sulphur dioxide, and under ordinary conditions the advantages on the side of sulphur dioxide would be much more marked.

"Sulphur dioxide is more efficient than carbon dioxide in the putting out of fire. Neither coal nor any other combustible material can possibly burn in an atmosphere containing any considerable quantity of sulphur dioxide. Sulphur dioxide is very heavy, being almost twice as heavy as carbon dioxide (1 cubic foot weighing 81 grains, while 1 cubic foot of carbon dioxide weighs 56 grains). and this heavier weight of the sulphur dioxide is also an element which leads to increased efficiency, since the readiness with which the air present in the interstices of a pile of burning coal will be displaced by any inert gas is dependent upon the density of the gas, and as sulphur dioxide is twice as heavy as carbon dioxide, it will have about twice the efficiency of the lighter gas in displacing the air from piles of burning material, and thus removing the oxygen available for continuing the combustion. Another important effect of the greater density of sulphur dioxide is that its cooling effect upon a bed of incandescent coal is greater, volume for volume, than with a less dense gas.

"None of the dangers incident to the use of carbon dioxide is present with sulphur dioxide. No explosive lower oxides are produced or can be produced by the reduction of sulphur dioxide. Still more important, the danger always present when using carbon dioxide, of men getting into the gas without knowing of its presence, and suffocating, is absent when sulphur dioxide is used, since its strong odor gives instant warning when but a small fraction of 1 per cent of the gas is present in the air.

"Any leakage of carbon dioxide from a mine can only with great difficulty be detected. Frequently, in places where this method has been applied, it is probable that millions of cubic feet of the gas have escaped through unknown fissures in the rock. Any leakage of sulphur dioxide would quickly make itself known, and the openings could accordingly be closed before more than a small portion of the gas had escaped.

"The keeping of oxygen-helmets as emergency apparatus at coal and other mines is believed to be increasing in the United States, and it is to be most strongly advocated. When such oxygen apparatus is at hand it will nearly always be possible to send men from time to time to see if the mine-fire is extinguished before turning the ventilation into that portion of the mine. Most forms of rescue-masks can thus be worn in an atmosphere of sulphur dioxide, so it is possible to know definitely when the fire is extinguished, and when it is safe to turn in the fresh air. But when the sulphur dioxide method has not been used, the large amount of carbon monoxide present is likely to be a source of danger to the person wearing the helmet, since it is an interesting fact that some of the simpler patterns of rescue-helmets which may be worn with safety in an atmosphere of sulphur dioxide are found to be but little protection when worn in an atmosphere containing much carbon monoxide. The reason for this is not clear, but it is most probably due to the greater permeability to carbon monoxide of the leather or other fabric of which the rescue-mask is made, the lighter carbon monoxide passing through the fabric with greater readiness than most other gases.

"The extremely simple manner in which sulphur dioxide can be produced, the cheapness of the method, and the efficiency of the gas in putting out fires, seem to make this a desirable means of combating mine-fires. The safety of the method, its convenience, and its utility in showing fissures which allow escape of gas and ingress of air, are also strong points in its favor. The following comparison of the physical properties and cost of producing sulphur dioxide and carbon dioxide will be of interest.

	Sulphur Dioxide	Carbon Dioxide
Molecular mass.	64.	44.
Mass of 1 liter..	2.87 g.	1.97 g.
1 cu. ft. weighs.	81.18 g.	55.78 g.
1,000 cu. ft. weighs.......	178.48 lb.	122.71 lb.
1,000 cu. ft. requires........	89.24 lb. sulphur.	300 lb. H_2SO_4 296 lb. $CaCO_3$
Cost materials per 1,000 cu.ft.	$1.35	$4.00
Cost of 1,000,000 cu. ft........	$1,350.00	$4,000.00

"In effectiveness, safety, and other considerations the advantages are also in favor of the sulphur dioxide."

RAILLESS ELECTRIC TRACTION.

A NOTE ON THE SUCCESSFUL SYSTEM LATELY INSTALLED AT MÜLHAUSEN, GERMANY.

F. Douglas Fox—British Association for the Advancement of Science.

IN the course of a long paper dealing exhaustively with the comparative economics of omnibuses and electric tramways for street transportation in towns of moderate size, read before the British Association for the Advancement of Science and printed in *Engineering* for September 18, Mr. F. Douglas Fox gives some interesting details of one of the latest installations in Europe of the railless electric traction system, that at Mülhausen, Germany. So successful has this project proved that it has been adopted as the model for a system about to be installed at Dundee, and Mr. Fox believes that when the pre-eminent suitability of the system to the solution of transportation problems under certain special conditions is more fully known, its use will be rapidly extended. We quote in its entirety this part of his paper.

"However much the electric omnibus, driven from accumulators, may yet be improved, the cost of the batteries added to that of the rubber tires, will in all probability limit its use to those circumstances where a fairly good revenue is to be obtained. The possibility is still a remote one of battery power being reduced in cost, and of some cheap substitute for rubber being found to reduce these items of working expense to a level with the cost of operating cars upon rails.

"Electricity has, however, in the method known as the 'trackless trolley system,' of operating road vehicles by overhead wires, entered the field of highway transportation with much more likelihood of favorable competition with both the tramway and with the light railway. The peculiar facility with which, by this system, both passenger and goods traffic can be handled over the same line, the latter not requiring the expense of rubber tires, renders this method probably the most economical system of highway transportation which has yet been devised.

"On the Continent of Europe numerous installations of electric road traction are in operation for the transportation of both goods and passengers, in which the driving current is obtained from aerial conductors, and taken by a swivelling contact-boom, having sufficient lateral freedom to enable the car to deviate in either direction sufficiently to pass other vehicles.

"These installations date from the year 1901, and each year sees not only fresh lines opened, but also installations of greater importance are being undertaken. Seven of these lines are in operation in Germany, one in France, and three in Italy. The Italian Government is said to have in contemplation the utilization of the public highways for this mode of transportation upon an extended scale.

"One of the latest of the projects, now well on the way to completion, is that of Mülhausen, in Alsace. The city, of 100,000 inhabitants, is already supplied with a tramway system, but it was found necessary to further connect the suburbs with these tramways, and also with one another. It is also desired to obtain better access to the Public Gardens during the summer months. The traffic was, however, estimated to be too light to render a tramway profitable. The corporation appointed a commission to report first as to whether any means of communication could be made remunerative, and secondly, as to what means to adopt.

"The complete scheme was to be for six and three-quarter miles of route, on which 550,000 car-miles were to be made per annum. The Commission reported on three alternative proposals:

1. For a very cheaply constructed tramway for which plans and specifications were prepared by their own engineer.

2. For a service of motor omnibuses operated by benzine engines, for which several tenders were made by manufacturers of these vehicles.

3. For a 'railless traction' line of electric omnibuses with aerial conductors.

"The line to the Public Gardens has gradients as steep as 1 in 12; the zone line is comparatively flat. The estimates were to include a fixed charge of 4 per cent. interest upon capital. The conclusions of the committee were, that the electric omnibus (trackless trolley system) was the only method having prospects of commercial success, and the installation was therefore contracted for, and is now under partial operation. The digest of the estimates is as follows:

—	Tramway	Benzine Omnibuses	Electric Omnibuses with Aerial Conductors (Trackless Trolley System).
Total cost..	62,530*l.*	23,581*l.*	25,050*l.*
Total cost per mile of route	9,260*l.*	3,500*l.*	3,700*l.*
Expenses per car-mile, including repairs, renewals, depreciation, and 4 per cent interest	7.30*d.*	9.45*d.*	5.13*d.*

"The benzine omnibuses and the electric vehicles were of about the same capacity; the tramcars would have given considerable more accommodation.

"The prices of labor for both construction and operation are lower in Germany than in England. The tariff is correspondingly low.

"The Mülhausen line is interesting, not only from being the longest yet undertaken upon this system, but also from the severity of the gradients. The corporation decided that the Public Garden line should precede the zone route, and that the brake tests should be such that the braking of either axle independently should be sufficient to hold the car on the steepest gradient, and also to bring it to a standstill in the shortest possible time. Also, that these tests should be carried out in winter. The road is of macadam saturated with tar by a new German process, which attains a smoothness almost equal to that of asphalt, and much resembles 'tarmac.'

"The car is steered and driven on the front axle, the wheels of which are rubber-tired, the rear axle having steel tires; both axles are supplied with mechanical brakes, and the front axle with an electric brake. The car accelerates and maintains speed on the gradient of 1 in 12 without any trouble; the single forward brake-gear is sufficient for holding the car, but the braking of the tired wheels on the rear axle has required modification. During a recent visit paid to this installation by Mr. Bertram Douglas Fox, chief electrical assistant to the writer's firm, the car was put through all the tests required by the authorities, and the performances were satisfactory. This section of the line is now opened for traffic. On some of the lines in Germany goods transportation is being carried on upon the same lines as a passenger business without any inconvenience, the former being handled by trains of cars hauled by a double-ender electric locomotive, the cars being provided with a coupling and steering device which compels them to follow the exact course taken by the locomotive.

"Making all due allowance for cheap labor in Germany, there appears good ground for the view that this method brings electric transportation upon highways into a possible competition with any other method of handling traffic. At the figures of working expense estimated by the Mülhausen committee, such a system could pay its way in this country with the smallest revenue earned by any tramway in England, even allowing for the higher rate of wages here than in Germany.

"As to the respective fields for the electric omnibus with accumulators or with overhead wires, these may be defined by the question as to whether overhead wires are permissible, and also whether, in the former case, the traffic is sufficiently heavy to cover the extra cost of the batteries. The two systems may be viewed as complementary, because in many problems of urban transportation it may be found expedient to operate different sections of the same city on one or the other method. Taken together recent advances point to the probability that in this way electricity has entered upon the field of transport upon public highways, to do as much for it as it has done for transport upon railways."

THE PRE-COOLING OF PERISHABLE FREIGHT.

METHODS, ADVANTAGES AND POSSIBILITIES OF PRE-COOLING IN RAILWAY REFRIGERATION.

Dr. Joseph H. Hart—Railroad Age Gazette.

COMMENTING on the slow progress made in adapting mechanical refrigeration to railway transportation in THE ENGINEERING MAGAZINE for December, 1907, Dr. Joseph H. Hart mentioned the air-cooling system as the most efficient in use for certain classes of freight and as one of the few systems which offered reasonable assurance of success in further development. In the *Railroad Age Gazette* for September 4, the same author calls attention to the remarkably rapid extension of the system and gives an interesting discussion of its advantages and possibilities from which we quote at length below:

"The installation of pre-cooling plants for the preparation of fruit and vegetables before transportation is a phase in the application of refrigeration to the transportation business which is rapidly attaining unusual proportions. A number of interesting results in regard to the effect of pre-cooling and the absence of this feature in railway transportation have been fully set forth in a bulletin in the process of publication by the Bureau of Plant Industry of the United States Department of Agriculture. Under best conditions for pre-cooling it takes from 18 to 24 hours to cool oranges or other fruit in bulk to a temperature at which decay is impossible, and even under these circumstances portions of the fruit are cooled considerably below the danger point at which freezing occurs. In the average shipment of oranges from California cooling occurs at such a slow rate with natural ice refrigeration that the oranges often arrive in New York before the pre-cooling stage is complete or the processes of decay stopped. Being then transferred to cold storage warehouses they receive during this process an increased impulse toward decay, augmented very greatly by the fact of their previous condition for a comparatively long period. The result is that their resistance to the ordinary processes of decay is much diminished, and even if maintained in cold storage they do not possess the quality obtainable from fruit placed immediately in cold storage, and this latter feature is especially noticeable in their keeping qualities. Thus both from the shipper's and consignee's end suitable refrigeration in transportation has become almost an absolute necessity, and this satisfactory refrigeration, at least for temporary conditions and conditions capable of alleviation, can be produced by the installation of suitable pre-cooling plants. Government experiment plants exist in California and the South and a number of railroads have erected plants of the pre-cooling type in both sections. The chief difficulty in this process of pre-cooling is the length of time which must elapse in order to accomplish this. Generally from 18 to 24 hours is required to cool oranges or other fruit in bulk to a temperature at which decay is impossible, and even under these circumstances the refrigeration is unsatisfactory owing to abnormally low temperatures in certain sections. Wherever installed, however, these plants will undoubtedly prove a commercial success not only on account of the saving in shipments due to diminution in decay and the better quality of the shipment after transit, but on account of a larger number of other factors which enter as well in limiting the efficiency of the transportation process.

"Thus, pre-cooled fruit requires less ice for its transportation, since the sole duty of the ice under these circumstances is to maintain an initial temperature. It is even advocated that pre-cooling be used during the period when ventilation is the prevailing method and icing is not necessary. With pre-cooled fruit, packing can be much closer and ventilation is not nearly as necessary and need not be as thorough. Thus, oranges have been recently shipped to New York City in car lots of from 549 to 584 boxes each, an increase of more than 40 per cent over the standard car of 384 boxes. This increase in capacity is due not only to closer packing, but higher packing as well. In many refrigerator cars during the icing period it is impossible to fill the car on the top tiers without very considerable loss due to the fact that the temperature is much higher at all times in the top of the car than in the bottom. With pre-cooling and ventilation only the average rise in temperature at the top of the car is from 8 to 10 degrees and at the bottom about half of this. Even with this rise in temperature the average temperature of the fruit on arrival is usually lower than it is in cars under standard icing and the same conditions of weather and temperature.

"Pre-cooling plants consist of several distinct types. the car cooling unit and the package cooling type. In the former the cars are packed for shipment in the ordinary way and run on tracks into a refrigerating apartment, where they are cooled in a number of ways. The United Fruit Company has a number of interesting plants of the former type for the refrigeration of bananas during transportation, and by utilizing pre-cooling plants has been able to eliminate refrigeration in transportation entirely. Bananas, however, represent a comparatively easy phase of the problem for solution, maintaining their condition best at a temperature of from 55 to 65 degrees. However, this is from a refrigerating capacity viewpoint alone, since they are a very delicate fruit which when once ripe cannot be prevented from decaying and for this reason are always cut green and shipped to this country. A large proportion of this fruit is landed in New Orleans and shipped all over the country and takes from eight to ten days to deliver it in various sections. A typical plant at Springfield, Mo., consists of a train shed with four lines of track capable of cooling 10 cars each. A large refrigerating machine cools off, by means of brine circulation, large quantities of air which are conducted by overhead troughs along the top of the cars and connected by canvas chutes to the various ventilator openings. By this method of air cooling the cars can be reduced from about 75 degrees to 60 degrees in 12 hours. They can travel for about two or three days before the temperature rises to the danger point again. In Los Angeles a somewhat similar plant exists for the pre-cooling of oranges in car lots. The Southern Pacific and Santa Fé Railroads in this section have developed a number of types of pre-cooling plants and private interests have entered the field, and there are government experimental plants in this section and in the South as well. An ordinary cold storage plant is in reality a pre-cooling plant of one type; it employs the package system. The freight or commodity should be installed in the cold storage plant house two or three days before shipment, but this involves the handling of the material twice and a considerable loss on this account. The train or car system of pre-cooling is undoubtedly superior from an efficiency point of view, although it requires a slightly longer time for the production of the required temperature. The chief difficulty in the pre-cooling plant is due, from an economic viewpoint, to the fact that its duty is essentially temporary and that it must have a large capacity due to various overloads at certain times. Thus one railroad system was recently compelled, in California, to ship in about 20,000 tons of ice to take care of about 20 per cent additional of the citron industry, the shippers of which had decided to use icing instead of ventilation. This represents the chief phase of the difficulty from the railroad viewpoint, the variability of the demand and the character of it at the option of the shipper. Under these circumstances satisfactory results can be attained only by municipal endeavor. A very large number of the smaller communities throughout the southern states have their own ice-making plant and cold storage warehouse and the installation of a pre-cooling addition to this represents a phase for legitimate progress. Again, it is undoubtedly a function of such communities to see that the terminal facilities are adequate to meet the demand, since in some respects it seems entirely outside the province of railroad work, or at least beyond the satisfactory solution by them under present economic conditions. The fact that in some localities more especially favorable the railroads have gone ahead in the installations of such plants is additional warrant for their good faith in this business and their attempt to install satisfactory working conditions. One of the chief difficulties at present arising from the outcry against the railroads in regard to discrimination on account of car shortage and terminal facilities has resulted in an attempt to give all parties equal service with the result that none is satisfactory and the general car movement has been much reduced due to readjustment at division points with this object in view.

"That the problem to the railroad is an essential one is without question. Not only cannot the demand for refrigeration be accurately foretold from crop conditions, but immediate weather conditions enter as well. The requirement for railroad refrigeration is for an extremely mobile and transportable refrigerating plant embodying all the increased efficiency of the mechanical refrigeration system in the production of the icing and one capable of operating in large units and under what are often regarded as inadequate conditions by the refrigerating engineer. Results can only be attained by the co-operation of the various communities among themselves and in conjunction with the various railroads involved in the problem as well."

THE ENGINEERING INDEX

THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE

The following pages form a descriptive index to the important articles of permanent value published currently in about two-hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

CIVIL ENGINEERING

BRIDGES.

Bascule.

A Remarkable Bascule Bridge at Syracuse, N. Y. Illustrates and describes a trunnion bascule bridge of 44 ft. span over the Oswego canal, located on a sharp skew. 3500 w. Eng News—Sept. 24, 1908. No. 95360.

Blackwell's Island.

The Construction of the Manhattan Approach of the Blackwell's Island Bridge. Illustrated detailed description. 2500 w. Eng Rec—Sept. 5, 1908. No. 94868.

Cables.

See Manhattan, under Bridges.

Concrete.

Data on 32 Concrete and Reinforced Concrete Bridges (20 Highway and 12 Railway), Including Yardage, Cost, Etc. Gives detailed records of material, cost, etc. 5500 w. Engng-Con—Sept. 2, 1908. No. 94859.

Culverts.

See Sewers, under Municipal.

Manhattan.

The Cables of the New Manhattan Bridge. H. R. Cobleigh. Illustrated description of the manner of stringing the wires of the supporting cables. 1500 w. Ir Age—Sept. 17, 1908. No. 95203.

We supply copies of these articles. See page 326.

Masonry.

The Design of Many-Span Masonry Arch Bridges (Calcul des Ponts en Maçonnerie à Plusieurs Arches). Henry Lossier. Describes the simplest method. Ills. 6000 w. Génie Civil—Aug. 15, 1908. No. 95114 D.

A Three-Hinged Masonry Arch with Metal Joints and Concrete Superstructure. M. Henri Tavernier, in *Ann. des Ponts et Chaus.* Illustrated description of an arch bridge near Lyons, France. 1000 w. Eng News—Sept. 10, 1908. No. 95010.

Piers.

Repairing the Concrete Pier of a Bridge by Injection of Liquid Cement Mortar. Trans. from *Génie Civil.* Describes methods used on a bridge over the Kiel Canal. 1000 w. Sci Am—Sept. 26, 1908. No. 95335.

Reinforced Concrete.

Light and Heavy Bridges (Ponts Lourds et Ponts Légers). A. Pendariés. Illustrated detailed description of a remarkably light, strong and cheap reinforced-concrete bridge over the Canal du Midi at Toulouse. 10000 w. Rev de Métal—Aug., 1908. No. 95104 E + F.

See also Concrete, under BRIDGES.

Removal.

Removing the Madison Avenue Bridge, New York. An account of the removal of a drawbridge and erection on temporary site to carry traffic during the construction of a new bridge on the old site. Ills. 1200 w. Eng Rec—Sept. 19, 1908. No. 95231.

Steel.

The Life of a Modern Steel Bridge. Editorial on means of lengthening their life. 1200 w. Eng Rec—Sept. 19, 1908. No. 95225.

Some Historic British Bridges. Illustrates and describes several large bridges of engineering interest and their construction. 3000 w. Eng News—Sept. 17, 1908. No. 95220.

Flood-Resisting Bridge Construction in the Western United States. H. A. Crafts. Illustrated descriptions of special bridge design and erection for California mountain streams. 800 w. Cassier's Mag—Sept., 1908. No. 94735 B.

The Reconstruction of the Central Spans of the Colesberg Bridge, Cape Colony. Illustrated description of the erection of new girders for three spans of this bridge in South Africa. 1500 w. Engng—Aug. 28, 1908. No. 94949 A.

See also Ganges, under WATERWAYS AND HARBORS.

Viaducts.

The Erection of the Sawyer's Canyon Viaduct. Illustrated description of methods used for a steel viaduct of 286 feet extreme height, in Idaho. 2000 w. Eng Rec—Sept. 26, 1908. No. 95382.

CONSTRUCTION.

Amusement Devices.

The "Flip-Flap." Illustrated description of an amusement device at the Franco-British exposition. 1200 w. Sci Am—Sept. 19, 1908. No. 95238.

Beams.

Notes on the Behavior of Beams. E. H. Fish. Compares actual results and theory. 2500 w. Am Mach—Vol. 31. No. 39. No. 95328.

Bins.

Methods and Cost of Constructing Concrete Silos. Information of value. 2000 w. Engng-Con—Sept. 9, 1908. No. 94998.

Building Removal.

Moving a Large Brick Factory Building. Illustrates and describes the methods used in moving a 5-story brick building in Chicago. 1800 w. Eng Rec—Sept. 19, 1908. No. 95227.

Campanile.

The Rebuilding of the Campanile of St. Mark's at Venice. Describes the original structure, its fall, and reconstruction now in progress. Ills. 1800 w. Eng News—Sept. 24, 1908. No. 95358.

Concrete.

See Roads, under MUNICIPAL.

Concrete Blocks.

See Sewers, under MUNICIPAL.

Demolition.

The Removal of the Trainshed of the Grand Central Station, New York. An illustrated account of methods used in demolishing this large shed while in full service. 4000 w. Eng Rec—Sept. 19, 1908. No. 95230.

Excavation.

See Panama Canal, under WATERWAYS AND HARBORS.

Failures.

Failure of a Water Tank Tower. W. H. Kellogg, Jr. An account of an accident to a steel tank at Grand Rapids, Mich. 800 w. Eng News—Sept. 24, 1908. No. 95366.

Floors.

A Study of the Elasticity and Resistance of Reinforced Concrete Floors on the Siegwart System (Studio del Comportamenta Elastico e delle Condizioni di Resistenza di un Solaio in Cemento Armato Constituito di Travi Tubolari Tipo Siegwart). Carlo Parvopassu. Mathematical. Ills. Serial. 1st part. 6000 w. Ann d Soc d Ing e d Arch Ital—July 15, 1908. No. 95119 F.

Foundations.

The Substructure of the Pope Building, Cleveland, Ohio. Illustrated description of the use of steel sheet pile cofferdams in constructing the foundations for a 10-story steel frame structure. 3500 w. Eng Rec—Sept. 26, 1908. No. 95380.

Reclamation.

The Reclamation of an Empire from the Swamps. George Ethelbert Walsh. Considers the vast areas of land in the United States available by drainage. 3000 w. Cassier's Mag—Sept., 1908. No. 94740 B.

Reclaiming Newark Meadows. Discusses the most economical method of reclaiming land in New Jersey, as reported by the commission appointed. Ills. 2000 w. Munic Jour & Engr—Sept. 16, 1908. No. 95083.

Records.

The Importance of Records in Engineering Work. E. E. Howard. Abstract of a paper in the Nebraska Blue Print, 1908. Emphasizes the importance of record making in general, and the characteristics records must possess to be valuable. 4000 w. Engng-Con—Aug. 26, 1908. No. 94707.

Reinforced Concrete.

Reinforced Concrete. J. Monash. Considers present practice in design and construction. 2500 w. Archt, Lond—Sept. 4, 1908. No. 95028 A.

Diagrams for Use in Designing Reinforced Concrete T-Beams. J. Nolman Jensen. Diagrams and explanations of their derivation. 600 w. Eng Rec—Sept. 19, 1908. No. 95228.

Expanded Metal for Reinforced Concrete Work. Ernest McCullough. Explains the advantages of expanded metal for reinforcement. 1200 w. Min Wld—Sept. 5, 1908. No. 94889.

Reinforced Concrete Farm Buildings. J. P. H. Perry. Illustrated description of a group of farm buildings near Sterlington, N. Y. 2000 w. Cement Age—Sept., 1908. No. 95063.

The Torrey Buildings, Boston, Mass. Illustrated description of reinforced-concrete factory buildings. 1800 w. Eng Rec—Sept. 19, 1908. No. 95229.

A new Application of Reinforced Concrete for Structures in Contact with Water. (Una Nuova Applicazione del Cemento Armato per le Costruzioni in Contatto coll' Acqua). A description of the Sanders System. Ills. Serial. 1st part. 2700 w. Il Cemento—July, 1908. No. 95123 D.

The Reinforced-Concrete Construction in the Markus Church, Stuttgart (Die Eisenbeton-Konstruktionen der Markuskirche in Stuttgart.) S. Zipkes. The first part illustrates and describes the tower. Serial. 1st part. 2000 w. Deutsche Bau—Aug. 19, 1908. No. 95144 D.

See also Bins, Floors and Stacks, under CONSTRUCTION; and Shipbuilding, under MARINE AND NAVAL ENGINEERING.

Stacks.

Wind Stresses in Reinforced-Concrete Chimneys, and a Diagram for Their Determination. E. R. Maurer. Considers two cases, explaining method used. 2200 w. Eng News—Sept. 10, 1908. No. 95009.

Steel Buildings.

Rational Ironwork for Store and Loft Building. George B. Ford. Illustrates and describes types of buildings using structural steel. 1500 w. Am Archt—Sept. 16, 1908. No. 95081.

The Erection of the Waverly Warehouse. Illustrated description of the erection of the Carnegie Steel Co.'s storage plant, near Newark, N. J. 2000 w. Eng Rec—Sept. 26, 1908. No. 95378.

The Hartford Armory Drill Shed. Illustrated description of framework for a structure 270 feet long, 187 feet wide, and 108 feet high. 1000 w. Eng Rec—Sept. 12, 1908. No. 94967.

See also Construction, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Tunnels.

Work on the Tunnel Under Washington Street. Edward S. Sears. Considers novel problems encountered in the construction of this Boston tunnel. Ills. 1500 w. Public Works—July-Sept., 1908. No 95320 B.

The Waterproofing of the Land Sections of the Detroit River Tunnel. Stacey H. Opdyke. Describes this work and also details of construction. Ills. 2500 w. Eng News—Sept. 24, 1908. No. 95362.

The Construction Plant and Methods Employed on the Approaches of the Detroit River Tunnel. Illustrates and describes important work in connection with improvements to eliminate the car ferry. 6500 w. Eng Rec—Sept. 19, 1908. No. 95226.

Waterproofing.

See Tunnels, under CONSTRUCTION.

Wind Bracing.

Wind Bracing with Knee Braces or Gusset Plates. A. C. Wilson. Aims to determine the stresses in the main members of a bent made of columns and girders, with the diagonals omitted. 3000 w. Eng Rec—Sept. 5, 1908. No. 94871.

MATERIALS OF CONSTRUCTION.

Brick.

How Sand-Lime Brick Should be Made. J. H. Van Glahn. Discusses practical methods, giving the best results. 1500 w. Ind Wld—Sept. 7, 1908. No. 94851.

Cement.

The Theory of the Binding and Hardening of Portland and Roman Cement. (Zur Abbindungs- und Erhärtungstheorie der Portland und Romanzemente.) F.

Janda. 3200 w. Oest Zeitschr f Berg u Hüttenwesen—Aug. 22, 1908. No. 95139 D.

The Testing and Properties of Hydraulic Cements. (Gli Assaggi e le Proprietà degli Agglomeranti Idraulici). The first part discusses the testing of Portland cement for homogeneity and fineness. Ills. Serial. 1st part. 3500 w. Il Cemento—July, 1908. No. 95124 D.

Paints.

Notes on Specifications for Painters' Work. Arthur Seymour Jennings. Considers the materials and paints in general use, giving a number of tests for determining their quality. 4500 w. Public Works—July-Sept., 1908. No. 95298 B.

The Inhibitive Power of Certain Pigments in the Corrosion of Iron and Steel. Allerton S. Cushman. Read before the Am. Soc. for Test. Materials. A report of tests made and their results. 1800 w. Eng Rec—Sept. 19, 1908. No. 95233.

Timber.

Spontaneous Ignition of Wood. Frank R. Fairweather. Discusses the effect on wood of long continued heating. 1000 w. Ins Engng—Sept., 1908. No. 95407 C.

The Hard Woods of Eastern Australia. Gives a graphical diagram showing results of Government tests, with notes. 700 w. Engr, Lond—Aug. 21, 1908. No. 94787 A.

Our Timber Supplies. A. D. Webster. Discusses the conditions in Great Britain principally, and the most feasible way to overcome the difficulty. 2000 w. Contemporary Review—Sept., 1908. No. 95075 D.

The World's Timber Supply. Discusses the supply, especially of the United Kingdom, Canada and New Zealand; the waste and need of Government action. 3500 w. Builder—Sept. 5, 1908. No. 95026 A.

MEASUREMENT.

Stream Flow.

Water Measurement (Wassermessung). A. Linker. Discusses theoretically and practically the methods of measuring stream discharge. Ills. 2500 w. Die Turbine—Aug. 5, 1908. No. 95148 D.

Surveying.

Stadia Surveys for the Location of the Catskill Aqueduct, Peekskill Division. Boris Levitt. Describes the method used. Ills. 2000 w. Eng News—Sept. 3, 1908. No. 94863.

Precise Level Operations on the Los Angeles Aqueduct. Charles H. Lee. Illustrates and describes methods used in running 525 miles of single-line levels, and establishing 136 permanent bench marks. 2500 w. Eng News—Sept. 17, 1908. No. 95224.

The Two-Instrument Method of Compass Adjustment. (Magnetorientierung mit zwei Orientierungsinstrumenten). Fl. Lederer. Mathematical demonstration. Ills. Serial. 1st part. 2500 w. Oest Zeitschr f Berg u Hüttenwesen—Aug. 22, 1908. No. 95138 D.

MUNICIPAL.

Gosport, Eng.

Gosport Public Works. H. Frost. Paper read before the Inst. of Munic & Co. Engrs. Outlines the history of this place and describes the more important public works. Ills. 7000 w. Surveyor—Aug. 28, 1908. Serial. 1st part. No. 94927 A.

Johannesburg.

Valedictory Address by the President of the South African Association of Engineers. G. S. Burt Andrews. The subject is municipal work in Johannesburg. Giving a brief description of some of the more important works. 11500 w. Jour S African Asso of Engrs—July, 1908. No. 94761 F.

Roads.

The History of Roads (Zur Geschichte der Landstrassen). Herr Layritz. Gives a brief review of the history of road making and discusses present practice. 3600 w. Zeitschr d Mit Motorwagen Ver—Aug. 31, 1908. No. 95161 D.

Effect of Motors on Macadam Roads. Logan Waller. Page address before the Good Roads Convention. Studies the effect of the shearing force of motor cars. 1700 w. Eng Rec—Sept. 26, 1908. No. 95379.

Dust-Laying and Permanent Surfacing. M. H. West. Gives results of recent experiments on roads in Chicago parks. 2500 w. Munic Jour & Engr—Sept. 16, 1908. No. 95084.

Dust Preventives. Prevost Hubbard. Considers the causes of dust on highways, indicating the measures that have been taken to solve the problem of dust prevention and road preservation. Ills. 24500 w. U S Dept of Agri, Bul No. 34—Sept. 22, 1908. No. 95323 N.

Concerning Roads, English and American. A Contrast and Its Explanation. Considers horse-shoe calks largely the cause of the difference. 3000 w. Eng News—Sept. 24, 1908. No. 95363.

Method and Cost of Repairing Macadam Roads by Scarifying Instead of by Patching. E. A. Hackett. The paper gives methods used in Ireland. 3000 w. Engng Con—Sept. 2, 1908. No. 94855.

A Nine-Mile Concrete Road for Automobiles. Illustrated description of the Long Island Motor Parkway. 2500 w. Eng Rec—Sept. 26, 1908. No. 95375.

Septic Tanks.

Domestic Septic Tanks. Herbert F.

Shade. Gives the writer's views as to the best system of sewage disposal for isolated houses. 1500 w. Dom Engng—Sept. 12, 1908. No. 95012.

Sewage Disposal.

Royal Commission on Sewage Disposal. Gives conclusions and general summary of the fifth report, just issued. 3500 w. Engng—Sept. 11, 1908. Serial. 1st part. No. 95090 A.

Recent Tendercies in Sewage-Disposal Practice. C. E. A. Winslow and Earle B. Phelps. Considers latest experiments, comparing with the conditions in America and Germany. 3500 w. Public Works—July-Sept., 1908. No. 95317 B.

Some Recent Experiments on the Biolysis of Sewage. W. D. Scott-Moncrieff. A report of experiments made to discover the periods of hydrolysis that gave the necessary purification, and if filtration would yield the required purification. Also discussion. 3500 w. Surveyor—Aug. 21, 1908. No. 94762 A.

Sewers.

Reinforced Concrete Block Construction for Culverts and Sewers. Gives two forms of block construction which have been developed with unusual care. 1500 w. Engng Con—Sept. 2, 1908. No. 94856.

The Construction of the Osnabrück Reinforced-Concrete Sewer and the Damage Caused by Swamp Waters Containing Oxide of Sulphur. (Der Bau des Abwasser-Sammelkanales in Osnabrück und die an demselben beobachteten Zerstörungs-Erscheinungen durch Einwirkung schwefelsauren Moor- bezu. Grundwassers). Friedrich Lehmann. Ills. Serial. 1st part. 2200 w. Deutsche Bau—Aug. 22, 1908. No. 95145 D.

Smoke Prevention.

The Service of a Well Organized City Smoke Department. Robert H. Kuss. Outlines the work the smoke department should undertake, the proper supervision, etc. 4500 w. Ind Wld—Sept. 21, 1908. No. 95080.

WATER SUPPLY.

Analysis.

Methods of Water Analysis. J. H. Brewster. From a paper before the Indiana San. & Water Supply Assn. Presents a scheme for a uniform system throughout the State of Indiana. 2800 w. Munic Engng—Sept., 1908. No. 94727 C.

Conduits.

The Big Cottonwood Water Works Conduit of Salt Lake City, Utah. An illustrated description abstracted from the report of L. C. Kelsey. 1000 w. Munic Engng—Sept., 1908. No. 94726 C.

Dams.

Progress on the Roosevelt Dam, Salt River Project, U. S. Reclamation Service. Chester Wason Smith. A general review from the inception until the present summer. Ills. 2500 w. Eng News—Sept. 10, 1908. No. 95005.

The Mari-Kanavè Dam in Southern India. Illustrated description of a recently completed rubble masonry dam, constructed by native labor, in connection with an important irrigation scheme. 1200 w. Sci Am—Sept. 5, 1908. No. 94900.

Filtration.

A Short Account of the Lawrence Filter Beds. Arthur D. Marble. 3000 w. Jour Assn of Engng Socs—Aug., 1908. No. 95403 C.

The Pittsburg Filtration Plant. H. M. Leh and E. A. Foster. Illustrated description of a plant in which cement was an important factor. 1500 w. Cement Age—Sept., 1908. No. 95064.

The Use of Recording Gauges in a Filtration Plant. F. B. Leopold. Gives typical charts, explaining their indications and use. 2000 w. Eng Rec—Sept. 19, 1908. No. 95234.

Ground Waters.

The Variations in Ground Water Level in Munich. (Die Schwankungen der Grundwasserstände in München). Chr. Mezger. Curves. 7700 w. Gesundheits-Ing—Aug. 8, 1908. No. 95151 D.

The Variations in Ground Water Level and the Flow of Springs (Die Schwankungen der Grundwasserstände und der Quellenausflüsse). Chr. Metzger. A record of extensive observations. Ills. 8800 w. Gesundheits-Ing—Aug. 8, 1908. No. 95150 D.

Hydrological Investigations for the Third Water Works for Leipzig. A. Thiem and Dr. Tugr. G. Thiem, in *Jour. für Gasbeleuchtung und Wasserversorgung*. Describes a method of determining the capacity of underground water basins. 1200 w. Eng Rec—Sept. 26, 1908. No. 95383.

Irrigation.

Depth of Water in Irrigation Canals. C. E. Grunsky. Comments on types of irrigation canals and related matters, advocating the broad shallow type when not prohibited by conditions. 5000 w. Eng News—Sept. 10, 1908. No. 95011.

See also Pumping Plants, under MECHANICAL ENGINEERING, Hydraulic Machinery.

Piping.

Diagrams for Spacing Bands on Wood-Stave Pipe. Diagram, with explanation of its use. 500 w. Eng News—Sept. 3, 1908. No. 94865.

Purification.

Purification of Drinking Water from Manganese by Means of Aluminium Silicate. (Reinigung des Trinkwassers von

Mangan durch Aluminatsilikate). Dr. H. Noll. Reports tests on the process. 7000 w. Gesundheits-Ing—Aug. 22, 1908. No. 95152 D.

Water Supply Plant of the Walsum Cellulose Works (Wasserversorgungsanlage der Zellstoff-Fabrik in Walsum am Niederrhein). Herr Berkenkamp. Illustrated description of pumping and purification plants for large paper works. 2800 w. Zeitschr d Ver Deutscher Ing—Aug. 15, 1908. No. 95183 D.

Typhoid.

Laboratory Tests of the Effect of Storage on the Vitality of the Typhoid Bacillus in the London Water Supply. A Contribution to the data on the beneficial effect of storage upon the sanitary quality of water, from a report by Dr. A. C. Houston. 600 w. Eng News—Sept. 3, 1908. No. 94862.

Water Works.

New Water Works at Selby. Illustrated detailed description of the new works, pumping engines, etc. 2800 w. Engr, Lond—Aug. 28, 1908. No. 94955 A.

Weir Discharge.

d'Ocagne's Method of Isoplethe Points Applied to the Francis Weir Formula. Richard Muller. An explanation of the principle and its application. 500 w. Eng News—Sept. 3, 1908. No. 94864.

WATERWAYS AND HARBORS.

Barge Canal.

The Barge Canal of the State of New York. David A. Watt. A brief description of this important engineering work, with history of the causes which led to its construction. Ills. and plate. 3000 w. Engng—Sept. 11, 1908. No. 95085 A.

Canals.

See U. S. Waterways, under WATERWAYS AND HARBORS.

Colorado River.

Changes in Bed and Discharge Capacity of the Colorado River at Yuma, Ariz. E. C. Murphy. Reports a study made to determine the cause of the apparent increase in the flow since 1903. 1800 w. Eng News—Sept. 24, 1908. No. 95365.

Docks.

The Methil Docks. Illustrated description of preliminary work in progress in preparation for harbor extension. 800 w. Engng—Sept. 4, 1908. No. 95052 A.

The New Ore and Coal Handling Dock of the Pennsylvania Company at Ashtabula Harbor, Ohio. Illustrated description of extensive terminal improvements. 6000 w. Eng Rec—Sept. 12, 1908. No. 94966.

Drydocks.

Modern Improvements in Dry Dock Construction. H. A. Crafts. Describes improvements in the handling of bilge blocks, method of drainage, cleaning the gate seats, etc. 500 w. Sci Am—Sept. 12, 1908. No. 94994.

A Floating Dock for Callao. Illustrated description of a dock of the double-sided, self-docking type. 800 w. Engr, Lond—Aug. 28, 1908. No. 94956 A.

Floating Dock for the Imperial Navy Yard at Wilhelmshaven (Schwimmdock für die Kaiserliche Werft in Wilhelmshafen). Herr von Klitzing. Illustrated detailed description. 2500 w. Zeitschr d Ver Deutscher Ing—Aug. 8, 1908. No. 95178 D.

Ganges.

The Narrowing of the Ganges and Construction of the Curzon Bridge. Illustrated description of interesting construction work in India. 1700 w. Sci Am—Sept. 26, 1908. No. 95336.

Glasgow.

Glasgow Harbor Extensions. Plan, illustrations and description of the new basins and quays at Yorkhill. 3000 w. Engr, Lond—Sept. 4, 1908. No. 95054 A.

Harbors.

See Glasgow, Philadelphia, Talcahuano, and Whitby, under WATERWAYS AND HARBORS.

Lake Michigan.

Currents in Lake Michigan. W. V. Judson. Read before the Lake Mich. Water Com. States the agencies which may produce currents, examining each. 2000 w. Eng Rec—Sept. 26, 1908. No. 95376.

Mississippi River.

Point Beka Crevasse, Mississippi River, Right Bank, Parish of Orleans, Louisiana. Frank M. Kerr. An illustrated account of the break and the attempts to close it, describing the construction. 2500 w. Jour Assn of Engng Socs—Aug., 1908. No. 95402 C.

Niger.

Navigation on the Niger (Le Service de la Navigation sur le Niger). Paul Privat-Deschanel. Discusses the navigability of the river, the type of boat in use, and the traffic handled. Ills. 4000 w. Génie Civil—Aug. 22, 1908. No. 95117 D.

Panama Canal.

Some Features of the Dry Excavation at Panama. An illustrated account of work in the Culebra Cut. 6500 w. Eng Rec—Sept. 5, 1908. No. 94867.

Philadelphia.

Philadelphia Harbor's Needs. A statement of conditions as they exist in Europe, with suggestions that might be followed, as given in the report of Joseph F. Hasskarl. 3500 w. Marine Rev—Sept. 10, 1908. No. 94965.

Piers.

Lackawanna Freight Pier No. 7, at Hoboken. A pier having a width of 100 ft. and a total length of 600 ft., with a one-story fireproof shed and other interesting features. 4000 w. Eng Rec—Sept. 12, 1908. No. 94969.

Talcahuano, Chili.

The Harbor Works at Talcahuano, Chili (Die Havenwerken van Talcahuano, Chili). W. C. van Manen. Illustrated description of the docks, etc. 9750 w. De Ingenieur—Aug. 27, 1908. No. 95196 D.

Tiber.

Rome and the Sea (Roma ed il Mare). Paolo Orlando. A general discussion of the possibility of making Rome an important port by improving the navigation of the Tiber. 4500 w. Ann d Soc d Ing e d Arch Ital—July 1, 1908. No. 95118 F.

U. S. Waterways.

The Anthracite - Tidewater Canals. Chester Lloyd Jones. Reviews their history, summarizing the conditions which determine whether or not they may again become available. 7000 w. R R Age Gaz —Sept. 4, 1908. No. 94885.

Water Powers.

The Conservation and Use of Water-Power Resources. H. von Schon. This second article examines the influence of conservation on industrial development. 3500 w. Engineering Magazine—Oct., 1908. No. 95399 B.

Whitby.

Whitby Harbor Improvement Works. Outlines the scheme of improvement at the mouth of the River Esk. Ills. 1200 w. Engr, Lond—Sept. 4, 1908. No. 95056 A.

MISCELLANY.

Japan.

Some Notes on Japanese Engineering. James D. Schuyler. Illustrated descriptions of interesting things observed during recent travels. 1600 w. Eng Rec—Sept. 26, 1908. No. 95374.

Stone Sawing.

Sawing a Building in Two. Illustrated description of methods used in sawing the façade and foundations of a four-story building in Paris. 1400 w. Sci Am—Sept. 26, 1908. No. 95337.

ELECTRICAL ENGINEERING

COMMUNICATION.

Condensers.

The Variation of Apparent Capacity of a Condenser with the Time of Discharge and the Variation of Capacity with Frequency in Alternating Current Measurements. B. V. Hill, in *Phys. Rev.* Describes tests and apparatus used. 1500 w. Electn, Lond—Aug. 21, 1908. No. 94770 A.

Electrical Vision.

Electiical Vision at a Distance. A. Troller. Illustrated explanation of the Armengaud system. 1000 w. Sci Am Sup—Sept 19, 1908. No. 95240.

Radio-Telegraphy.

On the Advantage of a High Spark Frequency in Radiotelegraphy. L. W. Austin. Gives results of investigations. 1000 w. Bul Bureau of Stand—Aug., 1908. No. 95387 N.

Propagation of Electric Waves in Wireless Telegraphy. James E. Ives. An attempt to give a physical explanation of the throwing off of electrical energy into space by a wireless antenna. 1700 w. Elec Wld—Sept. 26, 1908. No. 95332.

Electric Wave Detectors in Radiotelegraphy. Dr. J. A. Fleming. Describes the latest devices for receiving messages through space, and discusses related questions. Ills. 3000 w. Cassier's Mag—Sept., 1908. No. 94738 B.

Radio-Telephony.

The Collins System of Long Distance Wireless Telephony. Illustrated detailed description, with report of tests. 1400 w. Sci Am—Sept. 19, 1908. No. 95236.

Telephone Cables.

Methods of Locating Transpositions of Wires and Split Pairs in Telephone and Telegraph Cables. Henry W. Fisher. Shows how faults of this kind can be readily located by some methods devised by the author. 2000 w. Pro Am Inst of Elec Engrs—Sept., 1908. No. 94731 D.

Telephotography.

The Korn System of Image Transmission. C. S. Durand. Illustrated detailed description of the new apparatus and its use. 3500 w. Elec Rev, N Y—Sept. 5, 1908. No. 94860.

DISTRIBUTION.

Fuses.

Repaired Fuse Plugs (Repartierte Schmelzstöpsel). W. Klement and Paul H. Perls. Reports tests on repaired enclosed fuses showing that repairs are usually of no value. Ills. 3000 w. Elektrotech Zeitschr—Aug. 27, 1908. No. 95193 D.

Protective Devices.

New High-Tension Protective Devices of the Allgemeinen Elektricitäts-Gesellschaft (Neue geschlossene Hochspannungssicherungen der Allgemeinen Elektricitäts-Gesellschaft). W. Fellenberg. Illustrated description of various types and results of tests. Serial. 1st part. 2000 w. Elektrotech Zeischr—Jan. 16, 1908. No. 95302 D.

Switches.

See Insulating Oils, under MISCELLANY.

Wiring.

A Heavy-Conductor, Open-Work Installation. Arthur Gillman. Illustrates and describes details of construction. 2000 w. Elec Wld—Sept. 19, 1908. No. 95219.

DYNAMOS AND MOTORS.

A. C. Dynamos.

Continuous Free Hunting in the A. C. Dynamos (Ueber dauernde freie Pendelungen bei Wechselstrommaschinen). Karl Willy Wagner. Mathematical discussion. Ills. 1800 w. Elektrotech u Maschinenbau—Aug. 9, 1908. No. 95172 D.

Current Displacement in Armature Slots (Einseitige Stromverdrängung in Ankernuten). Fritz Emde. Mathematical. Ills. Serial. 1st part. 2500 w. Elektrotech u Maschinenbau—Aug. 16, 1908. No. 95173 D.

A. C. Motors.

The Classification of Single-Phase Motors (Die Klassifikation der Einphasen Motoren). J. Jonas. Proposes a new and simple system. Ills. 2000 w. Elektrotech Zeitschr—Feb. 27, 1908. No. 95313 D.

The Form of the Characteristic Curves of Three-Phase Motors and the Separation of the Losses (Die Kurvenformen der Ströme in Drehstrom-Motoren und die Trennung der Verluste). K. Simons and K. Vollmer. An oscillographic study. Ills. 2800 w. Elektrotech Zeitschr—Jan. 30, 1908. Uo. 95307 D.

Acyclic Dynamos.

Acyclic Dynamos. C. Feldmann. Illustrates and describes the main features in the design of the actual machines. 1800 w. Electn, Lond—Aug. 21, 1908. No. 94769 A.

Acyclic Generators. J. E. Noeggerath. An illustrated article on their mechanical design and notes on operation. Also editorial. 2500 w. Elec Wld—Sept. 12, 1908. No. 95014.

Breakdowns.

Breakdowns of Electrical Machinery. Michael Longridge. From the annual report of the British Engine, Boiler and Electrical Insurance Co. Information concerning accidents during 1907. 5500 w. Mech Wld—Aug. 28, 1908. No. 94932 A.

Commutation.

The Fundamentals of the Commutation Problem (Grundlagen des Kommutierungs Problems). Reinhold Rüdenberg. Mathematical. Ills. 4800 w. Elektrotech Zeitschr—Jan. 23, 1908. No. 95304 D.

Construction.

Modern Motor Building (Aus der modernen Motorenfabrikation). Alexander Rothert. Discusses standards and methods for economical construction. Serial. 1st part. 3500 w. Elektrotech Zeitschr—Feb. 13, 1908. No. 95310 D.

D. C. Motors.

The Starting, Regulating and Stopping of Continuous-Current Motors. John T. Mould. The devices in use are dealt with and their advantages and disadvantages discussed. Ills. 8500 w. Public Works—July-Sept., 1908. No. 95299 B.

Direct Current Motors for Mining Service. W. B. Clark. Describes the peculiar characteristics of different types of motors and the conditions of work to which each is suited. Ills. 2500 w. Mines & Min—Sept., 1908. No. 94810 C.

D. C. Turbo-Dynamos.

The Development of the D. C. Turbo Dynamo (Zur Entwicklung der Gleichstrom-Turbodynamos). Robert Pohl. A general review of present practice. Ills. Serial. 1st part. 3200 w. Elektrotech Zeitschr—Feb. 6, 1908. No. 95308 D.

Heating.

Heating of Ventilated and Enclosed Motors. W. Hartnell. Deals with eight types of motors classified according to their system of ventilation, concluding that totally enclosed motors are at a disadvantage. Discussion. 5000 w. Electn, Lond—Aug. 21, 1908. No. 94772 A.

Induction Motors.

Influence of the Slot-Ratio Upon the Starting Torque of Induction Motors. R. E. Hellmund. A study of the variations of the torque. 1200 w. Elec Wld—Sept. 26, 1908. No. 95330.

Calculation of the Starting Torque of Single-Phase Induction Motors with Phase-Splitting Starting Devices. I. E. Hanssen. Explanatory. 300 w. Pro Am Inst of Elec Engrs—Sept., 1908. No. 94732 D.

Materials.

The Comparative Aging of Electric Sheet-Steel. T. S. Allen. Reports results of tests on core material. Also editorial. 1600 w. Elec Wld—Sept. 12, 1908. No. 95016.

See also Steel, under MECHANICAL ENGINEERING, MATERIALS OF CONSTRUCTION.

Purchasing.

The Purchase of Electric Motors and Accessories. Howard S. Knowlton. Information concerning points that should be considered, etc. 3000 w. Power—Sept. 8, 1908. No. 94909.

Railway Motors.

The Alternating-Current Commutator Motor with Special Reference to Railway Motors (Ueber Wechselstrom-Kommutatormotoren mit besonderer Berücksichtigung der Bahnmotoren). M. Osnos. A mathematical discussion of the utility of this type of motor in railway work. Ills. Serial. 1st part. 2500 w. Elektrotech Zeitschr—Jan. 2, 1908. No. 95300 D.

Repulsion Motors.

The Alexanderson Series Repulsion Motor (Der Reihenschliess-Repulsionsmotor von Alexanderson). Rudolf Richter. A description and criticism of this single-phase motor. Ills. Serial. 1st part. 2200 w. Elektrotech Zeitschr—Aug. 20, 1908. No. 95192 D.

Synchronous Motors.

Condenser Action of Synchronous Motor. Shows graphically how the rating of a synchronous motor can be calculated. 500 w. Elec Rev, Lond—Aug. 21, 1908. No. 94767 A.

Windings.

Convenient Methods for Recovering Lost Winding Data. George T. Hanchett. Describes methods for determining missing data that will save the expense of employing a dynamo designer. 1500 w. Elec Wld—Sept. 12, 1908. No. 95018.

A Winding for Polyphase Generators (Eine Wicklung für Mehrphasengeneratoren). F. Punga. Describes a new winding especially suited to three-phase dynamos. Mathematical. Ills. 5200 w. Elektrotech Zeitschr—Feb. 6, 1908. No. 95309 D.

ELECTRO-CHEMISTRY.

Cleaning Baths.

Electrochemical Cleaning Baths. Charles H. Proctor. Read before the Am. Brass Found Assn. Discusses the cleaning of metallic surfaces by the aid of the electric current. 1200 w. Ir Age—Sept. 10, 1908. No. 94906.

Corrosion.

Rusting of Iron. F. H. Mason. Considers the experimental conclusions drawn by W. A. Tilden. 1000 w. Min & Sci Pr—Sept. 5, 1908. No. 94977.

Electrolysis and Corrosion. Allerton S. Cushman. Read before the Am. Soc. for Test Mat. An examination of causes of corrosion, especially the electrolytic theory. 3500 w. Eng Rec—Sept. 26, 1908. No. 95377.

Corrosion of Iron from the Electrochemical Standpoint. C. F. Burgess. From the presidential address before the Am. Electrochemical Soc. Considers corrosion of underground structures, galvanic action, influence of strain, etc. 4500 w. Elec Rev, N Y—Sept. 12, 1908. Serial. 1st part. No. 94980.

Electro-Metallurgy.

Researches on the Electric Furnace (Untersuchungen über den elektrischen Ofen). I. On a new Laboratory Arc Furnace: Louis Clerc and Adolphe Minet. II. On Electric Arcs Burning in a Completely Closed Chamber: Adolphe Minet. Ills. 1800 w. Elektrochem Zeitschr—Aug., 1908. No. 95127 D.

Electroplating.

How to Make a Cyanide Copper Solution, and the Manner in Which It Should be Used. Explains the advantages of a cyanide-copper solution, considering the quality of the cyanide in the present number. 1200 w. Brass Wld—Sept., 1908. Serial. 1st part. No. 95268.

ELECTRO-PHYSICS.

Hysteresis.

On the Hysteresis Loss and Other Properties of Iron Alloys Under Very Small Magnetic Forces. E. Wilson, V. H. Winson, and G. F. O'Dell. Abstract of paper read before the Royal Soc. Describes experiments and gives results. 600 w. Electn, Lond—Aug. 21, 1908. No. 94771 A.

Induction Coils.

Short Spark Phenomena. W. Duddell. Describes two effects observed in connection with some measurements of the current in the secondary circuit of an induction coil. 1700 w. Electn, Lond—Sept. 4, 1908. No. 95046 A.

Ohm's Law.

The Statement of Ohm's Law. Morton G. Lloyd. A discussion, considering its application to alternating currents. 900 w. Elec Rev, N Y—Sept. 19, 1908. No. 95212.

Oscillations.

A Method for Producing Fully Damped High-Frequency Electrical Oscillations for Laboratory Measurements. L. W. Austin. Describes the arrangement found to give the best results. 700 w. Bul Bureau of Stand—Aug., 1908. No. 95386 N.

Terrestrial Magnetism.

Gilbert's Magnetic Defense of the Copernican Theory. Brother Potamian. Historical Review. 2200 w. Elec Wld—Sept. 19, 1908. No. 95214.

The Discovery of Magnetic Dip. Brother Potamian. Quotes from some early writers on magnetic philosophy, discussing the first reference in print to magnetic dip. 2800 w. Elec Wld—Sept. 12, 1908. No. 95013.

GENERATING STATIONS.

Accumulators.

Storage Batteries, Their Construction and Uses. Percival Robert Moses. Second and concluding article discussing the methods of charging and discharging types of boosters and other auxiliary apparatus, care, maintenance, cost, etc. Ills. 1500 w. Engineering Magazine—Oct., 1908. No. 95393 B.

The Influence of Temperature on the Capacity of Lead Accumulators (Einfluss der Temperatur auf die Kapazität des Bleiakkumulators). Otto Hildebrand. Gives the results of tests. 2000 w. Elektrotech u Maschinenbau—Aug. 16, 1908. No. 95174 D.

Central Stations.

Generating Station of the Borough of St. Marylebone, London. Illustrated description. 2000 w. Elec Wld—Sept. 19, 1908. No. 95215.

Recent Development of the Worcester Electric Light Company. Illustrates and describes the development. 2500 w. Elec Wld—Sept. 5, 1908. No. 94833.

The Poughkeepsie Light, Heat & Power Company. Illustrated description of a plant furnishing electrical energy for all purposes. 2500 w. Elec Wld—Sept. 5, 1908. No. 94832.

A Steam-Power Central Station of Great Economy in Operation. Illustrated detailed description of a plant at Rodondo, Cal., and the tests made. 7500 w. Eng Rec—Sept. 12, 1908. No. 94968.

Power Supply in the North of France. Abstract translation from *Le Génie Civil*, describing an undertaking for supplying the industrial district of Lille, Roubaix, Tourcoing and surrounding places. Ills. 1600 w. Elec Engng—Aug. 27, 1908. No. 94933 A.

See also Turbine Plants and Turbines, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Construction.

Some Notes on Steel Constructional Work for Central Stations. 2000 w. Elec Rev, Lond—Aug. 28, 1908. No. 94939 A.

Economics.

Industrial Power Business from a Central Station Viewpoint. W. F. Lloyd. Discusses the handling of power propositions and possible economies. 1800 w. Elec Wld—Sept. 12, 1908. No. 95020.

Germany.

Statistics of Electric Power Plants in Germany (Statistik der Elektrizitätswerke in Deutschland). Gives details of every station existing in Germany on April 1, 1907. 75000 w. Elektrotech Zeitschr—Mar. 12, 1908. No. 95316 D.

Hydro-Electric.

Seattle Power Plant and Water Supply. Jay L. Stannard. Illustrates and describes details of construction of a hydro-electric plant being greatly increased in capacity. 2500 w. Munic Jour & Engr—Sept. 9, 1908. No. 94874.

A Unique Water-Power Plant. H. Lester Hamilton. An illustrated description of a small water power utilized for Christ School, N. Carolina. 1600 w. Elec Rev, N Y—Sept. 26, 1908. No. 95372.

Hydro-Electric Station Operating Without Attendant. M. A. Hicks. Brief illustrated description of a small station at Hartland, Vt., constructed so that it carries its load at night without an attendant. 1000 w. Elec Wld—Sept. 5, 1908. No. 94840.

European Hydro-Electric Power Development. C. H. Mitchell. Read before the Can. Elec Assn. An illustrated article indicating some of the interesting features of important plants recently installed. 5800 w. Can Elec News—Sept., 1908. No. 95077.

The Urfttal Hydro-Electric Development in Germany. Frank Koester. Illustrates and describes the interesting features, the heavy masonry dam, spillway, etc. 1800 w. Eng Rec—Sept. 19, 1908. No. 95235.

The Urft Dam and the Hydro-Electric Power Transmission. Some facts concerning the disturbance of the telephone service by the high-tension currents from this plant in Rhenish Prussia. 2000 w. Engng—Aug. 21, 1908. No. 94781 A.

The Power Supply of Marseilles (L'Alimentation de Marseille en Energie Electrique). J. A. Montpellier. A description of the Brillanne-Villeneuve plant on the Durance. Ills. 2800 w. L'Elecn—Aug. 22, 1908. No. 95111 D.

The Lucerne-Engelberg Plant (Das Elektrizitätswerk "Luzern - Engelberg"). L. Pasching. Illustrated description of this Swiss plant. Serial. 1st part. 1800 w. Elektrotech Zeitschr—Aug. 6, 1908. No. 95189 D.

See also Turbine Plants, and Water Wheels, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

Isolated Plants.

The Electrical Equipment of the Dan River Power & Manufacturing Company. N. H. Slaughter. Describes the interesting features of a plant near Danville, Va. 1200 w. Elec Wld—Sept. 26, 1908. No. 95329.

Rates.

Tariff Alterations. E. E. Hoadley. Considers a new system of charging made possible by the introduction of metallic filament lamps. 1500 w. Elec Rev, Lond —Sept. 4, 1908. No. 95044 A.

Switch Gear.

Switch-Gear for the Barrow Hematite Steel Works. Illustrated description of switch-gear of the flat-back type. 800 w. Engng—Aug. 21, 1908. No. 94783 A.

Voltage.

2 x 110 and 2 x 220 Volts (2 x 110 und 2 x 220 Volt). C. Heim. Discusses the influence of the metallic filament lamp on the choice of voltage for central stations. 3200 w. Elektrotech Zeitschr—Jan. 9, 1908. No. 95301 D.

2 x 110 and 2 x 220 Volts in Three-Wire Systems (Nochmals 2 x 110 und 2 x 220 Volt). C. Heim. Gives statistics of the voltage employed in German central stations, showing the predominance of 220-volt systems. Ills. 3000 w. Elektrotech Zeitschr—Aug. 6, 1908. No. 95188 D.

LIGHTING.

Arc Lamps.

The Present Status of the Flaming Arc Lamp. Alfred A. Wohlauer. Explains the principles of this lamp, describing its mechanical and illuminating features. Ills. 2000 w. Elec Wld—Sept. 5, 1908. No. 94836.

The Flaming Arc Lamp Abroad. L. J. Auerbacher. Reports the extensive adoption of this lamp, especially in Germany. 1200 w. Elec Wld—Sept. 5, 1908. No. 94835.

Some Recent Developments in Arc Lamp Construction. Dwight D. Miller. Illustrates and describes the "Carbone" lamps, the "Polar" flaming arc lamps, and others. 2000 w. Elec Rev, N Y—Sept. 12, 1908. No. 94986.

Comparison of the Cost of Lighting by Small Arc Lamps and Osram Lamps of High Candle Power (Vergleich von Betriebskosten kleiner Bogenlampen und hochkerziger Osramlampen). Hermann Remané. Tables and curves. Ills. 3500 w. Elektrotech Zeitschr—Aug. 20, 1908. No. 95190 D.

England.

The Position of Electric Lighting in England. Albert H. Bridge. A review of progress. 2500 w. Elec Rev, N Y—Sept. 12, 1908. 94984.

Illumination.

Indoor Illuminants. James Swinburne. Discusses the leading features of the various methods of lighting. 5000 w. Public Works—July-Sept., 1908. No. 95319 B.

Incandescent Lamps.

The Tungsten Lamp. Francis W. Willcox. Considers its manufacture, life, candle-power, introduction, etc. Ills. 2000 w. Elec Wld—Sept. 5, 1908. No. 94838.

The Tungsten Lamp Situation. Various opinions from Central Station men and discussions mainly bearing on the business aspects of this lamp. Also editorial. 13000 w. Elec Wld—Sept. 5, 1908. No. 94839.

The Tungsten Lamp Situation Abroad. Dr. Louis Bell. Reports the large use of metallic filament lamps abroad. 900 w. Elec Wld—Sept. 5, 1908. No. 94834.

A Twelvemonth's Achievement of the Tungsten Lamp. S. E. Doane. Discusses the progress made in the introduction of these lamps. 1500 w. Elec Rev, N Y—Sept. 12, 1908. No. 94981.

The Effect of the Tungsten Lamp Upon Electric Lighting. L. P. Sawyer. Considers this lamp the most successful illuminant yet developed. 1000 w. Elec Wld—Sept. 12, 1908. No. 95019.

The New Westinghouse Nernst Lamp. Otto Foell. Illustrated description of new features in these lamps. 3000 w. Elec Rev, N Y—Sept. 12, 1908. No. 94983.

The Helion Lamp. H. C. Parker and W. G. Clark. Information relating to the development. 1200 w. Elec Wld—Sept. 5, 1908. No. 94837.

See also Rates, under GENERATING STATIONS; and Arc Lamps, under LIGHTING.

Inspection.

Illumination Inspection. Albert J. Marshall. Presents the advantages of such a department. 2000 w. Elec Wld—Sept. 12, 1908. No. 95021.

Mercury Vapor.

Cooper Hewitt Lamp Progress. Illustrates and describes the mechanical construction of lamps available for commercial service. 700 w. Elec Rev, N Y—Sept. 12, 1908. No. 94982.

Photometry.

A New Photometer (Ein neues Photometer). C. Paulus. Description of the new Everett Edgcumbe & Co. photometer and report of tests made with it at Munich. Ills. 2100 w. Elektrotech Zeitschr—Feb. 20, 1908. No. 95312 D.

Note on the Primary Standard of Light. C. W. Waidner and G. K. Burgess. A new suggestion for realizing a primary standard of light, and discussing the Violle standard. 3500 w. Elec Wld—Sept. 19, 1908. No. 95217.

On the Relations of the Measures of Light and Power. Carl Hering. Points out a number of weak points in the theory of photometry, discussing the subject and offering suggestions. 6000 w. Elec Wld—Sept. 19, 1908. No. 95216.

Simplifying Some of the Calculations of Light. Carl Hering. A criticism of the photometric units in use, and a discussion of the relations between illuminated and reflected surfaces. Also editorial. 4000 w. Elec Wld—Sept. 26, 1908. No. 95331.

A New Method of Determining Light-Distribution Curves and the Degree of Uniformity of Artificial Sources of Light (Ein neues Verfahren zur Aufnahme der Lichtverteilungskurve und des Gleichförmigkeitsgrades künstlicher Lichtquellen). W. Voege. Ills. 2000 w. Elektrotech Zeitschr—Jan. 16, 1908. No. 95303 D.

Vacuum Tube.

Tube Lighting. D. McFarlan Moore. Recent installations of new style tubes are illustrated and described. 1000 w. Elec Rev, N Y—Sept. 12, 1908. No. 94985.

MEASUREMENT.

Dynamo Testing.

Artificial Load for Testing Electrical Generators. Norman Young. Remarks aiming to show how much cheaper and more efficient it is to work with low conductivity water. 1400 w. Elec Rev, Lond—Sept. 4, 1908. No. 95043 A.

Inductances.

On the Measurement of Large Inductances Containing Iron. Sir Oliver Lodge and B. Davies. Describes some interesting methods and experiments. 2000 w. Elect'n, Lond—Sept. 11, 1908. No. 95-286 A.

Laboratories.

The United States National Bureau of

Standards. Herbert T. Wade. An illustrated account of its equipment and its work. 6000 w. Engineering Magazine—Oct, 1908. No. 95392 B.

The Imperial Physical Laboratory in Charlottenburg (Die physikalisch-technische Reichsanstalt in Charlottenburg). Emil Warburg. A discussion of the important researches carried out and present activities. Ills. Serial. 1st part. 3000 w. Zeitschr d Oest Ing u Arch Ver —Aug. 7, 1908. No. 95162 D.

Meters.

Care and Adjustment of General Electric Recording Watt-hour Meters. O. F. Dubruiel. Directions. 1500 w. Power—Sept. 22, 1908. No. 95254.

A New Direct Current Ampere-hour Meter A. Königswerther. Abstract trans. from *Elek. Zeit.* Describes an instrument claimed by the author to give readings correct at all loads. 1000 w. Electn, Lond—Aug. 28, 1908. No. 94940 A.

Metering and Its Attendant Losses. Deals with the losses that are inseparable from any system of measurement of electricity by meter. 700 w. Elec Rev, Lond —Sept. 11, 1908. No. 95282 A.

Notes on the Measurement of Power in Alternating Current Circuits. J. W. Rogers. Describes the construction of a water meter, and considers the measurement of power in a polyphase circuit. 1600 w. Prac Engr—Aug. 28, 1908. Serial. 1st part. No. 94926 A.

Permeability.

Notes on the Plug Permeameter. C. V. Drysdale. Abstract of a paper before the Physical Soc. Describes tests which the author claims show that the plug permeameter gives as good results as other methods of iron testing. 1000 w. Electn, Lond—Aug. 28, 1908. No. 94942 A.

Power Factor.

Two Wattmeter Method of Measuring Power Factor Considered Graphically. Indicates a method of representing and measuring the power factor of three-phase circuits graphically. 1200 w. Elec Engr, Lond—Aug. 28, 1908. No. 94936 A.

Phase and Power-Factor Meters (Phasemètres et Indicateurs du Facteur de Puissance). A. R. Garnier. Brief descriptions and mathematical discussions of various types. Ills. 3000 w. L'Elecn—Aug. 15, 1908. No. 95110 D.

Standards.

Report of the British Association Committee on Practical Standards for Electrical Measurements. Slightly abbreviated. 4000 w. Electn, Lond—Sept. 11, 1908. Serial. 1st part. No. 95287 A.

TRANSMISSION.

The Theory of Cables (Zur Theorie der Kabel). Leon Lichtenstein. A theoretical and mathematical discussion. Ills. Serial. 1st part. 4500 w. Elek Kraft u Bahnen—Aug. 4, 1908. No. 95168 D.

High-Tension Underground Cable Operation. Henry Floy. On the reliability and present status of underground high-tension distribution. 2000 w. Elec Wld—Sept. 26, 1908. No. 95333.

High-Tension Cables and Transmission (Hochspannungskabel und Hochspannungs-Kraftübertragungen). Richard Apt. Discusses the requirements of a cable for high-tension transmission, etc. Ills. Serial. 1st part. 2200 w. Elektrotech Zeitschr—Feb. 20, 1908. No. 95311 D.

Current Rectifiers.

Some Contact Rectifiers of Electric Currents. L. W. Austin. Gives results of experimental investigations of silicon tellurium, etc., with conclusions. 3000 w. Bul Bureau of Stand—Aug., 1908. No. 95385 N.

Earthing.

Earthing. Discusses the connections to earth advisable to prevent accidents. 1000 w. Elec Engr, Lond—Aug. 28, 1908. No. 94937 A.

Inductance.

Formulae and Tables for the Calculation of Mutual and Self-Inductance. Edward B. Rosa and Louis Cohen. A collection of formulae of value, with examples to illustrate and test them, and useful tables. 30000 w. Bul Bureau of Stand—Aug., 1908. No. 95384 N.

Insulation.

The Potential of Partially Insulated Systems in Relation to the Potential of Earth. M. B. Field. A discussion of points having a bearing on efficient insulation. 7000 w. Elec Engr, Lond—Aug. 28, 1908. No. 94935 A.

Insulators.

Porcelain Insulators for High Voltage Lines. J. A. Sandford, Jr. Considers the Requirements of good insulators, how they are made, tested, etc. 3500 w. Cent Sta—Sept., 1908. No. 94964.

The Effect of Temperature on the Breakdown Voltage of Insulators. Abstract translation from *Elektrotechnik und Maschinenbau.* Discusses the experimental investigations of Prof. A. Grau at the Vienna Tech. Inst. 900 w. Elec Engr, Lond—Sept. 11, 1908. No. 95279 A.

Line Design.

The Design of Underground Mains and Networks. J. R. Dick. Considers the general design of low-tension network, giving useful methods. Graphical methods are discussed, and a law for determining the best feeder areas. 3500 w. Elect'n, Lond—Sept. 11, 1908. Serial. 1st part. No. 95285 A.

Lines.

Steel Tower Transmission. Line of the Milwaukee Electric Railway & Light

Company. Illustrated description. 1000 w. Elec Ry Jour—Sept. 26, 1908. No. 95346.

Protective Devices.

The "Merz-Price" System of Automatic Protection for High-Tension Circuits. Reviews the underlying principles and the applications made. Ills. 3000 w. Elec Rev, Lond—Aug. 28, 1908. No. 94938 A.

Rotary Converters.

Parallel Operation of Rotary Converters. H. R. Mason. Explains different methods of cutting in or out. Ills. 1800 w Power—Sept. 15, 1908. No. 95060.

The Cascade Converter. August Bloch. Abstract translation from *Elektrotechnik und Maschinenbau.* Description and explanation of its working. 3500 w. Elect'n, Lond—Sept. 4, 1908. No. 95045 A.

Three-Phase.

A Method of Balancing the Load on and Improving the Power Factor of Three-Phase Systems. A. A. Radtke. Explains difficulties in methods used, and describes a new method. 1600 w. Elec Wld —Sept. 12, 1908. No. 95015.

Three-Wire System.

The Three-Wire System with Two Dynamos. Cecil P. Poole. Explanation of the principles governing the operation. Ills. 1200 w. Power—Sept. 22, 1908. No. 95249.

Transformers.

Transformer Design (Ueber die Berechnung von Transformatoren). Emil Alm. Works out the dimensions of a transformer for a special case. Mathematical. Ills. 3000 w. Elektrotech Zeitschr—March 5, 1908. No. 95314 D.

Voltage Drop and Leakage in Transformers (Spannungsabfall und Streuung der Transformatoren). Gustav Benischke. A mathematical discussion. Ills. 4000 w. Elektrotech Zeitschr—Jan. 23, 1908. No. 95305 D.

See also Insulating Oils, under MISCELLANY.

Voltage Regulation.

Regulators for Alternating-Current Work. A. A. Tirrill. Illustrated description of two types and the method of operation. 1000 w. Elec Jour—Sept., 1908. No. 95066.

The Theory of the Tirrill Regulator (Zur Theorie des Tirrill-Regulators). M. Seidner. Ills. 2000 w. Elektrotech u Maschinenbau—Aug. 9, 1908. No. 95171 D.

Wire Joints.

Wire Joining in Transmission Lines (Ueber Drahtbundverfahren für Freileitungen). Robert Nowotny. Illustrates and discusses various methods. 2500 w. Elektrotech u Maschinenbau—Aug. 23, 1908. No. 95175 D.

MISCELLANY.

Accidents.

Report of the Electrical Inspector of Factories for the Year 1907. G. Scott Ram. On electrical accidents, dangerous conditions needing correction, etc. 2500 w. Mech Engr—Aug. 21, 1908. No. 94766 A.

Insulating Oils.

Switch and Transformer Oil. A study of the insulating oil question. 3000 w. Elec Rev, Lond—Sept. 11, 1908. Serial. 1st part. No. 95281 A.

INDUSTRIAL ECONOMY

Accounting.

Modern Office Practice. Ridgley Newcomb. A synopsis of the development of modern methods and machinery for office use. 4000 w. Ir Trd Rev—Sept. 17, 1908. Serial. 1st part. No. 95200.

Latest Developments in the Burroughs' System of Book-Keeping and Accounting. I. Development of the Accounting Machine. R. L. Burd. II. Mechanical Accounting. Thomas M. Jones. 3800 w. Jour Fr Inst—Sept., 1908. No. 94728 D.

Apprenticeship.

The Future of the Apprentice. R. I. Graves. A paper by one of the apprentices of the C. & N.-W. R. R. 1500 w. Am Engr & R R Jour—Sept., 1908. No. 94828 C.

Cost Systems.

Obtaining Actual Knowledge of the Cost of Production. F. E. Webner. This sixth article of the series deals with cost records as a part of the general accounting plan. 1800 w. Engineering Magazine—Oct., 1908. No. 95398 B.

Systematic Foundry Operation and Foundry Costing. C. E. Knoeppel. This first article of a series outlines the elements of the problem. 3500 w. Engineering Magazine—Oct., 1908. No. 95400 B.

Drafting Room Costs (Die Kosten des Zeichensaales.) F. Kerner. Outlines a system for the determination and distribution of drafting costs. Ills. 2500 w. Technik u Wirtschaft—Aug., 1908. No. 95126 D.

Education.

Technical Education in Spain (La Instrucción Técnico-Industrial en España). José G. Benítez. A general discussion of conditions. Ills. 2000 w. Energia Elec—Aug. 10, 1908. No. 95125 D.

The Partiality to Theory in Mechanical Engineering Education in the Technical High Schools of Germany (Inwiefern ist die Ausbildung der Maschineningenieure an unseren deutschen technischen Hochschulen eine einseitige). Theodor Löhe. Serial. 1st part. 2000 w. Die Turbine—Aug. 5, 1908. No. 95149 D.

Fire Loss.

The Discouragement of Preventable Fires. James C. Bayles. The importance of investigating all cases of fire, with remarks on the annual loss, and on methods in Berlin. 1500 w. Cassier's Mag—Sept., 1908. No. 94739 B.

Management.

Efficiency as a Basis for Operation and Wages. Harrington Emerson. This fourth article of the series considers standards; their relation to organization and to results. 4500 w. Engineering Magazine—Oct., 1908. No. 95394 B.

Apportioning Overhead Charges to Flat Cost. Oscar E. Perrigo. Twelfth of a series of articles on shop management and cost keeping. 4000 w. Ir Trd Rev—Sept. 3, 1908. No. 94844.

Stores Keeping.

System in Handling Material. N. M. Rice. Outlines a standard system, considering details. Ills. 2500 w. R R Age Gaz—Sept. 18, 1908. No. 95264.

Foundry Warehouse Methods. F. C. Everitt. Read before the Am. Found. Assn. Outlines two methods for stock accounting to be used in conjunction or separately. 1600 w. Ir Age—Sept. 3, 1908. No. 94812.

Tariffs.

The Collection of Data for Tariff Revision. Concerning efforts being made to collect reliable data of foreign cost of production, and other related matters. 1800 w. Ir Age—Sept. 10, 1908. No. 94904.

The Recently Proposed French Tariff. Translation of the suggestions reported by the Commission of French Manufacturers of machine and small tools asking for higher duties. 6000 w. Am Mach—Vol. 31. No. 37. No. 94920.

Trusts.

Combinations in the German Machinery Trade. Outlines the arrangements made in the direction of obviating competition. 1200 w. Engr, Lond—Sept. 11, 1908. No. 95293 A.

Waste.

National Waste. Oskar Nagel. Brief consideration of needed economy in the United States in connection with industries, the fuels, refuse, etc. 1500 w. Elec-Chem & Met Ind—Sept., 1908. No. 94725 C.

MARINE AND NAVAL ENGINEERING

Battleships.

The Brazilian Battleship "Minas Geraes." Illustration, description, and armament. 1000 w. Engng—Sept. 11, 1908. No. 95091 A.

H. M. Battleships "Agamemnon" and "Lord Nelson." Illustrated description of the two latest ships added to the British fleet. Plate. 1000 w. Engng—Sept. 4, 1908. No. 95050 A.

Compasses.

The Modern Developments of the Mariner's Compass. J. C. Dobbie. Information concerning the invention and adjustment of the compass, and the different types used. Ills. 2500 w. Marine Rev—Aug. 27, 1908. Serial. 1st part. No. 94700.

Cruisers.

The Trials of the Russian Armored Cruiser "Rurik." Editorial on the exhaustive trials and their success. 3300 w. Engng—Sept. 11, 1908. No. 95089 A.

Destroyers.

The British 38-Knot Destroyer "Swift." Illustration and brief description of a vessel said to be the fastest afloat. 600 w. Sci Am—Sept. 5, 1908. No. 94899.

Recent French Torpedo Boat Destroyers. Illustrations and information relating to these vessels. 1500 w. Engr, Lond—Aug. 21, 1908. No. 94788 A.

Dredges.

A Powerful Russian Hydraulic Dredge. H. Prime Kieffer. Illustrated description of the most powerful dredge ever constructed, built in Belgium; also report of trials. 2000 w. Ir Age—Sept. 24, 1908. No. 95324.

Electric Power.

See Steering Gear, under MARINE AND NAVAL ENGINEERING.

Ferry Boats.

The New Ferry Boat in Kiel Harbor (Die neuen Fahrdampfer des Kieler Hafens). Fr. Bertram. Illustrated description. Plates. 3300 w. Schiffbau—Aug. 26, 1908. No. 95160 D.

Internal-Combustion Engines.

The Field for the Combustion Motor in Marine Work (Anwendungsgebiete des Motors in der Schiffahrt). F. W. von Viebahn. Discusses the application of the combustion motor to various classes of vessels; compares it with steam engines and turbines, etc. Serial. 1st part. 2500 w. Schiffbau—July 25, 1908. No. 95158 D.

Japan.

Naval and Merchant Shipbuilding in Japan. A review of progress in this field. 4000 w. Engng—Aug. 21, 1908. No. 94782 A.

Lusitania.
The Performance of the New Steamers "Mauretania" and "Lusitania." Extract from an article by Sir William H. White, in the *London Times*, with comments. 1500 w. Eng News—Sept. 10, 1908. No. 95006.

Marine Transport.
The Earning Power of Ships (Beitrag zu einer Kritik der Rentabilität von Schiffen). Otto Alt. The first part discusses mathematically the general theory of profits. Serial. 1st part. 2500 w. Schiffbau—Aug. 12, 1908. No. 95156 D.

Model Basins.
German Experimental Tanks. General remarks, and illustrated detailed description of the three most recent tanks in Germany. 4000 w. Engr, Lond—Aug. 21, 1908. Serial. 1st part. No. 94785 A.

Motor Boats.
A Motor Launch for the River Tyne. Illustrated description of the oil-engine and reversing gear for the launch "Comet." 1200 w. Engr, Lond—Sept. 11, 1908. No. 95294 A.

Navigation.
New Aids for Navigation. Henry Emerson Wetherill. Brief illustrated descriptions of new instruments for special uses. 2000 w. Jour Fr Inst—Sept., 1908. No. 94730 D.

Resistance.
The Determination of Ships' Resistance (Iets over de Bepaling van den Weerstand van Schepen). J. K. E. Triebart. A mathematical discussion based on tests on models. Ills. 11500 w. De Ingenieur—Aug. 1, 1908. No. 95194 D.

Shipbuilding.
Reinforced Concrete as a Building Material for Boats. Illustrates and describes the system evolved by Carlo Nabellini, of Rome, Italy. 2000 w. Sci Am—Sept. 5, 1908. No. 94898.

New Repair Works of the Clyde Trust. Illustrates and describes the new works at Renfrew, for the repair and up-keep of the floating plant and shore appliances of the Clyde Trustees. 3500 w. Engr, Lond—Sept. 11, 1908. No. 95291 A.

Angle Iron in the Construction of Trading Vessels (Die Winkelprofile im Handelsschiffbau). Carl Kielhorn. Describes the historical development of the angle profile and the sections now available. 3100 w. Stahl u Eisen—Aug. 26, 1908. No. 95133 D.

Ship Design.
A Note on the Dimensioning of Ships (Beitrag zur Dimensionierung von Schiffen). Alfred Schmidt. Develops new and reliable formulae. Ills. 3600 w. Schiffbau—Aug. 26, 1908. No. 95159 D.

Steam Boilers.
Some Remarks on the Design, Construction and Working of the Marine Boiler. Richard Hirst. Opinions on the practice of boiler construction and working. 4000 w. Mech Wld—Sept. 1, 1908. No. 95273 A.

Steam Turbines.
Turbines at the German Shipbuilding Exhibition, 1908 (Die Turbomaschinen der Deutschen Schiffbau-Ausstellung, 1908). Illustrated description of the exhibits for marine work. Serial. 1st part. 2000 w. Zeitschr f d Gesamte Turbinenwesen—Aug. 29, 1908. No. 95147 D.

See also Condensers, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Steering Gear.
Electrical Operation of Steering Gear (Ueber den elektrischen Antrieb des Schiffssteuers). A Stauch. A comprehensive discussion of this application of electric power, the motors best adapted, etc. Ills. Serial. 1st part. 6000 w. Schiffbau—Aug. 12, 1908. No. 95157 D.

MECHANICAL ENGINEERING

AUTOMOBILES.

Adler.
The Adler Petrol Cars. Illustrated detailed description of a car built in Germany. 1500 w. Auto Jour—Aug. 22, 1908. Serial. 1st part. No. 94756 A.

Alldays.
The Alldays Petrol Cars. Illustrated detailed description. 800 w. Auto Jour—Sept. 5, 1908. Serial. 1st part. No. 95030 A.

American.
Concerning the Seven 1909 Americans. Illustrations and information relating to the seven models of the American Motor Car Co. 2000 w. Automobile—Sept. 3, 1908. No. 94849.

Cabs.
The Work and Design of Motor Cabs. Discusses details, giving diagrams of tests carried out. 1800 w. Engng—Aug. 28, 1908. No. 94948 A.

Carbureters.
Getting Acquainted With a Carbureter. Herbert L. Towle. Suggestions for amateurs. Ills. 2500 w. Automobile—Sept. 24, 1908. No. 95344.

Clutches.
The Crossley Car and Its Expanding Clutch. Illustrates and describes this

clutch. 1200 w. Auto Jour—Aug. 22, 1908. No. 94758 A.

Commercial Vehicles.

Motor Apparatus for Fire Departments. George W. Kerr. Considers the advantages of motor-driven vehicles over horse-drawn. 2500 w. Com Vehicle—Sept., 1908. No. 94815 C.

See also Springs, under AUTOMOBILES.

Ford.

Ford Light Touring Car for 1909. Illustrated description of a low-priced car. 2000 w. Automobile—Sept. 24, 1908. No. 95345.

Ignition.

A Chapter on Magnet Construction. Illustrated description of the new Bosch coil. 700 w. Automobile—Sept. 10, 1908. No. 94972.

High-Tension Magneto-Ignition Systems. Illustrates and describes the Gibaud Magneto, a machine of French origin. 1000 w. Auto Jour—Aug. 22, 1908. Serial. 1st part. No. 94757 A.

Lamps.

The Troubetzkoy Acetylene Lamps. A lamp manufactured in Milan, is illustrated and described. 1000 w. Auto Jour—Aug. 22, 1908. No. 94759 A.

Motor Cooling.

Radiator Efficiency Investigations. Dr. W. R. Ormandy and J. H. Lester. An account of investigations of several systems of cooling. 3000 w. Autocar—Aug. 22, 1908. No. 94753 A.

Motor Rating.

Rating an Automobile Engine. Thomas L. White. Explains method of determining horse power from the cylinder dimensions. 3000 w. Sci Am Sup—Sept. 12, 1908. No. 94996.

Horse Power Ratings of Automobile Motors. Thomas J. Fay. Discusses the importance of the stroke, its effect on compression, conditions affecting the torque, etc. 2500 w. Automobile—Sept. 24, 1908. Serial. 1st part. No. 95343.

Motors.

The Direct Injection of Motor Fuel. Thomas J. Fay. Discusses the essential elements of direct injection and related subjects. 3500 w. Automobile—Sept. 3, 1908. No. 94848.

Why the Long Stroke for Motors? S. F. Edge. Discusses why the long-stroke engine is being developed for racing cars, considering the objections to excessively long strokes. 2000 w. Automobile—Sept. 17, 1908. No. 95098.

Rover.

The 20 H. P. T. T. Rover Car. Illustrated description of a car that took part in the Tourist Trophy race. 2000 w. Autocar—Aug. 22, 1908. No. 94754 A.

Siddeley.

The Siddeley Motor Cab. Drawings and detailed description. 1000 w. Engng —Aug. 28, 1908. No. 94950 A.

Springs.

A Discussion of Commercial Vehicle Springs. Morris A. Hall. Discusses types usually employed, methods of suspension, etc. 2500 w. Com Vehicle—Sept., 1908. No. 94814 C.

Steering Gear.

The Steering Gear. An illustrated discussion of its defects and how they may be remedied. 3500 w. Autocar—Sept. 5, 1908. No. 95029 A.

A Study of Steering Connections. William Wreford. Illustrates faults shown in the ball and cup joints. 1500 w. Autocar—Aug. 22, 1908. No. 94755 A.

Stoddard-Dayton.

Stoddard-Dayton, 1909. Illustrated description. 2000 w. Automobile—Sept. 10, 1908. No. 94973.

Tires.

Motor Cycle Tires and Accessories. H. Gillard Cove. Abstract of paper read before the Auto Cycle Union. Gives the writer's experience and much general information. 3500 w. Auto Jour—Aug. 29, 1908. No. 94922 A.

Tractors.

The "Walking Engine." An illustrated account of the latest developments, and future prospects of the "Diplock" pedrail. 2800 w. Auto Jour—Sept. 5, 1908. No. 95031 A.

Trenching Machine.

An Automobile Trenching Machine (Charrue Automobile Militaire). G. Espitallier. Illustrated description. 3200 w. Génie Civil—Aug. 8, 1908. No. 95113 D.

Troubles.

Suggestions for the Man Who Drives His Car. Thomas J. Fay. Cases of trouble and the remedies are given. 1200 w. Automobile—Sept. 10, 1908. Serial. 1st part. No. 94971.

Vinot.

The 12 x 16 H. P. Vinot Car. Illustrated detailed description. 1200 w. Autocar—Aug. 29, 1908. No. 94923 A.

Wear.

Cause and Prevention of Wear in Motor-Driven Vehicles. F. H. Royce. Considers the causes of, and remedies for, wear in private cars. Ills. 2000 w. Auto Jour—Sept. 12, 1908. No. 95271 A.

Zedel.

The 15 H. P. Four-Cylinder Zedel. Illustrated detailed description of the chassis. 1400 w. Autocar—Sept. 12, 1908. Serial. 1st part. No. 95272 A.

COMBUSTION MOTORS.

Fuels.

Internal Combustion for Rotary Prime Motors. Edward C. Warren. Proposals for fuel and oxygen supply, indicating the lines the writer believes would prove successful. 3000 w. Engineering Magazine —Oct, 1908. No. 95395 B.

Gas Engine Failures.

Gas and Oil Engine Breakdowns and Their Lessons. Michael Longridge. From the annual report of the Chief Engineer of the British Engine, Boiler & Elec. Ins. Co., Ltd., giving causes of failures. 4500 w. Mech Engr—Sept. 4, 1908. No. 95034 A.

Gas Engines.

The Du Bois Tandem Gas Engine. George W. Malcolm. Illustrates and describes a new angle acting type. 1200 w. Power—Sept. 8, 1908. No. 94907.

Gaseous Explosions. First report of the committee appointed by the British Association for the investigation of gaseous explosions, with special reference to temperature. 13000 w. Engng—Sept. 11, 1908. Serial. 1st part. No. 95094 A.

The Influence of Mixture Ratio on the Thermal Efficiency of Internal Combustion Motors (Influence de la Proportion du Mélange sur l'Utilisation thermique du Fluide Moteur dans les Moteurs à Explosions). K. Kutzbach. Translated from *Zeitschr. d. Ver. Deutscher Ing.* Ills. Serial. 1st part. 2500 w. All Indus —Aug., 1908. No. 95108 D.

Gasoline Engines.

A Gasoline Motor With Rotating Cylinders. Illustrated description of Farwell motors and their control. 2000 w. Eng News—Sept. 10, 1908. No. 95008.

Economy in Gasoline Engine Operation. P. F. Walker. Considers conditions which tend to give economical results. 2000 w. Power—Sept. 1, 1908. No. 94750.

Horse Power Formulae for Petrol Engines. Gives some features of the report of the sub-committee of the Society of Motor Manufacturers and Traders. 4500 w. Autocar—Aug. 29, 1908. No. 94924 A.

Gas Power Plants.

The Gas Engine as Applied to the Operation of Textile Mills. A. Vennell Coster. Illustrates and describes successful applications of gas power in Lancashire manufactories. 4000 w. Cassier's Mag—Sept. 1908. No. 94734 B.

The Producer Gas Power Plant of the Minneapolis & St. Louis. Illustrated description of the first power plant of this character to be used for an American railroad shop. 1500 w. R R Age Gaz—Sept. 18, 1908. No. 95260.

Gas Power Standards.

Gas Power Section—Progress Report of the Committee on Standardization. Gives communications on various subjects received by the committee. 8000 w. Jour Am Soc of Mech Engrs—Sept., 1908. No. 95069 F.

Gas Producers.

The Suction Gas Producer Plant at the Shops of Fairbanks, Morse & Co. Illustrated description. 1200 w. Eng Rec—Sept. 5, 1908. No. 94872.

The Production of Cheap Power by Suction Gas Plants. Philip W. Robson. Read before the British Assn. at Dublin. Remarks on the development of these producers, explaining the principle of working, the advantages, etc., and giving much information. 5000 w. Engng—Sept. 11, 1908. No. 95087 A.

Oil Engines.

See Gas Engine Failures, under COMBUSTION MOTORS; and Motor Boats, under MARINE AND NAVAL ENGINEERING.

Producer Gas.

Producer Gas. J. Emerson Dowson. Read before the British Assn. at Dublin. Reviews the progress of recent years, results of practical experience and future possibilities. 3500 w. Engng—Sept. 11, 1908. No. 95092 A.

Water Gas.

Water Gas (Wassergas). Ottoman Kayser. Discusses the apparatus, methods and costs of its production. Ills. 5500 w. Oest Zeitschr f d Oeffent Baudienst—Aug. 15, 1908. No. 95164 D.

HEATING AND COOLING.

Air Cooling.

Air Cooling. Theodore Weinshank. Read before the Am. Soc. of Heat. & Vent. Engrs. Discusses problems in connection with air-washing. 1800 w. Heat & Vent Mag—Aug., 1908. No. 94744.

Engineering.

Reasons Why the Science of Heating and Ventilating Engineering Should be Observed. J. D. Hoffman. Read before tracts, etc. 3000 w. Heat & Vent Mag—Discusses the general requirements, contracts, etc. 3000 w. Heat & Vent Mag—Aug., 1908. No. 94742.

Heat Regulators.

An Automatic Heat-Regulator. Illustrated description of a device depending for its operation upon the law of the variation of vapor tension with differences in temperature. 1200 w. Sci Am Sup—Sept. 12, 1908. No. 94997.

Hot-Air Heating.

A Hot-Air Furnace in a House Without a Cellar. R. S. Thompson. Read before the Am. Soc. of Heat. & Vent. Engrs. Sketches and description of method used. 1500 w. Heat & Vent Mag—Aug., 1908. No. 94743.

Heat Transmission over Long Distances (Ueber Fernleitung von Wärme). O. Krell. A mathematical discussion, particularly of the use of hot air. Ills. 3800 w. Gesundheits-Ing—Aug. 29, 1908. No. 95153 D.

Hot-Water Heating.

The Schott Systems of Central Station Heating. J. C. Hornung. Gives briefly the history of steam and hot water systems, and describes Schott's balanced column hot water system, and the regulated steam system. 2800 w. Jour Assn of Engng Socs—Aug., 1908. No. 95401 C.

See also Shop Heating, under MACHINE WORKS AND FOUNDRIES.

Liquid Helium.

The Latest Advance Towards the Absolute Zero. Francis Hyndman. Information concerning the work of Prof. H. Kamerlingh Onnes, and his apparatus for the liquefaction of helium. Ills. 2000 w. Engng—Aug. 28, 1908. No. 94947 A.

Radiation.

Coefficient of Transmission in Cast Iron Radiation. John R. Allen. Read before the Am. Soc. of Heat. & Vent. Engrs. Gives results of tests made to determine the variation of the coefficient of conditions with different temperatures of steam and air on the two sides of a cast-iron radiator. 1200 w. Heat & Vent Mag—Aug., 1908. No. 94745.

Radiators.

The Relative Efficiency and Durability of Cast Iron and Pressed Steel Radiators. Ray D. Lillibridge. Short discussion. Ills. 1000 w. Heat & Vent Mag—Sept., 1908. No. 95404.

Refrigeration.

Manhattan Refrigerating Plant. Illustrates and describes the construction of the buildings, and the safeguards against loss by fire. 3000 w. Ins Engng—Sept., 1908. No. 95406 C.

The Absorption Refrigeration Machine. Gardner T. Voorhees. Describes the volatile liquid refrigerating machine, the compression machine, and the absorption machine. 4500 w. Ice & Refrig—Sept., 1908. Serial. 1st part. No. 94873 C.

Experiments with Binary Refrigeration. Edgar Penney. Read at meeting of Am. Soc. of Refrig. Engrs. Reviews the use of binary gases in refrigeration, experiments and conclusions, tests, etc., giving criticisms of the plant and explaining the theory on which it is based. Ills. 1500 w. Cold Storage & Ice—Sept., 1908. No. 95076 C.

Vapor Pressure of Dilute Ammonia Solutions (Dampfdruck von wässrigen Ammoniaklösungen). Hilde Mollier. Reports extensive investigations of the relation between condensation, pressure and temperature of dilute ammonia solutions, with reference to the absorption system of refrigeration. Ills. 3500 w. Zeitschr d Ver Deutscher Ing—Aug. 15, 1908. No. 95182 D.

See also same title, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Steam Heating.

An Exhaust Central Station Steam Heating Plant. James A. White. Describes a plant at West Chester, Penn., which supplies heat to over 200 customers in business blocks, residences, etc. 3000 w. Dom Engng—Aug. 29, 1908. No. 94708.

See also Hot-Water Heating, under HEATING AND COOLING.

Ventilation.

The Requirements of Good Ventilation. Walter B. Snow. A statement of the principal facts and laws governing ventilation giving practical applications, particularly with reference to the combined system of forced circulation and indirect steam heating. 3000 w. Dom Engng—Sept. 19, 1908. No. 95079.

Ventilation of the First Church of Christ, Scientist, Boston. Charles L. Hubbard. Detailed description of method, explaining conditions. 2000 w. Eng Rec—Sept. 19, 1908. No. 95232.

HYDRAULIC MACHINERY.

Centrifugal Pumps.

Diversified Uses of the Centrifugal Pump. E. F. Doty. Their adaptation in boiler feeding, dry dock and sewage pumping and general industrial purposes. 2500 w. Power—Sept. 1, 1908. No. 94752.

Hydrostatics.

Pressure of the Atmosphere on Liquids. Franklin van Winkle. Considers conditions of equilibrium in liquid columns, siphonage, etc. Ills. 3500 w. Power—Sept. 8, 1908. No. 94915.

Piping.

See Steam Pipes, under STEAM ENGINEERING.

Pumping Plants.

The Pumping Stations of the Intercepting Sewer System of Chicago. Plans, illustrations, with descriptions and general information. 4500 w. Eng News—Sept. 10, 1908. No. 95007.

The Pumping Plant of the Huntley Irrigation Project. F. W. Hanna. Illustrated description of a pumping system on the Yellowstone River, Montana. 1200 w. Eng News—Sept. 3, 1908. No. 94866.

See also Purification, under CIVIL ENGINEERING, WATER SUPPLY.

Pump Valves.

The Design of Pump Valves (Berechnung der Pumpenventile). Georg Lindner. An exhaustive mathematical discussion. Ills. 4500 w. Zeitsch d Ver Deutscher Ing—Aug. 29, 1908. No. 95186 D.

Turbine Plants.

The Cost of Water Power Plants (Baukosten von Wasserkraftanlagen). K. Thielsch. Enumerates the items in the cost of turbine and hydro-electric plants, giving costs of a large number of plants.

Tables and curves. 3200 w. Zeitschr f d Gesamte Turbinenwesen—Aug. 20, 1908. No. 95146 D.

Water-Wheel Governors.

A Water Wheel Governor and Its Operation. D. Ben Replogle. Gives diagrams showing the movements of the governor described. 1200 w. Min & Sci Pr—Sept. 5, 1908. No. 94978.

A New Type of Water Wheel Governor. Simpson Rice. Illustrates and describes an oil-pressure governor recently brought out, and its operation. 2500 w. Power—Sept. 15, 1908. No. 95062.

Water Wheels.

The Pelton Wheel Installation at the Nordhausen Municipal Electric Station (Die Peltonradanlage des Elektrizitätswerkes der Stadt Nordhausen). A. Pfarr. Illustrated description of a large installation. 2500 w. Zeitschr d Ver Deutscher Ing—Aug. 1, 1908. No. 95176 D.

MACHINE ELEMENTS AND DESIGN.

Clutches.

A Spring-Cushioned Clutch. Albert Walton. Describes its construction and operation. Ills. 1000 w. Am Mach—Vol. 31, No. 37. No. 94917.

Drafting Offices.

A Simple Drawing Office System. Ernest A. Vessey. Describes a simple, cheap and satisfactory system. 2000 w. Engr, Lond—Aug. 21, 1908. No. 94790 A.

Gears.

Laying Out Spur Gears (Die Bearbeitung der Zähne von Stirnrädern). P. Gerlach. A theoretical discussion of the method of designing the teeth. Ills. 6000 w. Zeitschr d Ver Deutscher Ing—Aug. 8, 1908. No. 95179 D.

Graphical Charts.

The Construction of Graphical Charts. John B. Peddie. Considers alinement charts with double scales and two pairs of axes, the hexagonal index chart, and a modification. 6000 w. Am Mach—Vol. 31, No. 36. No. 94831.

Riveted Joints.

The Distribution of Stresses in Riveted Joints (Zur Kraftverteilung in genieteten Stäben). Ivan Arnovlevic. Mathematical. Ills. 8000 w. Oest Zeitschr f d Oeffent Baudienst—Aug. 22, 1908. No. 95166 D.

Stuffing Boxes.

Designing Labyrinth Stuffing Boxes for Steam Turbines. P. Faber. Gives a method of calculating packings of labyrinth stuffing boxes, giving graphical solution. 1200 w. Power—Sept. 8, 1908. No. 94914.

MACHINE WORKS AND FOUNDRIES.

Automatic Machines.

See Chain Driving, under POWER AND TRANSMISSION.

Blacksmith Shops.

Tools for the Blacksmith Shop. James Cran. Suggestions for serviceable and satisfactory tools. Ills. 2000 w. Mach, N Y—Sept., 1908. No. 94803 C.

Boring.

Locating and Boring Oblique Holes in Jigs. C. L. Goodrich. Directions and methods. Ills. 1200 w. Am Mach—Vol. 31, No. 37. No. 94916.

Brass Founding.

Quartz Crucibles. Explains what they will and will not do. 600 w. Brass Wld —Sept., 1908. No. 95267.

Making Art Metal Work in Gutta-Percha Molds. The advantage of these molds, their manufacture and use. Ills. 1500 w. Brass Wld—Sept., 1908. No. 95266.

The Color of Brass Foundry Alloys. J. F. Buchanan. An exhaustive discussion of the color problem in so far as it effects alloys for castings. Ills. 3000 w. Foundry—Sept., 1908. No. 94716.

Care and Personal Attention Necessary to Produce Brass Goods of a Strictly High Grade Nature. Joseph H. Glauber. Read before the Metal Work. Club. Explains the methods and the great care needed. 2500 w. Dom Engng—Sept. 5, 1906. No. 94850.

Quality vs. Quantity in the Brass Foundry. J. N. Gamble. Read before the Am. Brass Found. Assn. Shows that quality and quantity must go together, and gives suggestions. 1800 w. Foundry—Sept., 1908. No. 94718.

A Résumé of the Effect of Impurities on Brass Intended for Rolling. Erwin S. Sperry. An illustrated article indicating the effect of the various metallic and non-metallic elements. 3500 w. Brass Wld—Sept., 1908. No. 95265.

See also Cleaning Baths, under ELECTRICAL ENGINEERING, ELECTRO-CHEMISTRY.

Castings.

Small Piston-Ring Castings. Walter J. May. Suggestions for their economical production. 500 w. Prac Engr—Aug. 28, 1908. No. 94925 A.

Cupolas.

Foundry Cupola Construction. Thomas D. West. Read before the N. Eng. Found. Assn. Discusses the features required to meet special conditions. 2500 w. Ir Age —Sept. 24, 1908. No. 95325.

Oil-Fired Cupolas (Ueber Kupolöfen für Oelfeuerung). Illustrated description of various firing devices, their efficiency, etc. 2500 w. Stahl u Eisen—Aug. 19, 1908. No. 95132 D.

Dies.

Threading Dies. Erik Oberg. Illustrated descriptions of their design, manufacture, and uses. 2500 w. Mach, N Y —Sept., 1908. No. 94804 C.

Enameling.

See Furnaces, under MACHINE WORKS AND FOUNDRIES.

Force Making.

Making Forces for Embossed Work. Chester L. Lucas. Describes methods of making forces. Ills. 1500 w. Am Mach —Vol. 31. No. 37. No. 94918.

Forging.

Drop Forge Work in an Automobile Shop. Ethan Viall. Illustrates and describes methods used in a factory at Kenosha, Wis. 2000 w. Mach, N Y—Sept., 1908. No. 94802 C.

Foundry Management.

See Cost Systems, and Stores Keeping, under INDUSTRIAL ECONOMY.

Foundry Materials.

The Testing of Foundry Irons. F. J. Cook. From the presidential address before the British Found. Assn. at Newcastle-on-Tyne. Discusses important tests. Ills. 2500 w. Ir & Coal Trds Rev—Sept. 11, 1908. No. 95296 A.

The Properties of Ferro-Silicon. From a report of D. R. Wilson it is said that it possesses explosive and poisonous characteristics which should be considered in its transportation. 1000 w. Ir & Coal Trds Rev—Sept. 11, 1908. No. 95297 A.

The Utilization of High Percentage Ferro-Silicon in the Foundry (Ueber Verwendung hochprozentigen Ferrosiliziums in der Eisengiesserei). Dr. Westhoff. Its utility, effects on cast iron, cost, etc. 2000 w. Stahl u Eisen—Aug. 26, 1908. No. 95135 D.

Foundry Practice.

Needless Foundry Wastes. Harrington Emerson. Read before the Am. Found. Assn. Considers preventable losses and wastes. 900 w. Foundry—Sept., 1908. No. 94715.

"Burning" a Propeller Wheel Blade. Thomas D. West. Read before Phila. Found. Assn. Illustrates and describes details of the operation. 1500 w. Ir Age —Sept. 10, 1908. No. 94903.

Open-Hearth Steel Foundry Practice. Illustrated description of the arrangement, equipment, and operating methods of a plant, containing one 15-ton acid furnace, at Lima, Ohio. 2000 w. Foundry—Sept., 1908. No. 94714.

Furnaces.

Applications of Oil Burning Apparatus. C. M. Ripley. A review of present methods. 1800 w. Sci Am Sup—Sept. 5, 1908. No. 94902.

Furnaces for the Enameling Industry. Joseph Vollkommer. Illustrated descriptions. 1500 w. Ir Age—Sept. 3, 1908. No. 94813.

A Tempering Furnace with Electrically Heated Bath (Ueber einen Härteofen mit elektrisch geheiztem Schmelzbad). C. R. Straube. Illustrated description of the A. E. G. furnace which employs three-phase current to fuse a salt varied according to the temperature required. 4500 w. Elektrotech Zeitschr—Aug. 6, 1908. No. 95187 D.

Grinding Machines.

Grinding Machine Troubles and Their Causes. A. B. Schleifer. 2500 w. Am Mach—Vol. 31, No. 36. No. 94830.

Grinding Machines and Their Applications (Schleifsscheiben und ihr Verwendungsgebiet). Alfred Lebert. Illustrates and describes machines for various classes of work. 5000 w. Zeitschr d Ver Deutscher Ing—Aug. 15, 1908. No. 95-181 D.

Milling Machines.

Cincinnati High Power Milling Machines. Illustrates and describes a series of machines built on the unit system. 4500 w. Am Mach—Vol. 31, No. 38. No. 95206.

New Le Blond Milling Machine Attachments. Illustrated descriptions of a number of attachments, including one for hobbing gears. 2000 w. Ir Age—Sept. 3, 1908. No. 94811.

Molding.

The Permanent Mold Problem. Edgar Allen Custer. Considers the difficulties in the art of making castings in permanent iron molds and how they have been overcome. 1500 w. Foundry—Sept., 1908. No. 94717.

Molding Machines.

Molding Machines (Machines à Mouler). M. Avaurieu. Illustrated description of the design and operation of types which have appeared during the last four years. Serial. 1st part. 6500 w. Rev de Mécan—Aug., 1908. No. 95106 E + F.

Molding Sand.

The Mechanical Preparation of Molding Sand (Le Sabbie da Fonderia e la loro Preparazione Meccanica). Aureli Aurelio. Illustrates and describes methods and machines for drying, disintegrating, etc. Serial, 1st part. 2500 w. Monit Tech—Aug. 20, 1908. No. 95120 D.

Patterns.

The Classification of Patterns. Oscar E. Perrigo. Illustrated discussion of various molding processes and their relation to pattern-making. 4000 w. Foundry—Sept., 1908. No. 94719.

Pneumatic Hammers.

New Pneumatic Hammers with Separate Hammer and Air-Pump Cylinders (Neuere Lufthämmer mit getrenntem Bär- und Luftpumpenzylinder). Herm. Meyer. Illustrated description of various types. 2500 w. Zeitschr d Ver Deutscher Ing—Aug. 22, 1908. No. 95-184 D.

Sawing Machines.

5-in. Hack-Sawing Machine. Illustrated description of a machine shown at the Franco-British exhibition. 500 w. Engng —Sept. 11, 1908. No. 95086 A.

Shop Appliances.

Some Old Gages and Filing Jigs. E. A. Dixie. Illustrations and information. 1500 w. Am Mach—Vol. 31, No. 37. No. 94921.

Profitable Methods in Metal Working (Vorteilhafte Arbeitsverfahren für Metallbearbeitung). H. Baessler. Describes methods, tools, and machines found useful by the writer. Ills. Serial. 1st part. 3300 w. Zeitschr d Ver Deutscher Ing—Aug. 1, 1908. No. 95177 D.

Shop Design.

Design and Construction of Metal Working Shops. W. P. Sargent. Discusses industrial plant extension as applied to metal working industries. Ills. 4500 w. Mach, N Y—Sept., 1908. Serial. 1st part. No. 94800 C.

Shop Heating.

Heating and Ventilating a Sheet Metal Shop. Illustrated description of a fan system delivering air near floor level. 1300 w. Metal Work—Sept. 12, 1908. No. 94963.

Heating the McKees Rocks Shops, Pittsburgh & Lake Erie R. R. Douglas P. Morrison. Describes the system of heating 8 shops. 1200 w. Eng Rec—Sept. 5, 1908. No. 94870.

Shop Practice.

Machining a Large Segmental Gear Wheel. C. Scholtka. Illustrates and describes methods and operations. 1500 w. Am Mach—Vol. 31, No. 39. No. 95326.

The Manufacture of Wood-Working Machinery. Illustrated description of shops at Rochester, N. Y., and the arrangements of departments. 2500 w. Ir Trd Rev—Sept. 10, 1908. No. 94974.

Points of Interest in a Railroad Shop. Ethan Viall. Illustrated description of some of the tools and methods in use in the Chicago & Alton shops, at Bloomington, Ill. 2000 w. Am Mach—Vol. 31, No. 38. No. 95207.

Shops.

Engineering Works in the Manchester District. The present number illustrates and describes the works of Messrs. Galloways, Ltd., and Messrs. Frank Pearn & Co., Ltd. 2500 w. Elec Engr, Lond—Sept. 4, 1908. Serial. 1st part. No. 95039 A.

Shop Ventilation.

Industrial Dust and Disease. Reviews a discussion at the Sheffield meeting of the British Medical Assn. 1200 w. Engr, Lond—Sept. 4, 1908. No. 95055 A.

Tempering.

Hardening Steel. E. R. Markham. Describes methods used by writer, calling attention to harmful effects and practice. Ills. 4000 w. Mech Wld—Aug. 28, 1908. No. 94929 A.

A New Design for Hardening Rooms. E. F. Lake. Illustrated detailed description of room designed and equipped for the Standard Tool Co. of Cleveland, O. 2500 w. Am Mach—Vol. 31, No. 36. No. 94829.

See also Furnaces, under MACHINE WORKS AND FOUNDRIES.

Welding.

A Fusion Process for Welding Steels. Illustrates and describes a process that appears to be successful. 2000 w. Ir & Coal Trds Rev—Aug. 28, 1908. No. 94960 A.

New Thermit Reactions. Hans Goldschmidt. Demonstrates some new thermit reactions, the main feature of which is the substitution of other metals for aluminium. 3000 w. Elec-Chem & Met Ind—Sept., 1908. No. 94722 C.

MATERIALS OF CONSTRUCTION.

Alloy Steels.

Special Alloy Steels and Their Mechanical Applications. Léon Guillet. Gives a summary of the present state of the art in France. 5000 w. Engineering Magazine—Oct., 1908. No. 95397 B.

Bearing Metals.

Bearings and Bearing Metals. L. Parry. Considers the properties sought for in white bearing metal, lubrication, etc. 3500 w. Min Jour—Aug. 22, 1908. No. 94778 A.

Breakages.

The Study of Breakages. Walter Rosenhain. Read before the British Assn. at Dublin. A plea for the thorough investigation of failures in engineering practice, describing in detail various examples, and discussing causes. Ills. 7500 w. Engng—Sept. 11, 1908. No. 95088 A.

Cast Iron.

Effects of Titanium on Cast Iron. Condensed from an article by Bernhard Feise, in *Stahl und Eisen*. 900 w. Ir Age—Sept. 10, 1908. No. 94905.

Gaskets.

A Practical Consideration of Gaskets. W. E. Sanders. Discusses the essentials of a good gasket, and the proper method of cutting them. 3500 w. Power—Sept. 22, 1908. No. 95250.

Packings.

The Purchase and Use of Packing. W. E. Sanders. Considers economy, cutting, lubricating, etc. 2500 w. Power—Sept. 15, 1908. No. 95061.

"Moisture" and "Expansion" Packings. W. E. Sanders. Describes the packings, especially the manufacture of rubber packings. Ills. 2500 w. Power—Sept. 1, 1908. No. 94747.

Automatic Steam and Ammonia Packings. W. E. Sanders. A discussion of the advantages, cost, and application of diagonal or automatic packings, and of packings for high temperatures and ammonia. 2500 w. Power—Sept. 8, 1908. No. 94908.

Steel.

Magnet Steel (Magnetstahl). G. Hannack. Discusses the physical properties of good magnet steel and the influence of various impurities and alloys. Ills. 1800 w. Stahl u Eisen—Aug. 26, 1908. No. 95134 D.

Tool Steels.

High-Speed Steel. H. H. Hill. Read befort the Liverpool Engng Soc. Considers recent advances made in tool steels and their application. 2000 w. Mech Wld—Aug. 21, 1908. No. 94765 A.

Wastes.

The Utilization of Industrial Wastes (La Mise en Valeur des Déchets Industriels). Paul Bellou. A general paper on the mechanical and chemical methods of effecting a separation of mixed refuse. Ills. 6000 w. Rev d'Econ Indus—Aug., 1908. No. 95100 D.

MEASUREMENT.

Cooling Curves.

On Methods of Obtaining Cooling Curves. G. K. Burgess. Discusses methods of thermal analysis, temperature-time curves, differential curves, direct and inverse rate curves, rapid cooling, and characteristics of cooling curves. Ills. 5500 w. Elec-Chem & Met Ind—Sept., 1908. Serial. 1st part. No. 94724 C.

Extensometers.

The Use of an Extensometer in Commercial Work. T. D. Lynch. Presents stress-strain diagrams on steel and other metals in tension, showing the comparative elasticity. 2500 w. Eng Rec—Sept. 12, 1908. No. 94970.

Hardness.

Instrument for Testing Hardness. J. F. Springer. Illustrates and describes the scleroscope and its use. 1000 w. Ry & Loc Engng—Sept., 1908. No. 94827 C.

Methods of Testing Materials for Hardness. J. F. Springer. An illustrated article comparing the ball, electric and drop methods. 5500 w. Cassier's Mag—Sept., 1908. No. 94733 B.

The Brinell Method of Testing the Hardness of Metals. Explains the principle of the method devised by J. A. Brinell, which consists in partly forcing a steel ball into the material to be tested. 2000 w. Mach, N Y—Sept., 1908. No. 94801 C.

Pyrometry.

Cold-Junction Temperature Corrections of Pt. Pt Rh and Pt. Pt Ir Thermo-Electric Pyrometers. Cornelius Offerhaus and Ernst H. Fischer. Discusses the measuring of temperatures by means of thermocouples. 2800 w. Elec-Chem & Met Ind—Sept., 1908. No. 94723 C.

The Wanner Optical Pyrometer for Temperatures Between 625 and 1000 degrees C. (Das optische Pyrometer Wanner für Temperaturen von 625°-1000° C.). Illustrated detailed description of construction and operation. Serial. 1st part. 1500 w. Elektrochem Zeitschr—Aug., 1908. No. 95128 D.

See also Cooling Curves, under MEASUREMENT.

POWER AND TRANSMISSION.

Air Compressors.

A Variable Volume Air Compressor. H. V. Haight. Illustrated description of a duplex-tandem machine which varies the delivery by quarter loads while maintaining full compound efficiency. 1000 w. Compressed Air—Sept., 1908. No. 94818.

An Improved Hydraulic Air Compressor System. George C. McFarlane. Illustrates and describes the system, giving details of construction of air tanks, pipes and nozzle. 1000 w. Min Wld—Sept. 19, 1908. No. 95210.

Belts.

The Use of Jockey-Pulleys on Belts. Illustrated description of the "Lenix" belt drive. 1500 w. Mech Wld—Sept. 4, 1908. No. 95036 A.

Chain Driving.

Chain Drive for Automatic Forming Machines. Explains the advantages of this smooth and positive spindle drive. Ills. 1500 w. Am Mach—Vol. 31, No. 38. No. 95208.

Electric Driving.

Two-Motor Drive—Automatic Web Printing Press Control. S. H. Sharpsteen. Diagram and description. 3500 w. Elec Rev, N Y—Sept. 19, 1908. No. 95213.

The Dynamic Brake in Printing Press Drive. S. H. Sharpsteen. Discusses dynamic brake troubles. 1500 w. Elec Wld—Sept. 19, 1908. No. 95218.

The Storage Battery for Web Printing Press Control. S. H. Sharpsteen. Describes a method of control that uses no resistance in circuit with the armature. 2000 w. Elec Wld—Sept. 12, 1908. No. 95017.

The Application of Motors to Machine Tools. Dexter S. Kimball. Explains the advantages and discusses methods. 4000 w. Wood Craft—Sept., 1908. No. 94819.

An Electrically-Operated Gas Plant. Dr. Alfred Gradenwitz. Illustrations and description of a plant in Germany. 800 w. Sci Am Sup—Sept. 26, 1908. No. 95339.

Gas Compressors.

Gas Compressors of Special Type. Silas R. Stone. Illustrated description of a type built for special service. 800 w. Power—Sept. 8, 1908. No. 94912.

Hydraulic Power.

Modern Hydraulic Power Stations. N. S. Trustrum. Shows that there is still use for hydraulic power, and considers the means of transmission. 1500 w. Prac Engr—Sept. 11, 1908. Serial. 1st part. No. 95274 A.

Lubrication.

Piping Oil to Several Hundred Machines. Illustrates and describes methods used by the Standard Tool Co., of Cleveland, O., for overcoming the clogging of pipes with chips by means of open gutters and filters. 1000 w. Am Mach—Vol. 31, No. 37. No. 94919.

See also Bearing Metals, under MATERIALS OF CONSTRUCTION.

Power Plants.

Practical Notes on Gas Engine Driven Dynamos. Discusses the causes that are liable to give trouble. 2500 w. Mech Wld —Aug. 21, 1908. No. 94763 A.

STEAM ENGINEERING.

Boiler Cleaning.

Cleaning Babcock and Wilcox Boilers. Percival Hastings. Directions and suggestions, 1200 w. Power—Sept. 22, 1908. No. 95251.

Boiler Design.

Calculating the Strength of New Steam Boilers (Sterkteberekening van nieuwe Stoomketels). A report of a commission to the Dutch Minister for the Colonies. An exhaustive discussion. Tables. Curves. Ills. 18000 w. De Ingenieur—Aug. 22, 1908. No. 95195 D.

Boiler Efficiency.

The Real Efficiency of Steam Boilers. W. H. Booth. On methods of computing efficiency, and the errors. 2200 w. Power —Sept. 1, 1908. No. 94749.

Boiler Explosions.

See Boiler Scale, under STEAM ENGINEERING.

Boiler Houses.

Standard Boiler House Design of the Oliver Iron Mining Co. A. M. Gow. Read at meeting of the Lake Superior Min. Inst. Explains conditions to be met and considers in detail the design adopted. Ills. 5000 w. Eng News—Sept. 17, 1908. No. 95221.

Boiler Management.

Modern Steam Boiler Practice. W. H. Booth. Discusses points in boiler practice which affect the efficiency. 2500 w. Elec Rev, Lond—Sept. 4, 1908. No. 95042 A.

Management and Design of Lancashire and Cornish Boilers. Vernon Smith. Directions for their care and discussion of sources of trouble in the present number. 2000 w. Prac Engr—Sept. 4, 1908. Serial. 1st part. No. 95032 A.

Boiler Scale.

Corrosion and Incrustation—A Source of Boiler Explosions. Illustrates and describes a number of instances of scale formation, showing its harmful effects. 2200 w. Boiler Maker—Sept., 1908. No. 94805.

Boiler Tests.

See Steam Calorimetry and Stokers, under STEAM ENGINEERING.

Boiler Theory.

The Influence of Velocity of Furnace Gas on the Rate of Heat Transfer. F. Kingsley. Examines theories of boiler heating and gives conclusions. 1600 w. Eng Rec—Sept. 5, 1908. No. 94869.

Boiler Waters.

A Large Oil Eliminating Plant. Illustrates and describes the plant at Summer Lane station of the Birmingham Corporation, which is believed to be the largest of its kind. 1500 w. Engr, Lond—Sept. 4, 1908. No. 95059 A.

Boilers and Boiler Compounds. C. N. Chubb. Deals with the economical operation of steam boilers, irrespective of the fuel used, and with their proper care and maintenance. Discussion. 5000 w. Pro Age—Sept. 1, 1908. No. 94799.

Condensers.

A Note on Condensation. Maurice Leblanc. Translation of paper read before the Assn. Tech. Mar., Paris. Discusses the requirements of condensers for steam turbines. 8000 w. Engng—Aug. 28, 1908. No. 94952 A.

Engine Breakdowns.

The Prevention of Steam Engine Breakdowns. H. S. Knowlton. Notes from reports of large casualty companies, showing where improvements are needed. Ills. 1800 w. Power—Sept. 8, 1908. No. 94910.

Steam Engine Breakdowns and Their Lessons. Michael Longridge. From the annual report of the Chief Engineer of the British Engine, Boiler and Elec. Ins. Co., Ltd., for 1907. Ills. 6000 w. Mech Engr—Sept. 11, 1908. No. 95277 A.

Engines.

280 H., P. Superheated Steam Side-by-Side Compound Condensing Engine. Illustrated description of the latest design of the Schmidt superheated steam engine. 2500 w. Engng—Aug. 28, 1908. No. 94951 A.

Engine Tests.

Economy Tests of High Speed Engines. Discussion of the paper by Messrs. Dean and Wood. 4500 w. Jour Am Soc of Mech Engrs—Sept., 1908. No. 95073 F.

Entropy.

On the Meaning and Use of Entropy. William McEntee. A discussion of the fundamental principles on which considerations of fuel economy are based where heat is made to do mechanical work. 2000 w. Pro U S Nav Inst—Sept., 1908. No. 95270 F.

Fuel Oil Storage.

A Modern Fuel Oil Storage System. H. W. Beecher. Describes the system installed at Redondo, Cal. 1200 w. Min & Sci Pr—Sept. 19, 1908. No. 95350.

Fuels.

Liquid Fuel. Charles L. Hubbard. Reviews the advantages and disadvantages.

1600 w. Power—Sept. 8, 1908. No. 94913.

The Use of Natural Gas in the Joplin District. Doss Brittain. Describes methods of using gaseous fuel in boiler plants and compares the economy of the steam engine and the internal combustion motor. Ills. 2500 w. Eng & Min Jour—Sept. 19, 1908. No. 95245.

Coal Tests at McGill University. A report of the investigations made by the Canadian Department of Mines. 2500 w. B C Min Rec—July, 1908. No. 95322 B.

Purchase of Coal on Specifications. J. E. Woodwell. Gives results of recent experiences in the purchase of coal for the Treasury and other departments of the Government through the application of the Government specification. 2400 w. Pro Age—Sept. 15, 1908. No. 95082.

The Modification of Illinois Coal by Low Temperature Distillation. S. W. Parr and C. K. Francis. Preliminary report of a series of experiments, having in mind such a change in the chemical composition of coal as would modify or minimize the production of smoke. Ills. 10700 w. Univ of Ills, Bul 24—June 22, 1908. No. 95065 N.

Laboratories.

The Establishment of Steam Engineering Laboratories in Germany and their Utility for Austria (Ueber die Einrichtung feuerungs- und dampftechnischer Versuchsanstalten im Deutschen Reiche und ihre Nutzanwendung für Oesterreich). Oskar Friedmann. Describes the plants and their work. Ills. 2500 w. Oest Zeitschr f d Oeffent Baudienst—Aug. 15, 1908. No. 95165 D.

Plant Management.

Economic Considerations on the Management of Plant. W. H. Patchell. Suggestions in regard to water, fuel and many possible economies. 4000 w. Public Works—July-Sept., 1908. No. 95318 B.

Steam Calorimetry.

The Quality of Steam. W. D. Spooner. Explains the principle of action of the throttling calorimeter, and the barrel calorimeter. Ills. 1800 w. Power—Sept. 1, 1908. No. 94748.

Steam Pipes.

Hangers and Supports for Piping Systems. William S. Fischer. Illustrates and describes various arrangements, 600 w. Power—Sept. 22, 1908. No. 95252.

The Piping Systems of High Pressure Plants. Charles L. Hubbard. Directions for arranging steam and water piping. Ills. 3500 w. Power—Sept. 22, 1908. No. 95248.

Steam Temperature.

The Regulation of the Temperature of Steam and the Jankovsky Regulator (Die Regulierung der Dampftemperatur und der Jankovsky-Regler). Sigmund Bourdot. Illustrated description of construction and details of operation. 1600 w. Elektrotech Rundschau—Aug. 20, 1908. No. 95167 D.

Stokers.

A Boiler Test, Showing Efficient Mechanical Stoking. R. T. Coe. Illustrated article calling attention to details of the Lardner's Point pumping station at Tacony, Pa., and giving a record of an interestng test made of the mechanical stoking equipment. 1200 w. Ir Age—Sept. 17, 1908. No. 95204.

Superheating.

Thermal Properties of Superheated Steam. Discussion of paper by R. C. H. Heck. 3000 w. Jour Am Soc of Mech Engrs—Sept., 1908. No. 95072 F.

Steam Superheaters and Their Applications. W. H. Watkinson. Read before the Liverpool Engng. Soc. Discusses the advantages derived from the use of superheated steam with stationary and locomotive boilers. 2500 w. Mech Wld—Aug. 28, 1908. No. 94930 A.

Thermodynamics.

Historical Review of the Theory of Heat Engines. Dugald Clerk. Presidential address to the Engineering Section of the British Assn. 4800 w. Mech Engr—Sept. 4, 1908. Serial. 1st part. No. 95035 A.

Turbine Accidents.

A Turbine Runaway. T. J. Walsh. An account of an accident at Woonsocket, R. I. 1000 w. Elec Wld—Sept. 5, 1908. No. 94841.

Turbine Plants.

Double Deck Turbine Power Plants. A résumé of the most characteristic features of the double deck station. Ills. 2000 w. Elec Jour—Sept., 1908. No. 95067.

Turbines.

Steam Turbines in Power Stations. Harry Webber. Facts in connection with the running and maintenance of turbines of the Parsons type. 2500 w. Elec Rev, Lond—Sept. 4, 1908. No. 95040 A.

Recent Advances in Steam Turbines. Gerald Stoney. Read before the British Assn, at Dublin. Shows the rapid progress of the steam turbine and its applications. 3000 w. Elec Engr, Lond—Sept. 11, 1908. No. 95278 A.

Steam Turbine Development. J. C. Thorpe. A collection and discussion of facts recently learned. Ills. Discussion. 11000 w. Jour W Soc of Engrs—Aug., 1908. No. 95391 D.

The First American Steam Turbine. F. E. Drake. An illustrated account of the "Bailey Jack," patented by a New Englander more than 100 years ago. 1000 w. Power—Sept. 1, 1908. No. 94751.

See also Stuffing Boxes, under MACHINE ELEMENTS AND DESIGN.

Turbine Tests.

New Steam Turbine Tests (Einige neue Versuche an Dampfturbinen). F. Marguerre. Reports tests on a 1000 k. w. Parsons turbine. Ills. 4400 w. Zeitschr d Ver Deutscher Ing—Aug. 22, 1908. No. 95185 D.

Valve Gears.

An Exact Method of Slide Valve Design. Frank W. Merrill. Explains the use of the valve diagram and a study of the exact relations between rotary and reciprocating motions. 4000 w. Power—Sept. 22, 1908. No. 95253.

TRANSPORTING AND CONVEYING.

Cableways.

Ropeway at a Colliery. Illustrates and describes a ropeway on the endless running rope system, constructed where no other means of transport would have been possible. 600 w. Engr, Lond—Aug. 21, 1908 No. 94789 A.

Coal Handling.

See Docks, under CIVIL ENGINEERING, WATERWAYS AND HARBORS.

Conveyors.

Simple Forms of Coal and Ash Conveyors. Warren O. Rogers. Illustrates and describes several types. 1200 w. Power—Sept. 1, 1908. No. 94746.

The Conveying of Materials. Discussion of five papers given at Detroit, on the hoisting and conveying of materials. Ills. 10000 w. Jour Am Soc of Mech Engrs—Sept., 1908. No. 95071 F.

Performance of Belt Conveyors. Edwin J. Haddock. A report of experiments made with this form of conveyor. 2000 w. Jour Am Soc of Mech Engrs—Sept., 1908. No. 95068 F.

Dock Machinery.

The Relative Advantage of Hydraulic and Electric Power for Port and Dock Work. Brysson Cunningham. An illustrated comparison of power transmission methods. 3000 w. Cassier's Mag—Sept., 1908. No. 94736 B.

Elevators.

The Plunger Hydraulic Elevator. William Baxter, Jr. Describes the construction of passenger elevators of this type. Ills. 1600 w. Power—Sept. 8, 1908. Serial. 1st part. No. 94911.

MISCELLANY.

Aeronautics.

The Wreck of the "Zeppelin IV." Brief illustrated accounts of the disaster. 1000 w. Sci Am Sup—Sept. 5, 1908. No. 94901.

The Improved Parseval Airship. Illustrated description of Germany's non-rigid military dirigible. 800 w. Sci Am Sup—Sept. 26, 1908. No. 95341.

The Construction of the Wright Aeroplane. Illustrates and describes the constructional details. 2000 w. Sci Am—Sept. 26, 1908. No. 95338.

The "Mystery" of the Wrights. A discussion of the claims of the Wright Brothers, and of what they have accomplished. Ills. 1700 w. Auto Jour—Aug. 22, 1908. No. 94760 A.

The First Flight of the Wright Aeroplane at Fort Myer. A brief illustrated account. 700 w. Sci Am—Sept. 12, 1908. No. 94993.

How Orville Wright Made His Flights. E. Percy Noel. An illustrated account of flights at Fort Myer, Va. 2000 w. Automobile—Sept. 17, 1908. No. 95099.

Soaring Flight. Marcel Deprez. Illustrates and describes models for its mechanical investigation. 1500 w. Sci Am Sup—Sept. 12, 1908. No. 94995.

The Problem of Aerial Navigation. Prof. Simon Newcomb. An inquiry as to what measure of rational hope we can entertain that aerial flight will serve some practical purpose in the world's work. 6500 w. Nineteenth Century—Sept., 1908. No. 95074 D.

The Laws of Flight. F. W. Lanchester. Read before the British Association for the Advancement of Science at Dublin. Considers information obtained by observation and experiment, explaining the theory of flight developed by the author. 3000 w. Engr, Lond—Sept. 18, 1908. Serial. 1st part. No. 95414 A.

Exhibitions.

The Prague Jubilee Exhibition, 1908. Describes this exhibition in Bohemia and the exhibits. Ills. Engr, Lond—Aug. 28, 1908. Serial. 1st part. No. 94954 A.

Mechanical Features of the Franco-British Exhibition. An illustrated critical review of the engineering exhibits. 3500 w. Cassier's Mag—Sept., 1908. No. 94737 B.

The Franco-British Exhibition (L'Exposition Franco-Britannique de Londres, 1908). E. Lemaire. Discusses the attractions and exhibits from the French point of view. Ills. 5600 w. Génie Civil—Aug. 1, 1908. No. 95112 D.

Flour-Milling Machinery.

Flour Milling Machinery. The present number deals with the reception, cleaning and storing of grain. Ills. 4500 w. Engng—Sept. 4, 1908. Serial. 1st part. No. 95051 A.

Sugar Factories.

Cane Sugar Factories. Cyril W. Dawson. Deals with the chief problems in connection with such factories. 2500 w. Engr, Lond—Aug. 21, 1908. Serial. 1st part. No. 94791 A.

Textile Machinery.

Features of the "Ideal" Automatic Loom. Illustrates and describes features in the design, operation and manufacture of the latest development in automatic cotton weaving looms. 4500 w. Am Mach—Vol. 31, No. 39. No. 95327.

MINING AND METALLURGY

COAL AND COKE.

Alberta.

Taber Plant of the Canada West Coal Co., at Taber, Alberta. Methods of constructing concrete buildings in a Canadian winter are illustrated and described. 2500 w. Mines & Min—Sept., 1908. No. 94809 C.

Coal Cutting.

Coal Cutting Machinery. Allan R. Connal. Brief consideration of the use of coal cutters in Great Britain, especially the electric cutters. 1200 w. Elec Rev, Lond—Aug. 21, 1908. No. 94768 A.

The Operation of Coal Cutting Machinery. George E. Lynch. A discussion of the use and economy of various coal cutters, showing the advantages and disadvantages of each type. 2500 w. Eng & Min Jour—Sept. 12, 1908. No. 94991.

Coke Ashes.

The Variable Color of Coke Ashes. W. P. Young. A résumé of experiments to determine the cause. 1200 w. Eng & Min Jour—Sept. 12, 1908. No. 94992.

Coke Ovens.

The By-Product Coke Oven. Discussion of paper by W. H. Blauvelt. 3500 w. Jour Am Soc of Mech Engrs—Sept., 1908. No. 95070 F.

By-Product Coke Ovens. Abstract of a report of R. Forbes Carpenter, chief inspector under the Alkali works act. 3500 w. Col Guard—Sept. 4, 1908. Serial. 1st part. No. 95049 A.

Mechanical Levelling Machines (Ueber mechanische Planiervorrichtungen). A. Thau. Illustrated description of various appliances for levelling off the charge in coke ovens. 2000 w. Glückauf—Aug. 8. 1908. No. 95140 D.

Coking By-Products.

New Method of Obtaining Sulphate of Ammonia. R. S. Moss. Describes improvements in the Kopper system. Ills. 2000 w. Min Wld—Sept. 19, 1908. No. 95211.

Coking Plants.

New By-Product Coke Plant at Joliet. Ill. Illustrates and describes the first installation of Kopper's ovens in America. Plate. 2800 w. Ir Trd Rev—Sept. 3. 1908. No. 94843.

Electric Power.

The Electric Plant at the Mines of the König Ludwig Company, Recklinghausen (Die elektrischen Anlagen auf den Zechen der Gewerkschaft König Ludwig in Recklinghausen). Kurt Perlewitz. Illustrated detailed description. Serial. 1st part. 1600 w. Elektrotech Zeitschr—Aug. 20, 1908. No. 95191 D.

Some Applications of Electric Power in Belgium (Quelques Applications de l' Electrotechnique en Belgique). Alfred Lambotte. The fourth part of the serial describes the installations of the Société anonyme des Charbonnages de Ham-sur-Sambre et Moustier. Ills. 7500 w. Soc Belge d'Elecns—Aug., 1908. No. 95101 E.

Explosions.

Report on the Washington "Glebe" Colliery Explosion. Report of the inspector of mines on the explosion in the county of Durham, on Feb. 20, 1908. Ills. 8500 w. Col Guard—Aug. 21, 1908. No. 94780 A.

Dust Explosion at Minneapolis, May 2, 1878, and Other Dust Explosions. S. F. Peckham. Extract from report of Prof. Peckham and Prof. Peck, of experiments of interest in connection with dust explosions in mines. Ills. 4500 w. Mines & Min—Sept., 1908. No. 94807 C.

Explosives.

Recent Researches on the Use of Explosives in the Presence of Gas and Coal Dust (Nouvelles Recherches sur l'Emploi des Explosifs en Présence du Grison et des Poussieres de Charbon). H. Schmerber. The first part reviews Herr Bichel's investigations at Schlebusch. Ills. Serial. 1st part. 2500 w. Génie Civil—Aug. 15, 1908. No. 95115 D.

Germany.

The Development of the Rhine Lignite Industry and its Importance to the Domestic Fuel Supply of West and South Germany (Die Entwicklung der rheinischen Braunkohlenindustrie und ihre Bedeutung für die Hausbrandversorgung des westlichen und südlichen Deutschlands). H. E. Böker. Ills. 5600 w. Serial. 1st part. Glückauf—Aug. 22, 1908. No. 95142 D.

Holland.

The Results of New Deep Bore Holes in Eastern Holland (Die Ergebnisse der neuern Tiefbohrungen in östlichen Holland). Dr. Ahlburg. An account of the strata and coal measures encountered. Ills. 9500 w. Glückauf—Aug. 22, 1908. No. 95141 D.

India.

Mining in India in 1907. Reviews the report of J. R. R. Wilson, Chief Inspector of Mines in India. 3000 w. Ir & Coal Trds Rev—Sept. 11, 1908. No. 95295 A.

Mine Dust.

Experiments with Coal Dust at the Home Office Testing Station. A report of experiments made to determine whether all coal dusts are to be regarded

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as dangerous. 3500 w. Ir & Coal Trds Rev—Aug. 28, 1908. No. 94961 A.

British Coal Dust Experiments. An account of experiments recently carried out to test the explosive qualities of coal dust, and its capacity for intensifying the effect of explosives in mines. Ills. 7000 w. Col Guard—Aug. 28, 1908. Serial. 1st part. No. 94945 A.

Coal Dust and Colliery Explosions. V. Wattegue, in *An. des Mines de Belgique*. Reviews the conditions observed in the Courrieres pit after the accident there, and also the explosion at La Boule pit in 1887. Ills. 1500 w. Col Guard—Aug. 28, 1908. No. 94946 A.

Mine Gases.

The Composition and Physiological Effects of Black Damp. From *The Science and Art of Mining*. A report of research work, giving conclusions. 2000 w. N Z Mines Rec—July 16, 1908. No. 95342 B.

Mine Ventilation.

An Improved System for Ventilation of Mines. W. E. Elliot and J. G. Wilson. Illustrated description of a system that makes it possible to flood a mine in case of fire. 1500 w. Min Wld—Sept. 5, 1908. No. 94891.

Mining.

Operation of Carmaux Coal Mines in France. Lucius W. Mayer. Illustrates and describes a system of mining thick seams in slices. 4000 w. Eng & Min Jour—Sept. 19, 1908. No. 95246.

Peat.

Peat and Lignite. A review of the Canadian Government report on their future. 2000 w. Elev Rev, Lond—Sept. 4, 1908. No. 95041 A.

The Utilization of Peat. H. Riall Sankey. Read before the British Assn, at Dublin. Considers its use for making gas or charcoal, with recovery of by-products. Ills. 8500 w. Engng—Sept. 11, 1908. No. 95093 A.

Some Notes on the Development of the Peat Fuel Industry and Its Possibilities. Ernest V. Moore. Reviews the attempts made to utilize these deposits, showing why they have been unsuccessful, and how success may be attained. Ills. Discussion. 15000 w. Can Soc of Civ Engrs, Bul No 3—May., 1908. No. 95367 N.

Pennsylvania.

Coal Mining in Southern Anthracite Field. Thomas F. Downing. Describes methods used where seams are gaseous, and conditions very different from the northern field. 2500 w. Eng & Min Jour—Sept. 5, 1908. No. 94880.

Rescue Appliances.

Rescue Appliances in Modern Mining (Das Rettungswesen im modernen Bergbaubetriebe). Friedrich Okorn. A general discussion of breathing apparatus and rescue methods. Serial. 1st part. 2000 w. Oest Zeitschr f Berg-u Huttenwesen—Aug. 1, 1908. No. 95136 D.

Wales.

Geological Features of the Red Seam at Clydach Vale. David Davies. Illustrates and describes the plant life and gives conclusions concerning the formation, climate, etc. 3500 w. Ir & Coal Trds Rev—Aug. 21, 1908. No. 94793 A.

Washing.

Chemical Control of Coal Washers. Randolph Bolling. Illustrates and describes methods used by the Nova Scotia Steel & Coal Co. 1000 w. Eng & Min Jour—Aug. 29, 1908. No. 94706.

Dust-Separating Devices at the Mines of the Ruhr District (Vorrichtungen zum Abscheiden von Kohlenstaub auf den Zechen des Ruhrkohlenreviers). Herr Hasebrink. Illustrated description. 3500 w. Glückauf—Aug. 29, 1908. No. 95143 D.

COPPER.

Alaska.

Some Notes on the Copper River District, Alaska. William M. Brewer. Information obtained on a personal visit to this district concerning the conditions, ore deposits, etc. 3500 w. B. C. Min Rec—July, 1908. No. 95321 B.

Australia.

Copper Mining in South Australia. Reginald F. Barker. Remarks on the mines of the northern districts. 2500 w. Aust Min Stand—Aug. 12, 1908. No. 95371 B.

California.

Mining and Smelting on Shasta Copper Belt. Al. H. Martin. Describes these deposits in California, the methods of mining, smelting, etc. Ills. 2500 w. Min Wld—Aug. 29, 1908. No. 94709.

Costs.

Official Reports of Costs of Producing Copper. Arthur R. Townsend. A comparison of tabulated statements of costs of mining, smelting, transportation and administration from reports of 22 companies. 4000 w. Eng & Min Jour—Sept. 19, 1908. No. 95242.

Lake Superior.

Ontonagon County Mines; Past and Present. Robert H. Manerer. Explains recent activities caused by the remarkable find of the "Lake" lode on an abandoned property. 2200 w. Min Wld—Aug. 29, 1908. No. 94711.

Mexico.

Some Notes from the Cananea Copper Field. Charles A. Dinsmore. Illustrates and describes the method of handling ore and the reduction in cost of production. 1500 w. Min Wld—Sept. 12, 1908. No. 95022.

Refining.

Electrolytic Refining of Gold, Silver and

Copper at the United States Mint, San Francisco, Cal. Robert L. Whitehead. Illustrated description of the recently installed equipment for electrolytic refining, which is said to be the most up-to-date plant. 3000 w. Elec-Chem & Met Ind—Sept., 1908. Serial. 1st part. No. 94721 C.

Smelters.

Douglas Smelting Works, Funidicion, Sonora. W. P. Tucker. Illustrated description of a new plant with mining and smelting costs. 800 w. Eng & Min Jour—Aug. 29, 1908. No. 94704.

Smelting.

Pyritic Smelting in Tilt Cove, Newfoundland. F. S. Nicholls. Gives early experiences in producing matte from pyritous ores without fuel. Ills. 1000 w. Eng & Min Jour—Sept. 5, 1908. No. 94877.

Washington.

The Copper Deposits of Lake Osoyoos, Wash. Horace F. Evans. Describes the geological features of extensive deposits. 2500 w. Min Wld—Sept. 5, 1908. No. 94892.

GOLD AND SILVER.

Alaska.

See Placers, under GOLD AND SILVER.

Cobalt.

Cobalt, Canada. Alex. Gray. Nipissing and La Rose mines are contrasted. 3500 w. Min Jour—Aug. 29, 1908. No. 94943 A.

Cobalt, Canada. Alex. Gray. Information concerning the Right-of-Way mine, and the La Rose mine, with general remarks on the mining camps. 3500 w. Min Jour—Aug. 22, 1908. No. 94775 A.

The Prospects of the Cobalt Central Company. Alex. Gray. An account of development work, etc. Ills. 2500 w. Min Wld—Sept. 12, 1908. No. 95025.

Property and Plant of Right-of-Way Company. Alex. Gray. Plan of underground workings with information concerning development, methods, etc. 1500 w. Min Wld—Sept. 5, 1908. No. 94890.

See also Concentration, under ORE DRESSING AND CONCENTRATION.

Colorado.

Mineral Prospects Around Death Valley. Robert E. Rinehart. Information concerning present conditions. Ills. 1500 w. Min & Sci Pr—Aug. 29, 1908. No. 94853.

Cyaniding.

Cyaniding Slime. E. B. Wilson. An illustrated article on different ways of treating slime. 3500 w. Mines & Min—Sept., 1908. No. 94808 C.

Dredging.

Dredging in the Yukon. T. A. Rickard. Data gathered by personal observation. Ills. 3000 w. Min & Sci Pr—Aug. 29, 1908. Serial. 1st part. No. 94852.

Improved English Gold Dredge in West Africa. Frank C. Perkins. Illustrates and describes the construction of gold dredges, comparing advantages in operation. 1200 w. Min Wld—Sept. 5, 1908. No. 94888.

Mexico.

Zacatecas, a Famous Silver Camp of Mexico. Claude T. Rice. An illustrated account, giving the history, geology and developments, etc., 4500 w. Eng & Min Jour—Aug. 29, 1908. No. 94701.

Pachuca and Real del Monte Silver District. Claude T. Rice. An account of construction work, mining and milling methods. The silver ore contains little gold. Ills. 5500 w. Eng & Min Jour—Sept. 12, 1908. No. 94989.

Placers.

Dry Placers of Northern Sonora. F. J. H. Merrill. Describes these formations and the methods of working. 1200 w. Min & Sci Pr—Sept. 12, 1908. No. 95095.

The Beach Placers of the South Pacific Coast. C. D. Irvine. Describes the deposits, the difficulties in recovering the gold, etc. 2000 w. Min Wld—Aug. 29, 1908. No. 94712.

The Gold Placers of Parts of Seward Peninsula. Compiled from the U. S. Geol. Survey reports by C. C. Longridge. An illustrated historical résumé of Alaska placer fields and their development. 6000 w. Min Jour—Aug. 29, 1908. Serial. 1st part. No. 94958 A.

Queensland.

The Etheridge Goldfield. W. E. Cameron. Maps and illustrated description of these gold fields, the geology, condition of mining, ore treatment, etc., 9500 w. Queens Gov Min Jour—July 15, 1908. No. 94817 B.

The Mount Morgan Gold Mining Co., Ltd. (Queensland). J. Bowie Wilson. An interesting account of the ore occurrence. 3000 w. Aust Min Stand—Aug. 12, 1908. Serial. 1st part. No. 95370 B.

Rand.

Inaugural Address by the President. R. G. Benington. On the progress of mining and metallurgical work on the Rand. 4000 w. Jour Chem, Met, & Min Soc of S Africa—July, 1908. No. 95037 E.

Costs and Profits on the Witwatersrand. James Ralph Finlay. Showing that the methods compare favorably with other fields where conditions are unsettled. 3000 w. Eng & Min Jour—Sept. 19, 1908. No. 95244.

The Genesis of the Rand Gold. Dr. F. W. Voit. A discussion of the theories on the origin of the gold, especially some points not generally known. Ills. 2200 w. Min Jour—Sept. 5, 1908. Serial. 1st part. No. 95048 A.

Refining.

See same title, under COPPER.

Tasmania.

Gold Mining and Milling Practice in Tasmania. Ralph Stokes. Describes the geology and development and the conditions affecting the mining industry. Ills. 2500 w. Min Wld—Sept. 5, 1908. No. 94893.

IRON AND STEEL.

Assaying.

The Determination of the Nitrogen Contained in Iron and Steel (Sur le Dosage de l'Azote contenu dans le Fer et l'Acier). A. S. de Osa. A review of methods. 5500 w. Rev de Métal—Aug., 1908. No. 95103 E + F.

Australia.

Yampi Sound Iron Ore Deposits (Western Australia). W. D. Campbell. The location, geology and deposits are dealt with. 1200 w. Aust Min Stand—Aug. 12, 1908. No. 95368 B.

Blast-Furnace Charges.

See Blast Furnace Slag, under Iron and Steel.

Blast Furnace Plants.

A Furnace Plant with a History. Illustrated account of a furnace at Dunbar, Pa., where pig iron has been made continuously since 1791. 1000 w. Ir Trd Rev.—Sept. 10, 1908. No. 94975.

Blast Furnaces.

An Oval Blast Furnace. Illustrates and describes a furnace at Middlesborough, Eng. 600 w. Engr, Lond—Aug. 28, 1908. No. 94957 A.

The New Rebecca Furnace of the Kittaning Iron & Steel Mfg. Co. Illustrated description. 2500 w. Ir Trd Rev—Sept. 24, 1908. No. 95348.

The Shape of the Iron Blast Furnace. Henry M. Howe. Considers the factors that have determined the dimensions of the stack in the past and are likely to govern changes in the future. Ills. 4000 w. Eng & Min Jour—Sept. 12, 1908. No. 94987.

Blast-Furnace Slag.

Graphical Representation of the Composition of Blast Furnace Slags and Graphical Ore Mixture Calculations (Die Zusammensetzung der Hochofenschlacke in graphischer Darstellung. Graphische Möllerberechnung). W. Mathesius. Gives analysis of many slags and shows method of constructing slag diagrams. Ills. 10500 w. Stahl u Eisen—Aug. 5, 1908. No. 95129 D.

Electro-Metallurgy.

Electro-Metallurgy and Electric Furnaces. F. Louvrier. Abstract trans. from Bol. de la Sec. de Fomento. Classification and comparison of electric furnaces, electric manufacture of ferro-alloys, etc. 3000 w. Min Jour—Aug. 22, 1908. No. 94776 A.

Desulphurization of Steel in the Electric Furnace. Reviews an article by Dr. T. Geilenkirchen, in *Stahl und Eisen*, describing the elimination effected in the Heroult type of furnace. 1600 w. Engr, Lond—Sept. 4, 1908. No. 95058 A.

The Roechling-Rodenhauser Electric Furnace. Dr. B. Newman in *Stahl und Eisen.* Gives results of a study of a new electric furnace designed to use three-phase alternating current. Ills. 2500 w. Ir Age—Sept. 17, 1908. No. 95205.

The New Röchling-Rodenhauser A. C. Electric Furnace and Progress in the Production of Steel in the Electric Furnace Röchling-Rodenhausers neuer Drehstromofen und weitere Fortschritte in der Elektrostahlerzengung). Dr. B. Newmann. Describes the furnace, its operation and results obtained. Ills. Serial. 1st part. 3000 w. Stahl u Eisen—Aug. 12, 1908. No. 95130 D.

Ferro-Alloys.

See Electric Metallurgy, under Iron and Steel.

Germany.

The German Syndicates. Interesting information relating to their operations, taken from the report of Sir Francis Oppenheimer. 4000 w. Ir & Coal Trds Rev —Aug. 28, 1908. No. 94959 A.

Ingot Molds.

The Production of Ingot Molds. G. B. Waterhouse. Illustrated description of an improved method of molding which involves the use of collapsible cores. 1200 w. Ir Trd Rev—Sept. 17, 1908. No. 95201.

Italy.

The History of the Italian Iron Industry (L'Industria Siderurgica Italiana al Momento Attuale). Francesco Massarelli. A general and statistical review. Ills. Serial. 1st part. 4000 w. Industria—Aug. 2, 1908. No. 95121 D.

Moore-Heskett Process.

The Moore-Heskett Process for the Manufacture of Iron and Steel. Short description of recent improvements, with illustrations. 1500 w. Mech Engr—Aug. 28, 1908. No. 94931 A.

Scrap.

The Classification of Old Material. An analysis of prevailing practices in the scrap market. Also editorial. 9800 w. Ir Trd Rev—Sept. 3, 1908. No. 94842.

Steel Works.

The Equipment of the Mill Buildings of the Gary Steel Plant. Illustrated detailed description of unusually interesting features, particularly the power plant. 5500 w. Eng Rec—Sept. 26, 1908. No. 95381.

The Glengarnock and Ardeer Works of the Glengarnock Iron & Steel Co., Ltd. Illustrated description of works equipped for the production of steel joists, angles, ties, channels, rails, etc., 2200 w. Ir & Coal Trds Rev—Aug. 21, 1908. No. 94792 A.

LEAD AND ZINC.

Lead Smelting.

Blast Furnace Gases in Silver-Lead Smeltng. T. S. Austen. A report of tests. 700 w. Min & Sci Pr—Sept. 12, 1908. No. 95097.

A Peruvian Lead Smelter. Lester W. Strauss. Describes the smelter at Vesubio, at an altitude of 1400 ft. above sea level. Ills. 2000 w. Min & Sci Pr—Sept. 12, 1908. No. 95096.

The Bag-House at Selby, California. James C. Bennett. Illustrated description of a reinforced concrete structure for large lead smelting works. 2500 w. Eng & Min Jour—Sept. 5, 108. No. 94875.

Mexico.

The Granadena Mines. S. F. Shaw. Information concerning these mines in Mexico. The ores are complex, carrying gold and silver. Ills. 2000 w. Min & Sci Pr—Sept. 19, 1908. No. 95352.

Zinc Smelting.

The Ferrites, Compounds of an Iron Acid. J. S. C. Wells. Gives a report of laboratory experiments showing that oxide of iron forms a number of insoluble salts when heated in contact with zinc oxide. 2000 w. Eng & Min Jour—Aug. 29, 1908. No. 94705.

MINOR MINERALS.

Antimony.

Treatment of Antimony Ore. E. Chatillon. Illustrates and describes the process invented by the author. 1000 w. Min Jour—Aug. 22, 1908. No. 94779 A.

Manganese.

Manganese Ores; Occurrence, Uses and Value. E. C. Harder. Extract from Min. Resources of U. S. A record of uses, prices and production. 1200 w. Min Wld—Sept. 5, 1908. Serial. 1st part. No. 94894.

Molybdenum.

Molybdenum Ores. Information from a bulletin recently issued by the Imperial Institute on the occurrence and uses of molybdenum ores. 1200 w. Mech Engr—Sept. 11, 1908. No. 95276 A.

Oil.

Extracting Oil from Boreholes. A description of the Leinweber process, recently installed at the Kryg oil field, in Austria. 1800 w. Sci Am Sup—Sept. 26, 1908. No. 95340.

On the Question of Regulating Naphtha Gushers. Ira M. Pitersky. Trans. from *Gorny Jour*. Considers the conditions governing the movement of a jet of liquid and applies the experience to oil wells. Ills. 1600 w. Min Jour—Aug. 29. 1908. No. 94944 A.

Salts.

See Electric Power, under MINING.

Vanadium.

The New Vanadium Deposit of Peru. Describes the deposit and gives analysis. 1200 w. Min Jour—Sept. 5, 1908. No. 95047 A.

MINING.

Blasting.

A Selective Electric Fuse Spitting Device. Robert N. Bell. Describes a device for selective firing of holes from a distance by means of electric current. Ills. 1200 w. Eng & Min Jour—Sept. 12, 1908. No. 94990.

Boring.

Brejcha's Improved System of Boring. W. Galloway. Illustrated description of a system involving certain improvements in the diamond drill and in some of the appliances used in connection with it. Explains the advantages. 2000 w. Col Guard—Sept. 11, 1908. No. 95290 A.

Costs.

Costs of Mining Quartz Pyride Gold Deposits. James Ralph Finlay. A study of the costs of mining and milling. 6000 w. Eng & Min Jour—Sept. 12, 1908. No. 94988.

Drills.

The Siemens-Schuckert Electric Percussion Drill in Tunnel Driving in the Ausseer Salt Mines (Die Slossschrämmaschine—System Siemens-Schuckert Werke —mit elektrischem Antriebe beim Streckenvortriebe am Ausseer Salzberge). Hans Vogl. Gives details of operation in numerous tables. Ills. Serial. 1st part. 2800 w. Oest Zeitschr f Berg u Hüttenwesen—Aug. 15, 1908. No. 95137 D.

Drill Steel.

Cruciform Steel for Machine Drills. E. P. Kennedy. On the advantages of all cruciform steel and cruciform chuck-bushings. 700 w. Min & Sci Pr—Sept. 19, 1908. No. 95351.

Economics.

The Economy of Winning Ore. W. H. Doherty. Deals with the getting and transporting of ore from face to mill 2500 w. Min Jour—Aug. 22, 1908. No. 94777 A.

Electric Power.

The Utilization of Electric Power in Salt Mines. H. R. Speyer. Explains the requirements for producing commercial salts, giving an illustrated description of the power house and electrical equipment of mines of the Harz Mountains. 4000 w. Elec Engng—Aug. 27, 1908. No. 94934 A.

The Electric Plant at the Friedrichshall Potash Mines at Sehnde, near Hannover (Die elektrischen Anlagen auf den Kaliwerken Friedrichshall, A. G., Sehnde bei Hannover). W. Phillippi. Illustrated description. 3500 w. Elek Kraft u Bahnen—Aug. 24, 1908. No. 95170 D.

See also D. C. Motors, under ELECTRICAL ENGINEERING, DYNAMOS AND MOTORS.

Hoisting.

A note on the Koepe Hoisting System

(Note sur l' Extraction par le Système Koepe). A translation by M. Lecuir of an article by Herr Kaufhold, giving a mathematical demonstration of a proposed new method for determining the capacity of the Koepe hoisting system. Ills. 3000 w. Rev de Mécan—Aug., 1908. No. 95107 E + F.

Hoisting Engines.

The Notbohm-Eigemann Safety Apparatus for Winding Engines. Illustrated description of the apparatus and explanation of the principles of its construction. 2000 w. Ir & Coal Trds Rev—Aug. 28, 1908. No. 94962 A.

Mine Models.

Court-Maps and Models. T. S. Harrison and C. H. Zulch. Illustrated description of methods used for representing the workings of mines in court proceedings. 4000 w. Mines & Min—Sept., 1908. No. 94806 C.

Prospecting.

The Recognition of Minerals. C. G. Moor. A collection of notes and simple tests for the use of prospectors. 5500 w. Min Jour—Aug. 22, 1908. Serial. 1st part. No. 94774 A.

Shaft Sinking.

Shaft Sinking by the Freezing Process. An account of the sinking of two colliery shafts on the east coast of England to a depth of 484 feet through water-percolated soil and quicksand. Ills. 1500 w. Sci Am—Sept. 19, 1908. No. 95239.

Sinking a Reinforced Concrete Mine Shaft Near Wilkes-Barre, Pa. Louis L. Brown. The methods used for sinking this shaft of the D. L. & W. R. R. are illustrated and described. 2500 w. Eng News—Sept. 24, 1908. No. 95361.

Stoping.

Reclaiming Caved Ground After a Squeeze. J. J. Rutledge. Describes the method of mining at Davis, Mass. commenting on its disadvantages, and giving method of recovering the caved stope. Ills. 1200 w. Eng & Min Jour—Aug. 29, 1908. No. 94703.

ORE DRESSING AND CONCENTRATION.

Briquetting.

Iron-Ore Briquette-Making Plant. Illustrated description of a special plant for the manufacture of briquettes out of iron ore, as it has been found convenient for use in blast furnaces. 500 w. Engng—Sept. 4, 1908. No. 95053 A.

The Briquetting of Iron Ores (Das Brikettieren von Eisenerzen). An account of a discussion in the *Verein Deutscher Eisenhüttenleute.* 6300 w. Stahl u Eisen—Aug. 19, 1908. No. 95131 D.

Classifiers.

The Richards' Modern Pulsator Classifier and Jig. Illustrated detailed description. 3000 w. Min Wld—Sept. 19, 1908. No. 95209.

Concentration.

Methods of Concentration at Cobalt, Ontario. George E. Sancton. Brief description of methods at the Buffalo, the Cobalt Central, and Coniagas mines, and the proposed method at the Muggley concentrator. 3000 w. Can Min Jour—Sept. 15, 1908. No. 95247.

Filtration.

Filtration of Slimes at El Oro, Mexico. D. L. H. Forbes. Plan, sections and detailed description of plant for this purpose. 1100 w. Eng & Min Jour—Sept. 5, 1908. No. 94876.

Gold Milling.

Battery and Cyanide Gold Smelting. A. Thomas. An outline of present practice. 2500 w. Jour Chem, Met, & Min Soc of S Africa—July, 1908. No. 95038 E.

Apparatus for Extracting and Filtering Ore. J. E. Porter and A. L. Clark. Describes the cyaniding of dry crushed ore in new apparatus. Ills. 2500 w. Min Wld—Sept. 12, 1908. No. 95024.

The Goldfield Consolidated 600-Ton Mill. Percy E. Barbour. Illustrated description of plant and equipment. 5000 w. Eng & Min Jour—Sept. 5, 1908. No. 94879.

Milling Plant of the Montana-Tonopah Mining Company. G. H. Rotherham. Illustrates and describes a plant presenting new features for the treatment of gold and silver-bearing sulphide ores. 2500 w. Min & Sci Pr—Sept. 5, 1908. No. 94976.

See also Costs, under MINING.

Jigs.

See Classifiers, under ORE DRESSING AND CONCENTRATION.

Lead.

See Sorting, under ORE DRESSING AND CONCENTRATION.

Silver Milling.

Some Metallurgical Processes at Pachuca, Mex. Claude T. Rice. Cyanidation is rapidly replacing the older processes. Ills. 3000 w. Eng & Min Jour—Sept. 19, 108. No. 95243.

Slimes Treatment.

Slime Treatment in Western Australia. Percy Ifould. Principally devoted to a description of the Cassell process. 1800 w. Aust Min Stand—Aug. 12, 1908. No. 95369 B.

Sorting.

Ore Sorting at the Cabrestante Mine, Santa Barbara, Mexico. Claude T. Rice. Illustrates and describes methods of jigging and sorting lead-silver ores for shipment to the smelter. 1200 w. Eng & Min Jour—Sept. 5, 1908. No. 94878.

Stamp Mills.

Tremain Steam Stamps. Cyril E. Parsons. Describes these stamp mills and gives notes on the results obtained. Ills, 2500 w. Min & Sci Pr—Sept. 19, 1908. No. 95349.

MISCELLANY.

Alloys.

The Alloys of Iron (Les Alliages de Fer). A. Portevin. Summarizes the results of Prof. Tammann's researches on the alloys of iron with silver, gold, aluminum, bismuth, cobalt, cadmium, copper, manganese, nickel, lead, platinum, iron sulphide, silicon, tin, thallium, vanadium, vanadium-silicon and zinc. Ills. 7000 w. Rev de Métal—Aug., 1908. No. 95105 E + F.

Assaying Furnaces.

Assay Furnaces at the Melbourne University. Donald Clark. Illustrates and describes new and important improvements. 500 w. Aust Min Stand—July 22, 1908. No. 94816 B.

Ore Deposits.

Rock Pressure and Metamorphism. H. M. Chance. A study of earth stresses and their effects on rock structure. 3000 w. Min & Sci Pr—Aug. 29, 1908. No. 94854.

Association of Magnetite with Sulphides in Mineral Deposits. John B. Hastings. The present number quotes largely the opinions of experts in regard to such deposits. 2000 w. Min & Sci Pr —Sept. 5, 1908. Serial. 1st part. No. 94979.

See also Rand, under GOLD AND SILVER.

Petrography.

Identification of Rocks of Commercial Value. Evans W. Buskett. The occurrence and distinguishing features of rocks other than metallic ores, which have value. 2000 w. Min Wld—Sept. 12, 1908. No. 95023.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Collisions.

Collision at Contich, Belgium. Louis Weissenbruch. Also editorial. A report of the disastrous collision of passenger trains occurred last May and information relating to the operation of the Belgian State railways. 4000 w. R R Age Gaz—Sept. 11, 1908. No. 95002.

Derailments.

Concerning the Derailment of Tenders. F. P. Roesch. Discusses the causes and remedies. 2500 w. Ry & Loc Engng—Sept., 1908. No. 94825 C.

Signalling.

The First Interlocking Plant in America. J. A. Anderson. An account of an installation at Trenton, N. J., in 1870. Ills. 1300 w. R R Age Gaz—Sept. 25, 1908. No. 95353.

The Use of Special Semaphore Signals. L. Weissenbruch and J. Verdeyen. A discussion of the question of signalling shunting operations as practiced in Belgium and Germany. 3800 w. Bul Int Ry Cong—Aug., 1908. No. 94794 G.

The Signalling of the Glasgow Central Station, Caledonian Railway. Illustrated description of the interesting features. It possesses the largest locking frame in the world and the whole station is controlled from one signal-box. 3000 w. Engr, Lond—Sept. 11, 1908. No. 95292 A.

Signals.

New Forms of Distant and Home Signals in Germany. Hans A. Martins. Also note by Mr. Förderreuther. The signalling system in the Danish State Rys., and Bavarian State Rys. 3500 w. Bul Int Ry Cong—Aug., 1908. No. 94796 G.

Trains.

Asbury Park Flyer. Illustrated description of this fast train, and the country traversed. 1200 w. Ry & Loc Engng Sept., 1908. No. 94820 C.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Broken Air Pipes. Explains how the brakes can be operated from the engine when certain breaks occur. 1500 w. Ry & Loc Engng—Sept., 1908. No. 94824 C.

Brakes.

See Couplers, under MOTIVE POWER AND EQUIPMENT.

Cars.

Anti-Friction Side Bearings. A. Stucki. Discusses their forms and construction, etc. 1500 w. R R Age Gaz—Sept. 11, 1908. No. 95004.

Oliver 20-Yard Air Dump Car. Illustrated description. 500 w. R R Age Gaz—Sept. 4, 1908. No. 94886.

An Air-Operated Spreader Car for Railway and Other Work. Illustrated description. 800 w. Eng News—Sept. 17, 1908. No. 95222.

Our Ponderous Passenger Cars. Editorial on the weight of Pullman cars and means of reducing it. 1000 w. Sci Am—Sept. 26, 1908. No. 95334.

Steel Cars for Passenger Train Equipment. Illustrates and describes a number of steel cars for various railways. Also editorial discussing the design and construction of such cars. 11000 w. Eng News—Sept. 3, 1908. No. 94861.

Couplers.

Automatic Couplings and Hand Brakes for British Freight Cars. H. Raynar Wilson. Considers the reasons why they have not been adopted in Great Britain. 3000 w. Ry & Engng Rev—Sept. 19, 1908. No. 95241.

Electrification.

Midland Railway Electrification. An account of the first single-phase line in Great Britain. Ills. 6000 w. R R Age Gaz—Sept. 25, 1908. No. 95356.

Locomotive Design.

Correctives in Link Motion Design. Roger Atkinson. Describes modifications introduced which produce satisfactory results. 1000 w. Ry & Loc Engng—Sept., 1908. No. 94822 C.

Locomotive Fireboxes.

Sloping Fire Boxes on Locomotives. C. H. Caruthers. Reviews the history of fire boxes with a sloping roof-sheet and gives information relating to their use. Ills. 3000 w. R R Age Gaz—Sept. 4, 1908. No. 94882.

Locomotive Grates.

Locomotive Grate Area. Editorial on the Altoona tests. 1500 w. R R Age Gaz —Sept. 18, 1908. No. 95256.

Locomotive Repairs.

The Average Cost of Repairing Locomotives in America Compared with the Cost on the Northern Pacific, together with comments on plant depreciation and repairs. 1500 w. Engng Con—Sept. 2, 1908. No. 94857.

Locomotives.

Recent Locomotive Types Abroad. A R. Bell. Brief illustrated descriptions of recent types. 1000 w. Ry & Loc Engng —Sept., 1908. No. 94823 C.

The Passing of the Steam Locomotive. Wilson E. Symons. An illustrated review of the history and development, outlining improvements, with special reference to Chicago. Discussion. 9500 w. Jour W Soc of Engrs—Aug., 1908. No. 95390 D.

Heavy Tank Locomotives; British and Foreign. Charles S. Lake. Illustrates and describes examples of tank-engine design showing that larger and more powerful types are being employed. 3500 w. Mech Engr—Sept. 4, 1908. No. 95033 A.

Note on Some Recent Types of Express Locomotives. Maurice Demoulin. Discusses details of recent types and their performance. 3000 w. Engr, Lond—Aug. 28, 1908. No. 94953 A.

Express Locomotive, Southeastern and Chatham Railway. Illustrated detailed description of a modern locomotive exhibited at the Franco-British Exhibition. Plate. 250 w. Engr, Lond—Sept. 4, 1908. No. 95057 A.

Modern Locomotive Engineering in France. Charles S. Lake. Discusses the influence of the DeGlehn system, illustrating and describing types. 800 w. Prac Engr—Sept. 11, 1908. Serial. 1st part. No. 95275 A.

DeGlehn Compound Pacific Type Locomotive. Illustrated description of engines built in America, by the metric system measurements, for the Paris-Orleans Ry. 2500 w. Am Engr & R R Jour—Sept., 1908. No. 94826 C.

DeGlehn 4-Cylinder Compound Pacific Type Locomotives for the Paris-Orleans Railway. Illustrated detailed description of one of 30 locomotives built in America from drawings furnished by the railway company. 3000 w. R R Age Gaz—Sept. 11, 1908. No. 94999.

Tank Engine for the Rahway Valley. Illustrated description of an engine for passenger service on a short line. 600 w. Ry & Loc Engng—Sept., 1908. No. 94821 C.

Ten-Wheel Locomotives for the Southern Pacific. Illustrated detailed description of a recently built oil-burning engine. 900 w. R R Age Gaz—Sept. 18, 1908. No. 95259.

Mogul Locomotives for the Iowa Central Railway Co. Illustration, dimensions and description of one of six engines recently built. 800 w. Ry & Engng Rev—Sept. 5, 1908. No. 94895.

Superheated Steam Locomotives Designed and Built by the Berlin Maschinenbau-Aktiengesellschaft (Studien über Heissdampflokomotiven entworfen und ausgeführt von der Berliner Maschinenbau - Aktiengesellschaft vorm. L. Schwartzkopff). E. Brückmann. Illustrates and describes a number of recent locomotives. Serial. 1st part. 3500 w. Zeitschr d Ver Deutscher Ing—Aug. 15, 1908. No. 95180 D.

Two-Cylinder Compound Six-Wheeled Coupled Locomotive of the Luxey-Mont de Marsan Local Line and of the Bornand Marensin Railways (Note sur les Locomotives-Tenders à Six Rones Accouplées Compound á deux Cylindres du Chemin de Fer d'Intérêt Local de Luxey à Mont de Marsan et des Chemins de Fer du Born et du Marensin). M. Ménétrier. Ills. 4000 w. Rev Isen d Chemins de Fer —Aug., 1908. No. 95155 G.

Motor Cars.

Steam Motor Car for the Rock Island. Illustrated detailed description. 2000 w. R R Age Gaz—Sept. 18, 1908. No. 95263.

The Accumulator Car of the Mainz Railway (Die Akkumulatorenwagen der Eisenbahndirektion Mainz). K. Fürst. Illustrated detailed description. Serial. 1st part. 1200 w. Elektrotech Zeitschr—Jan. 30, 1908. No. 95306 D.

Refrigeration.

Pre-Cooling Plants in the South. Joseph H. Hart. Describes pre-cooling plants for the preparation of freight and vegetables for transportation and discusses their value. 2500 w. R R Age Gaz—Sept. 4, 1908. No. 94883.

Shops.

Early Locomotive Works. A review of early locomotive building in America. 2000 w. R R Age Gaz—Sept. 11, 1908. No. 95001.

We supply copies of these articles. See page 326.

Wheels.

Cast Iron Car Wheels. Editorial letter discussing the wheel question, the design, inspection, etc. 1600 w. R R Age Gaz—Sept. 18, 1908. No. 95258.

PERMANENT WAY AND BUILDINGS.

Curves.

See Track Maintenance, under PERMANENT WAY AND BUILDINGS.

Frogs.

Frog and Crossing Construction. Thomas P. Keane. Illustrated description of the Ramapo manganese hard-center bolted frog. 1200 w. Ry & Engng Rev—Sept. 5, 1908. No. 94896.

Rails.

Mechanical Defects in Rails. J. P. Snow. Discussion of Mr. Howard's paper, presented at the convention of the Am. Soc. for Test. Materials. 1400 w. R R Age Gaz—Sept. 11, 1908. No. 95003.

Rail Failures—Mashed and Split Heads. M. K. Wickhorst. From a paper before the Am. Soc. for Test Mat. Shows the relation of this type of failure to segregation. 600 w. R R Age Gaz—Sept. 4, 1908. No. 94884.

Steel Rails for Present Service; Their Manufacture and Their Failures. Dr. P. H. Dudley. An account of investigations made. Discussion. Ills. 5500 w. Jour W Soc of Engrs—Aug., 1908. No. 95388 D.

Stations.

High Tension Electrical Installations in Brussels Railway Stations (Les Installations à Haute Tension des Gares de l' Agglomération Bruxelloise). Emile Uytborck. Describes the uses to which electric power is put and the transforming and distributing installations. Ills. 6000 w. Soc Belge d'Elecns—Aug., 1908. No. 95102 E.

Switches.

Methods and Cost of Melting Snow in Switches. James S. Lang. From a paper before the Ry. Sig. Assn. 1200 w. Engng Con—Sept. 2, 1908. No. 94858.

Track Maintenance.

Track Maintenance at Curves. Dr. Heubach. The subject of methods of curve measurements is discussed, the maintenance of curves, rail wear, etc. 3500 w. Bul Int Ry Cong—Aug., 1908. No. 94795 G.

Readjustment of Curves and Tangents in Maintenance of Way Work. W. H. Wilms. Notes on the principles and methods involved in realinement of curves and tangents. Diagrams. 8500 w. Eng News—Sept. 17, 1908. No. 95223.

Yards.

Rock Island-Colorado & Southern Yards and Terminals at Galveston. Plan and illustrated description of recently constructed yards. 800 w. R R Age Gaz—Sept. 25, 1908. No. 95354.

TRAFFIC.

Commodity Clause.

The Coal Carriers' Decision. Editorial discussion of the recent decision of the U. S. Circuit Court of Appeals for the Eastern District of Pennsylvania. 1500 w. R R Age Gaz—Sept. 18, 1908. No. 95255.

"Commodity Clause," of I. C. C. Law Unconstitutional. Discussion of the clause that forbids railroad companies to transport in interstate commerce any article or commodity manufactured, mined or produced by them or under their authority, except lumber. 1700 w. R R Age Gaz—Sept. 18, 1908. No. 95261.

Freight Rates.

Texas Railroads' Reasons for Raising Rates. States facts in explanation of the railroad situation in Texas. 2000 w. R R Age Gaz—Sept. 4, 1908. No. 94887.

The Missouri River Jobbers' Case. Editorial discussion of the results of this decision of the Interstate Commerce Commission is enforced. 1500 w. R R Age Gaz—Sept. 18, 1908. No. 95257.

MISCELLANY.

Africa.

The West African Government Railways. Frederic Shelford. The Sierra Leone government railway and its equipment and operation is described. Ills. 2000 w. R R Age Gaz—Sept. 25, 1908. No. 95357.

Florida East Coast.

Importance of the Railway to Key West. William Mays Venable. Considers the wonderful engineering in the construction of the Florida East Coast Ry. extension to Key West, and its relation to traffic via the Panama Canal. Ills. 4000 w. Engineering Magazine—Oct., 1908. No. 95396 B.

STREET AND ELECTRIC RAILWAYS

Brakes.

The Freund Self-Winding Track Brake. Illustrated description of an ingenious mechanical track brake applied by a spiral spring. 1800 w. Elec Rev, Lond—Sept. 11, 1908. No. 95283 A.

Braking.

Taking Advantage of Transfer of Weight in Braking on One-Way Cars. W. H. McAloney. Shows the advantages that can be secured by such a transfer. 1600 w. Elec Ry Jour—Sept. 5, 1908. No. 94847.

The Felten & Guilleaume-Lahmeyer-werke System of Train Control (Die Zugsteuerung der Felten & Guilleaume-Lahmeyerwerke). Chr. Kraemer. Illustrates and describes the system. 3200 w. Elektrotech Zeitschr—Mar. 5, 1908. No. 95315 D.

Car Fenders.

Public Service Car Fender and Wheel Guard Tests. An account of tests to be held Oct. 20, 1908, at Pittsburg, Pa. 1200 w. Sci Am—Sept. 19, 1908. No. 95237.

Cars.

Philadelphia's Pay-Within Car. Cars remodelled for fare-prepayment are illustrated and described. 1200 w. Elec Ry Jour—Sept. 26, 1908. No. 95347.

Electric Traction.

Electric Traction on Tramways and Railroads. Gives method of calculating the traction effort, horse power, etc. 800 w. Mech Wld—Aug. 28, 1908. No. 94928 A.

Power Requirements in Trunk-Line Operation (Kraftbedarf für den Betrieb von Vollbahnen). R. Sanzin. Discusses the method of calculation, the points to be considered, etc. Ills. Serial. 1st part. 2500 w. Zeitschr d Oest Ing u Arch Ver —Aug. 21, 1908. No. 95163 D.

Elevated Railways.

The Problem of the Chicago Elevated Railway Loop. Editorial on the existing conditions, discussing means of improvement. 1800 w. Eng News—Sept. 24, 1908. No. 95364.

History.

The Development of the Electric Railway. James N. Hatch. An illustrated historical review, with discussion. 11000 w. Jour W Soc of Engrs—Aug., 1908. No. 95389 D.

Interurban.

The Ohio Valley Scenic Route. Illustrates and describes the lines of this route between Steubenville, Ohio, and East Liverpool, Ohio. 3500 w. Elec Ry Jour —Sept. 19, 1908. No. 95202.

The Kokomo, Marion & Western Traction Company. C. A. Tupper. An account of a very successful development of a railway, light and power distribution system. 3500 w. Elec Rev, N Y—Sept. 26, 1908. No. 95373.

The Traffic Problems of Interurban Electric Railroads. Thomas Conway, Jr. Discusses changed conditions and the early mistakes in construction of interurban lines, etc. 4000 w. Jour of Acc—Sept., 1908. Serial. 1st part. No. 95405 C.

Nottingham.

The Tramways of Nottingham. Illustrates and describes the successful municipal lines and their equipment. 4000 w. Tram & Ry Wld—Sept. 3, 1908. No. 95289 B.

Rail Corrugations.

The Formation of Rail Corrugations (Ueber Riffelbildung an Strassenbahnschienen). K. Sieber. A mathematical inquiry into the causes of their formation. Serial. 1st part. 4500 w. Elek Kraft u Bahnen—Aug. 14, 1908. No. 95169 D.

Railless.

General Urban and Interurban Transportation and Railless Electric Traction. F. Douglas Fox. Read before the British Association at Dublin. Aims to show in detail the comparative economics of the tramway and the mechanical omnibus. 4000 w. Elec Engr, Lond—Sept. 11, 1908. Serial. 1st part. No. 95280 A.

Single Phase.

Thamshavn to Lokken Electric Railway. A. C. Kelly. Illustrated description of the first single-phase line in Norway. 1500 w. Tram & Ry Wld—Sept. 3, 1908. No. 95288 B.

The Locarno-Pontebrolla-Bignasco Single-Phase Railway (Ferrovia a Corrente Monofase Locarno-Pontebrolla-Bignasco). S. Herzog. Illustrated description of this line, commonly called the Valle Maggia Line. Serial. 1st part. 1400 w. Industria—Aug. 23, 1908. No. 95122 D.

Equipment and Operation of the Electric City and Suburban Blankenese-Ohlsdorf Railway (Einrichtung und Betrieb der elektrischen Stadt- und Vorortbahn Blankenese-Ohlsdorf). C. Röthig. Ills. Serial. 1st part. 3000 w. Glasers Ann—Aug. 1, 1908. No. 95154 D.

The A. E. G. and Union E. G. System of Single-Phase Electric Traction on European Railways (La Traction électrique par Courant Alternatif Simple sur les Chemius de Fer en Europe, Système de l' Allgemeine Elektricitäts Gesellschaft et de l' Union E. G.). M. Henry. A general description. Ills. Serial. 1st part. 1600 w. L'Elecn—Aug. 1, 1908. No. 95109 D.

See also Electrification, under RAILWAY ENGINEERING, Motive Power and Equipment.

Subways.

Accounts of the London Electric Tube Railways. Gives tables of comparison, showing a complete analysis of the published accounts for the past half-year. 1500 w. Elec Rev, Lond—Sept. 11, 1908. No. 95284 A.

The Construction of the Paris Subway Lines. Louis Dubois. Gives particulars of interesting extensions being made and methods adopted. 2500 w. Elecn, Lond—Aug. 28, 1908. No. 94941 A.

Toronto, Canada.

Toronto's Pioneer Electric Railway. Brief account of what is said to be the first practical electric road in America. 1500 w. Can Elec News—Sept., 1908. No. 95078.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated: W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.

Camptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *w.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electric Railway Review. *w.* Chicago.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *m.* Milan.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *w.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Men. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *b-m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Age Gazette. *w.* New York.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Street Railway Journal. *w.* New York.
Surveyor. *w.* London.
Technology Quarterly. *qr.* Boston, U. S. A.
Technik und Wirtschaft. *m.* Berlin.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagon Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

CURRENT RECORD OF NEW BOOKS

NOTE—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to* THE ENGINEERING MAGAZINE.

Architectural Composition.

Architectural Composition. By John Beverley Robinson. Size, 8½ by 6 in.; pp., 234. Ills. Price, $2.50. New York: D. Van Nostrand Company.

In any form of artistic composition too close adherence to theory and convention must inevitably result in defeating the true ends of art. Nothing more uninspiring could well be imagined than, for instance, an architecture based wholly on tradition and precedent. A work, therefore, which proposes in its preface to formulate the approved practice of architects in designing the exterior of buildings excites at first glance a not unnatural suspicion. One has only to read the first few pages of Mr. Robinson's book, however, to realize the value in architectural composition of the application of such theories as he puts forward. They comprise not hard and fast rules, but generalizations, developed in coherent and logical form, of principles which have long been recognized in their individual application. Such a treatment of the subject is one which cannot fail to give to architects themselves a truer conception of the æsthetic side of their profession and to form a profitable study for the structural engineer. The book is very profusely illustrated and attractively bound.

Harbor Engineering.

A Treatise on the Principles and Practice of Harbor Engineering. By Brysson Cunningham. Size, 9 by 6 in.; pp., 283. Ills. Price, $5. London: Charles Griffin and Company, Limited; Philadelphia: J. B. Lippincott Company.

The author's treatise on "Dock Engineering" has been long and favorably known; the present volume needs no further introduction than to say that it is intended as a companion treatise to the earlier work. The two subjects overlap at a good many points and it was impossible to produce a complete and self-contained treatise on the broader subject of harbor engineering without recapitulating a considerable amount of material which had already been used in the author's previous volume. The common material, however, is here presented from fresh points of view, with additional features of interest and new illustrations, and the book gains, rather than loses, in interest and value through its inclusion. In addition to a brief general introduction there are chapters on harbor design; marine and submarine surveying; piling; natural and artificial stone; breakwater design; breakwater construction; pierheads, quays and landing stages; entrance channels; and channel demarkation. The book is profusely illustrated and fully indexed.

Railroad Engineering.

The Elements of Railroad Engineering. By William G. Raymond. Volume II. Size, 9 by 6 in.; pp., xvi, 405. Ills. Price, $3.50, 15/. New York: John Wiley & Sons; London: Chapman and Hall, Limited.

This book forms Volume II of a treatise on the whole subject of railroad engineering to be completed in three volumes. It deals with what may be termed Railway Economics. The first and third projected volumes will be entitled, respectively, Railroad Field Geometry and the Railroad Field-book.

The present volume consists of an Introduction, three main divisions, and an Appendix. The Introduction discusses in very condensed form the inception of railroad enterprises, company formation, stocks, bonds, engineers' estimates, construction, operation, over-capitalization, stock watering, railroad valuation, the relation between railroads and the public, and the duties of the engineer. Part I treats of the permanent way, separate chapters being devoted to alinement, rails fastenings, ballast, bridges, yards, signaling, etc. Part II discusses the locomotive and its work, with chapters on locomotive and grade problems, railroad expenditures, effect on operating expenses of change in the number of trains, problems of change of ruling grade, distance, rise and fall and curvature, and other subjects. Part III deals with railroad construction and betterment surveys. The appendix is a paper by W. D. Taylor before the American Society of Civil Engineers on the location of a new road, a branch of the Louisville and Nashville system across the Cumberland Mountains and the Clinch River Valley in Kentucky and Tennessee. The whole book is clearly conceived and admirably executed and should rapidly attain a foremost place as a text book and standard work of reference.

THE ENGINEERING MAGAZINE
"THE WORLD IS ITS FIELD"

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THE BASIC CAUSE OF INCREASED EFFICIENCY.

By Walter M. McFarland.

Mr. McFarland believes that in industrial organization the human element is vastly the most important factor, and that increased efficiency is to be obtained principally through the stimulation of the *personnel* by a system of individual reward. In the following pages he elaborates this view in convincing fashion, drawing his illustrations from ancient military history, from modern industry, and from recent experience in the United States Navy.—THE EDITORS.

IT is probable that there was never a time when there was not an effort on the part of some especially energetic individuals to bring about an improvement in existing methods, but with the advent of the steam engine as an active factor in human affairs, this effort for improvement has become more marked, with an intensity which has been steadily growing, down to the present time, so far as relates to increased efficiency of machines. The improvement has come about partly by good fortune, partly by experiments (not always well directed), and partly as the result of effort directed by a thorough knowledge of theory. The last quarter-century has witnessed a greater concentration of effort towards the increase of efficiency in the human element, and it is proposed to discuss briefly what is really the basis for the undoubted improvement which has resulted.

It is one of the elementary chapters in political economy which proves that unorganized society is of necessity inefficient, and the books go on to show that specialization produces a decided increase in the individual and the general efficiency. This is true even on a small scale. When the scale of operations is greatly increased, we find, as we might expect, that thorough training and organization are productive of increased efficiency, as is notably shown in the history of armies in ancient times.

The great success of Alexander in his expedition through Asia is attributed in part to the fine organization and drill of the army by his father, Philip, who in turn was a pupil of Epaminondas. The latter was apparently the inventor of the first material change in tactics in introducing a movement similar to the flying wedge, which was popular in football some years ago. The utilization of this idea in his battles was a great feature in Alexander's victories. In the same way the successes of Hannibal against the Romans were apparently due to the much higher skill and training of his officers and men, under the direction of his consummate generalship. Organization and drill alone, however, are not sufficient, as was shown in a most remarkable way in Napoleon's campaigns. Leaving aside for the moment the marvellous military genius of Napoleon and the great ability of some of his chief lieutenants, the fact remains that prior to the Revolution none of them had had any experience in battles on a large scale and they were often pitted against veteran commanders of many years' experience. They had troops who were comparatively raw, and the enemy in many cases had troops who were veterans. There must be some reason for the immensely greater efficiency which was developed, and it seems, on even moderate analysis, to rest upon a basis of rewards of some kind. In the early days—those of Alexander and Hannibal—it was expected that the victorious army, besides receiving its usual pay, would glut itself with loot. We may not regard a spirit thus satisfied as of a very high grade; but for the time the incentive was thoroughly adequate. Hannibal's soldiers were all mercenaries and had no patriotic impulses to influence them in the slightest degree, while the Romans were fighting for their country. Something of the same sort was true of Alexander's men, as we know that it was customary among the Greek soldiers to hire out their services. In the case of Napoleon's armies, there can be no doubt whatever that the splendid rewards which he held out for splendid services were calculated to bring out the very best work of which each man was capable. It was commonly said that every soldier carried a marshal's baton in his knapsack, and we know that a majority of his marshals actually rose from the ranks.

The very difference in quality between the men who are usually obtained for soldiers in peace and those who enter the service during a war emphasizes this point. In times of peace there is ordinarily little chance for an enlisted man to get much advancement. In war, for a bold and brave man there are splendid opportunities; and the history of the American Civil War, with the large number of men who entered as privates and afterwards became officers of the regular army, shows the much greater opportunity. An actual count of a recent Army Register showed sixty general officers (two lieutenant-generals) who had risen from the ranks and whose names were on the list. We can see all these things very clearly now when we look back and study them, but in times of general indifference or stagnation this basic principle seems to be entirely ignored.

In the early days of hand-workmanship, men were either their own masters or, at least, worked in small groups where they were thoroughly under the master's eye, so that questions of organization did not enter. The advent of the steam engine, and following it the growth of the factory system, changed the problem of craftsmanship almost completely and in a way to make the questions of organization and discipline somewhat analogous to those obtaining in military organizations. When the factories were still small and the masters could be personally acquainted with every man, so that there was a personal touch, there was still something of pride on the part of all decent workmen in rendering an adequate return for the wage received; but with the development into the huge establishments of recent years this personal touch has been entirely lost, and it is an undoubted fact that there has been a tendency on the part of the men to render less than an adequate return for their wage.

Two methods are always open in handling large bodies of men—by leading or by driving. With work that requires no particular skill and mere brute strength, the method of driving may succeed moderately; this was the method in both ancient and modern times of handling slaves. Where the skill of the workmen is involved, however, driving is practically out of the question. Something can be accomplished, but there is almost sure to be a reduction in quality of product. We then come to exactly what was found two-thousand years ago in the military organization—that to get zealous and efficient work, an adequate reward must be offered.

It can hardly be asserted with confidence that in industrial lines the perfect system of reward has yet been discovered—that is, one which, while perfectly just in theory to master and man, is accepted cheerfully by both. Piece work seemed very promising (and it certainly is just) but in one way it did even more than was expected. It proved almost always that the men had produced so much less than was easily possible that the masters would have been more than human if they had not cut the piece-work rate, and, of course, the result was strikes and other troubles. Then came the premium system, which seemed to be entirely fair to both masters and men; but the labor organizations are against this because they claim that it leads men to produce too much, thereby throwing many out of employment. Others, like Mr. F. W. Taylor and his followers, have shown very admirably how a proper bonus system would produce the proper results, although this would doubtless be opposed by the labor agitators. There can be no doubt whatever that all of these systems have shown very thoroughly that they do offer an adequate reward to men who are willing to be fair, and that, as a result, the efficiency of work and of the plants is enormously increased. It will, of course, be understood that it is assumed that the other essentials of success—proper organization, modern labor-saving methods, etc., are to go along with the factor specially affecting the *personnel*—but I believe that the human factor is vastly the more important.

It is very interesting to look at the history of the United States Navy in the last forty years, as showing how the application of this same basic principle has been productive of splendid results. For a period extending from shortly after the Civil War until almost the beginning of this century, the promotion of officers was absolutely by seniority, this in turn depending on vacancies produced by natural causes alone, thus assuring extreme slowness in attaining higher rank. As if this were not enough to discourage able men, in 1882 the number of officers was reduced, making it almost certain that a lifetime would be spent in the lower grades. The natural result followed, and a great many very able young officers, whose services should never have been lost, left the Navy to engage in private business with its much greater pecuniary reward. In 1897 the Personnel Board, under the chairmanship of Mr. Roosevelt, then Assistant Secretary of the Navy, provided for a steady flow of promotion, which would guarantee to competent officers that they would get to positions of importance, with reasonable compensation, before they were old men. This system has been in operation now for about ten years only, yet the results are shown by an almost complete absence of resignations. The bright men, whom the Government has educated at great expense, are retained in the service, and it would require inducements which very few outside concerns would be prepared to offer, to get them to leave. Indeed, the prospects of any but the most brilliant men below the age of thirty are now much better in the Navy than in business life. Incidentally it may be remarked that the only thing that did keep the good men who remained in the service during these discouraging times was the assurance of a fixed tenure of office and the retired list in old age or in the case of breakdown. These, however, are rewards—although inadequate for the ablest men, the very ones whose resignation should have been made almost impossible.

In the case of the enlisted *personnel,* for a long time there was little inducement for good men to make more than one cruise. At the end of his period of enlistment a man was discharged with practically no better claim for preferential treatment when re-enlisted than one without this previous experience. The first improvement was what was known as "the continuous service system," which provided that men who had made a good record could have a vacation of three months with pay, provided they re-enlisted at its end (the pay being given on re-enlistment) and during this re-enlistment their pay was increased. The effect of this was excellent and brought a better class of men into the service.

A mistaken notion as to methods of discipline had provided that, in the vast majority of cases, petty officers were always to be appointed by the commanding officer of the ship for the time being. The law permitted the captain to punish by "reduction of any rating established by himself" without a court martial, thus enabling prompt, but often unjust, action to be taken. In fact, it made the tenure of these offices depend on the impulse, if not the whim, of the captain, as the punishment was almost invariably summary and under the stress of the moment. A court martial, at least, would have let everybody cool off. Within the last twenty years a far better system has been adopted in giving competent petty officers who have proved their ability a permanent appointment on the recommendation of the captain. These appointments can, however, be revoked by sentence of court martial, just as a commissioned officer may lose his commission. It is astonishing that people in high positions often ignore the fact that human nature is pretty much alike in all grades. Thus it was not at first generally realized that the men would prize these permanent appointments almost as highly as the commissioned officer does his commission. My personal experience while a naval officer showed, however, that the men do prize these permanent appointments very highly, and it is an undoubted fact that the change has tremendously raised the standard of efficiency among the petty officers of the Navy.

With the greatly increased interest in naval matters which has obtained in the United States since the Spanish-American war, everybody has read with pride of the great improvement in the gunnery records, until the experts tell us that the efficiency is now very high indeed, perhaps the highest in the world. Without detracting in the least from the credit due the officers who have been instrumental in bringing this about, nor from the effect due to emulation and competition among the ships of the fleet, there can hardly be any doubt that the basic principle of adequate reward for efficiency has had a tremendous influence in the improvement. Reference to the official documents shows that a material inducement is offered for skill as gun pointers. The Naval Year Book for 1907 says:

"Enlisted men of the Navy, after having qualified as gun pointers and who are regularly detailed as gun pointers by the commanding officer of the vessel, receive monthly *in addition* to the pay of their respective ratings extra pay as follows:—

Heavy gun pointers,	
First class	$10.00
Second class	6.00
Intermediate gun pointers,	
First class	8.00
Second class	4.00
Secondary gun pointers,	
First class	4.00
Second class	2.00

Men detailed as gun captains receive $5.00 per month additional pay."

These sums may not seem large to those who do not know the rates of pay in the Navy, but the highest figure means an increase of from 20 to 40 per cent of the monthly pay. Such a percentage increase for greater efficiency would be considered very liberal indeed in industrial work.

Quite a long list could be made up of the various items of extra pay which are given to men in the Navy for qualifying for important positions. It all comes to this—that dependence is no longer placed alone on the skill of the officer, however great, in imparting instruction, or in driving the men, but actual individual reward is offered for excellence.

As illustrating in a somewhat different way how men respond and adjust themselves to reward, or, what comes to the same thing, the maximum satisfaction for a given amount of effort, two instances that came under my observation while in the Navy are very interesting. One cruise was made on a vessel whose executive officer was, in most respects, a very able man. Discipline in general was admirable. In arranging for shore leave of the enlisted men, however, he managed so to arrange matters, strange as it may seem, that it was possible for a man in an inferior conduct grade to get more liberty than one of the best-behaved men. This was, of course, entirely unnatural and came about from a combination of two separate systems. The reason was that naval regulations compelled the giving of at least a certain amount of shore leave to men in the second grade, while the system he was using actually allowed less to a man in the first grade. The result was that in a short time the bulk of the men were in the second conduct grade where they could get the most liberty. At a later date, on another ship, the executive officer was an extremely able man, who had studied this question more carefully and was a great believer in making it worth while for the men to behave themselves and keep in a high-conduct grade. He so arranged matters that if any man behaved himself sufficiently well and did all his work with high efficiency he could have an unusual amount of liberty. The result was that this ship had more than half its crew in what is known as the "special first class," far and away the largest percentage that ever came under my observation.

When the Engineer Corps of the Navy was absorbed into the line at the suggestion of Captain (now Admiral) Evans, I believed that this was only a first step and that ultimately all of the enlisted force would likewise be trained to do double duty, both with the battery and with the machinery. It is obviously, therefore, quite appropriate that a discussion of some aspects of naval efficiency should be conducted in The Engineering Magazine, because the modern Navy has become more and more an engineering organization.

I assume that it will not be supposed, because I do not discuss other vital elements to efficiency, such as proper organization, thorough discipline, specialization, etc., that I underrate them, but it has seemed to me that in many of the schemes which are put forward for increased efficiency there is too great a tendency to assume that the human beings who have to carry them out are machines. This mistake is akin to that which is so often made where it is believed that an evil can be cured by simply passing a law against it, forgetting that public opinion must be back of the law.

In these days, some branches of business, notably advertising and selling, are showing a firm belief in the truth of Pope's saying "The proper study of mankind is man," with splendid results. They aim to show a man that it is to his interest to buy. What we have to do in production is to show the men that it is to their interest to produce with the highest efficiency. The most practical way to do this—is it not indeed the only way?—is to provide an adequate reward. The rare men who are sure to rise to higher positions are naturally satisfied with this as their reward; but the vast majority cannot hope to rise higher than skilled artificers. These men have exactly the same human nature as the executives of the establishment, and what causes the executives to be efficient will certainly have the same effect upon the workmen—and this is adequate reward for the highest efficiency.

EFFICIENCY AS A BASIS FOR OPERATION AND WAGES.

By Harrington Emerson.

VI. THE MODERN THEORY OF COST ACCOUNTING.

The parts of Mr. Emerson's series, which began in our issue for July last, already presented have discussed the world-wide evils of inefficiency in almost every branch of human activity; the peculiar national qualities which have thus far helped the leading industrial nations to mitigate the losses due to inefficiency; the necessity for supplementing the line system of organization on which industrial management principally depends with modern staff organization; the relation of standards to organization and to results; and, last month, the realization of standards in practice.

In the following pages Mr. Emerson outlines the theory that actual costs must be subdivided into standard costs and preventable wastes; that standard costs must be based on full equivalency in service rendered for money spent; that standard costs must always be predetermined; that average wastes are part of general expense and can be currently anticipated; that the chief duty of the operator is the maintenance of all standards; and that cost standards can only be attained through methods, records, ideals and checks furnished jointly by the comptroller and the efficiency engineer to the executive line officials.—The Editors.

THERE are two radically different methods of ascertaining costs, the first method to ascertain them after the work is completed, the second method to ascertain them before the work is undertaken. The first method is the old one, still used in most manufacturing and maintenance undertakings; the second method is the new one, beginning to be used in some very large plants, where its feasibility and practical value have already been demonstrated.

The objections to the old method are not only that it delays information until little value is left in it, but that it is wholly and absolutely incorrect, mixing up with costs incidents that do not have the remotest direct connection with them, so that analysis of cost statements, as, for instance, repair costs per locomotive mile, does not lead to elimination of wastes. The advantages of the second method are not only that costs must be ascertained before the work is begun, but that the costs as finally tabulated are the real costs divided as to each unit, whether a single element or aggregated out of a million separate elements (1) into standard expense and (2) into avoidable loss. An analysis of costs so stated, facilitates an almost inexorable elimination of inefficient conditions of all kinds, standard expenses being constantly standardized at new levels—wastes, as to standards, being constantly removed.

The general method of anticipation as opposed to the method of retrospect is not a new one, and has already largely made its way in other lines of human activity. The old method was to call out the priests and tom-toms when an eclipse was occurring and thus drive away the devil who was eating the sun. The modern method is to predict the eclipses decades or centuries in advance, and check up our clocks, watches and calendars by the actual occurrence. Under the old method the farmer planted what seed he had, fertilized it with any available manure, and trusted to nature to do the rest. The modern farmer predetermines conditions, selects and tests in advance special seed, feeds the soil with chemically adjusted fertilizer, irrigates scientifically, and trusts as little as possible to nature. In California he forces the lemon trees to bear for the Fourth of July and the orange trees to bear for Christmas. In hygiene, the old method is to wait until a whole community is infested with yellow fever or bubonic plague and then to quarantine and use chloride of lime; the newer method is to prevent the mosquitoes potentially capable of carrying the germs of yellow fever from ever being born, and to kill off the rats and ground squirrels that carry the fleas whose saliva infects the human body with bubos. In travel, the old method was to start an ox team from St. Joseph for California and to arrive somewhere between six months and a year after the start. The new method is to leave San Francisco on the minute, and to arrive in New York on the Century Limited also on the minute. That precision and exactness are more largely due to organization than to conditions is proved by the fact that the pony express of fifty years ago which made its runs between Sacramento and St. Joseph, a distance of nearly 2,000 miles, under unparalleledly adverse conditions of Indian hostility and climatic accident, adhered more closely to time schedule than many a modern railroad. In ocean travel the old method was to sail at some indefinite date from Europe and to arrive at a more indefinite date in America, much as Columbus did on his first voyage, an uncertainty of a couple of months not mattering; but the modern method is to build vessels whose exact speed is predetermined before the keel is laid, as for the Lusitania and Mauretania, which leave port on the minute and arrive almost on the hour.

Predetermination of results is the main characteristic of the modern method. The acceptance of the hap-hazard is the main characteristic of the old method, still in full and orthodox standing in cost accounting. Predetermination of results is based on scientific certainties modified by experience. It ought not to be necessary to prove that retrospect costs based on servile record of the hap-hazard cannot be of value, but actual illustrations from actual practice of their unreliability may hasten the conversion of those who are still skeptical.

Two closely similar types of locomotives were operating on a great railroad, one type in the east, the other in the west, both doing virtually the same work. The vice-president of the road desired to order a large number of new locomotives of the general type in question. He called for the records of the two classes and found that the locomotives operating in the west cost $0.14 per mile for maintenance, but that the locomotives in the east cost $0.10 per mile for maintenance. With these records before him he felt inclined to order the type costing for repairs $0.10 per mile. The facts were, however, that the western round-houses and repair shops were operating at 50 per cent efficiency and the eastern shops and round-houses at 80 per cent efficiency, so that the real respective costs of the locomotives were for the western $0.07 per mile and for the eastern $0.08 per mile. In this case so-called actual costs were expensively misleading.

A large manufacturing plant turned out forty special machines at a hap-hazard labor cost of $400,000, or $10,000 each, but after they were completed and the costs tabulated, the manager declared that if he were given another similar lot, the labor cost would not exceed $5,000 each. Was the $200,000 extra cost of the first lot real cost, or was it the cost of inefficiency due to unstandardized operations?

A waiter bringing in an expensive dinner to a guest at a hotel stumbles and crashes dinner and dishes to ruin. Shall the guest, besides being put to the annoyance of waiting another half hour, be charged not only double price for his dinner, but also for the broken dishes, or is the expense of the accident to be charged to inefficiency, a general overhead burden on all dining-room operations, taken care of in the standardized cost of each dish, without reference to specific accident?

There was a railroad shop in which charges were distributed with such painful care that the shop sweepers subdivided their time to the various locomotives around which they loitered. But locomotives, as well as men, can loiter, and one of the locomotives stood in this shop three months waiting for a steel deck plate. Being familiar with its number, the workers charged all the time they could not readily account for to this locomotive, so that at the end of three months the total amounted to more than $5,000. The fictitious accuracy as to the sweepers' time made more glaring the gross falsity of the locomotive charge. In principle there is no difference between charging an hour of wholly wasted time to a locomotive and charging it with two hours of time when one hour should have accomplished the work. The moment specific wastes of any kind are charged to a definite order instead of being charged to some inefficiency account, real costs are vitiated.

Assuming, under the old method, an elaborately carried out cost system, anywhere from one to two months after the operation is completed there may be put up to the superintendent in tabulated form comparative records covering many thousand different operations. The superintendent does not have any time himself to examine all these different records, so he entrusts the work to a clerk, often without shop experience, instructing him to bring up those records that require investigation. The clerk who has learned to apply "the method of exceptions" passes over as satisfactory those costs that show slight change from previous records and notes down for action those that show great variations. Because costs are not standardized, the variations due to inefficiency under identical conditions are in the records either increased or lessened by the much larger variations due to change of conditions. It is evident that a job done one month under 100 per cent conditions, but with 60 per cent labor efficiency, may equal in cost the same job done another month under 60-per cent conditions but 100 per cent labor efficiency. The tabulated costs of this job show no variation and are consequently passed as satisfactory, although in both cases as to half of the elements the expense is 25 per cent too high. In another case, perhaps, the clerk notes that one month the surfacing of a slide valve is reported to have cost $37.00 and in another month to have cost $3.65. Having found, as it seems to him, a variation worth following up, he begins an interminable and irritating investigation. The foreman in whose department the discrepancy occurred denies it, claiming that the accounting department is in error. If the time and cost accounting is so accurately looked after that it can be demonstrated that the first order was done by an expensive man on a big slow machine, with a very high hour rate, but that the cheaper second order was done by a low-priced man, on a small quick machine, with a low hourly rate, then as to this six-weeks-old occurrence the foreman advances plausible excuses—the little suitable machine was otherwise employed—the expensive man was out of work—it was in any case an emergency job and the customer had to pay for it—so the investigation results in naught in the way of cost reduction, but the whole system is discredited both in the opinion of the foreman and of the superintendent, and the cost clerk soon ceases to take more than perfunctory interest in his duties.

The human mind is curiously irrational and perverse. The Chinese are more interested in their ancestors than in their children, and other individuals besides the Chinese are more interested in tracing their descent to the 1024th part, even on the wrong side of the blanket, of some rascally nobleman, than in training their own children in paths of righteousness. If the object of cost accounting is to record fictitious and valueless genealogies, then the old methods should be given Godspeed; but if the object of cost accounting is to record accurately present facts and facilitate future improvements, then the new method alone is suitable. The old system of cost accounting is deficient firstly because it looks backwards instead of forwards, and it is even more deficient because it has failed to recognize the difference between exchange and equivalency. A birthright may be sold for a mess of pottage. This is exchange without equivalence. When 100,000 bushels of wheat of certified grade are exchanged at the market quotation, for dollars, there is both exchange and equivalence, the operation being reversible, as the money can be immediately reconverted into wheat with only a small frictional loss. In this operation of exchange with equivalence the Government not only standardizes the dollar, but it puts its stamp on the standard dollar—the grade of the wheat is certified to by qualified and approved inspectors—the scales on which wheat is weighed are inspected as to accuracy.

It is, however, only recently that Governments have furnished the standard dollars now used in exchange. When I was studying commercial law at a German commercial school, most of my time, that might have been better employed, was wasted in learning to value and reduce to a common denominator the various coins of brass, tin, copper, silver, gold and platinum which were currently used to settle balances. Before Napoleon made a cleaning up in Germany there were some three-hundred independent States, each with its own rights of coinage and money issue. Many of these issues were still current in 1870, and without an assay and metal market quotations as to value there was nothing definite in a safe full of alleged money. The *Thaler* or *Gulden* was indeed standardized at so many grains of silver, but the current coins were not *Thalers* or *Guldens* and had first to be reduced to *Thaler* or *Gulden* values. Similarly today in operating concerns there are many expressions, as "a day's work," "a pound of material," "the performance of a machine;" but exactly what constitutes a fair day's work, how far a pound of material should go, and what a machine should do per hour, have only in a few cases been determined. They should be predetermined in all cases.

The modern method of cost accounting anticipates standard expenses because it first determines equivalency between dollars spent and standard service. In the mining of precious metals, as also in the German banker's assay of the strange coins he handled, there has always been this determination of equivalency. An ounce of pure gold is worth $20.67; an ounce of alloyed and impure gold is worth $20.67 multiplied by an efficiency figure which may be anything from 99.99 per cent down to a fraction of one per cent. Whatever the mixture, whatever the ore or coins, sample and assay determine the value per ounce, thus determining the efficiency coefficient. As in mining and in former coin assays, so also in modern cost accounting there must be initial determination of equivalency, standard equivalency consisting for dollars paid out, of actual costs multiplied by current coefficient of efficiency. In present commercial transactions the old time slugs and base coins of every kind, country, and date have been eliminated. Dollars, francs, sovereigns and marks, all definitely and precisely related to one another, constitute the common standards of the commercial world, but in industrial equivalency we are still in the dark ages.

It is the function of the efficiency engineer to give the industrial and operating world:

1.—Standards as definite as the dollar, franc, sovereign or mark, for all services, materials, or equipment operations.

2.—To make assays, as definite and reliable as the assayer's determination of bullion values, of all current operations, thus establishing current efficiency.

3.—To provide remedies which will bring current efficiency (often, one might say usually, only 50 per cent of what it should be) up to 100 per cent.

It is the function of the comptroller, auditor, accountant, to locate and record all expenditures, to locate and record all receipts.

Both comptroller or auditor and efficiency engineer are staff officers the work of each of whom is supplementary to that of the other and who both together supply the line officers with the tools and the methods needed to carry on operations with exact knowledge as to cost and efficiency.

Because efficiency is the most important item in modern costs, the modern comptroller and the efficiency engineer must affiliate, associate, so that they may jointly solve the problem, the efficiency engineer being deprived of his most powerful instrument of determination and betterment if the comptroller does not supply him with the necessary current and correct records which he needs. The effect of association of comptroller and efficiency engineer on costs will be illustrated for a specific case, any other possible case being capable of similar solution, the illustration being used, not to show the results of efficiency, but to show how the auditor and the efficiency engineer, before any current work is begun, can predetermine standard costs and current efficiency, ultimately making the latter 100 per cent.

It is evident, when the efficiency engineer predetermines standard costs, that the difference between standard costs and actual costs is the volume of the loss due to inefficiency. It is also evident that if by assays the efficiency engineer ascertains current wastes, he is able to determine standard costs by deducting the wastes from actual costs.

When standard costs are adopted the efficiency engineer is pledged to supply methods which will eliminate the wasteful difference between standard and actual costs, and from time to time, as this work of elimination progresses, standard costs will themselves be revised, sometimes upwards, sometimes downwards, since the basic elements of costs, materials, services and operations are not constant in value.

Predetermination of cost on the basis of standard cost and inefficiency charges will be illustrated by a cost item of railroad operation. A certain railroad operated 1,000 locomotives. Test questions put by bankers, investors, officials are: What is the cost of locomotive repairs per mile? What should be the cost of locomotive repairs per mile? The auditor answers the first question, the efficiency engineer answers the second question; and only where they have worked in harmony are the two answers the same. The staff officer in charge of the accounts, whatever his title—comptroller, general auditor or vice-president—carries his organization as to methods of accounting and checking down to the minutest details. The efficiency engineer's work runs parallel with the auditor's from top to bottom, but on a wholly different line, much as telegraph lines run parallel to railroad lines, each having relations to the same operation, train movement, at every station. In accounting the auditor is responsible for correct cost statements as to every item of expense, and the efficiency engineer is responsible for correct cost attainments—namely, 100 per cent efficiency, as to every service, material issue, or equipment operation.

As a preliminary to co-operation, the efficiency engineer learns that the mileage of locomotives is approximately known, because engineers and firemen are paid on the mileage basis, and that the total annual mileage for the 1,000 locomotives is 30,000,000 miles; that under the Interstate Commerce provisions, all costs of labor and material for locomotive repairs have been charged to one given account whose total for the previous fiscal year was $3,000,000. This works out to a mile cost for repairs of $0.10. The efficiency engineer then goes over the road, makes numerous assay tests of service, of material used, of equipment operation, and while there is great variation in individual assays, some running as low as 5 per cent and others as high as 100 per cent, it is his opinion that the road assays as to this account, 60 per cent of standard; that costs are therefore 67 per cent higher than they ought to be. The accountant thereupon divides his estimate for the coming year into two parts and adopts (on the recommendation of the efficiency engineer) $0.06 as standard of average repair cost per mile, and he adopts 60 per cent as the current efficiency factor, carrying the remaining charge of $0.04 to a preventable waste account. Until further notice any average expense for repairs above $0.06 is considered preventable loss.

It is the business of the efficiency engineer to eliminate wastes, and it is the business of the auditor to carry the accounts in such a manner as to record the results of the efforts of the efficiency engineer. The initial 60 per cent efficiency should gradually increase to 100 per cent and the auditor is to record the increase. The president of the company is advised by the auditor that repair costs as standardized by the efficiency engineer are $0.06 per mile, and that preventable losses amount to $0.04 per mile. The proportionate loss due to inefficiency is 40 per cent, and if current yearly mileage is to be 36,000,000 miles (on basis of current wastes) the loss will be $1,440,000, which loss, if his original assay is correct, it is the task of the efficiency engineer attaining 100 per cent to eliminate, just as certainly as the Century Limited can make the Chicago-New York run in 18 hours.

The president need not look deeper than the standard of $0.06 per average mile, and the efficiency for the total account of 60 per cent. The standard will not be changed for a year—although ultimately it might be made $0.055 or even $0.05, standards being wholly distinct from efficiency—but from month to month the president will watch the efficiency factor and expect to see it rise from the initial 60 per cent to a final 100 per cent, actual costs per mile correspondingly dropping from $0.10 to $0.06. It is, however, not the cost per mile but the *efficiency* which is important. A severe winter might occur, greatly adding to repair costs; a round-house might burn down and damage many locomotives. If all the necessary repairs are made at 100 per cent efficiency, officers and shareholders will have to be content, even though the standard cost has to be advanced after all consideration and for sufficient reason to $0.10 a mile. On the other hand, extraordinarily favorable conditions may drive the actual costs down to $0.05, but if average efficiency in details is only 50 per cent, officers and shareholders know that $0.05 is not low but twice what it ought to be. In the effort for economy many railroads have been making records of low cost which are wholly fictitious, since necessary work has not been done, standards are not maintained and inefficiency as shown by the labor and operation assay is even greater than usual.

To attain 100 per cent efficiency—$0.06 a mile—and to record the downward progress from $0.10, are respective duties of the two staff officers, efficiency engineer and auditor. The latter meets the former's needs in the way of records and accounts. As the largest operating units are the divisions of the road, and as locomotive operation is about 30 per cent of the total road-operating expense, the efficiency engineer asks the auditor to subdivide operations, all the expenses for services, for materials, and for equipment operation (as to locomotive repair accounts),

1.—To separate locomotives;

2.—To the respective divisions;

3.—To the kind of work done, as tire turning, flue welding, etc.

From these records it will be possible to tell not only what each separate locomotive costs per year, but also what each class of work costs. On many roads charges are already subdivided to respective divisions, on others, even to separate locomotives, although not in such a way as to be of any practical use, but it has not been usual to classify as to operations because this has hitherto served no purpose from an exclusively accounting point of view.

Necessary records being available, the efficiency engineer investigates divisions, shops, round-houses, locomotives, and operations. He finds that shop conditions on one division are only 50 per cent, on another 70 per cent, and he forthwith adopts such remedies as will most rapidly bring up the inefficient divisions. He may find, for instance, that lighting and heating or other elementary sanitary conditions on a division are so poor that the men, even with best intentions, lose 25 per cent of their time. Some of this can be remedied, often in a surprisingly easy manner, or work can be diverted to the more efficient shops. The policy of concentration of work at efficient points is steadily pursued. In a given instance, a boiler-shop punch made by day work at an outlying shop cost for labor $6.00, the same punch made on an automatic machine at a central shop costing for labor $0.06.

When it is stated that an efficiency engineer brings about improvements it is to be remembered that he is a staff officer—that he merely provides standards for the officials to follow—that he may indeed establish a standard of 60 per cent efficiency below which no man ought to be permanently retained in the service of the company, but being a staff officer he will not directly discharge an employee, although the efficiency standing is only 10 per cent. Discharge is the prerogative of the line officer. As a staff officer, the accountant may report that a given locomotive costs $0.20 a mile to maintain, while another locomotive on the same kind of work costs only $0.08; as a staff officer the efficiency engineer may report that $0.20 a mile is 100 per cent performance while the $0.08 is only 80 per cent performance; but neither the auditor nor the efficiency engineer has the right to order the uneconomical locomotive out of service.

High cost and inefficiency are not identical. High cost may occur with high efficiency, low cost may occur with low efficiency. The Indian who carried 250 pounds on his back over Chilkoot Pass in Alaska at the time of the Yukon gold rush was tremendously efficient but the method was costly, rates being $0.60 a pound. This is an illustration of high cost and high efficiency. The Alaskan locomotive which today hauls freight over the neighboring White Pass may be very inefficient, only able to drag half a normal load, yet the rate is down to $0.02 a pound. This is relatively low cost combined with low efficiency. The railroads of the United States carry freight at lower rates than any other railroads—cost of service is relatively low. Many of the operating and maintenance methods are extremely wasteful, at least 50 per cent above reasonable standard, therefore efficiency is very low, but the low costs of service are not the result of inefficiency.

Just as the shops are each separately investigated in the pursuance of the work, so the conditions as to locomotive operation are investigated as to each division. Surprising troubles are often revealed. One railroad on which efficiency work was undertaken had neither turn-tables nor round-houses large enough to turn certain new locomotives; on another road some of the curves were so sharp that decapod locomotives could not back over them. In another case the tracks leading to the main round-house were so easily blocked that it was almost impossible to move locomotives in or out. An engineer experienced in detecting inefficiencies will discover a vast number of conditions that are not standard, but which can be easily improved by the line officers, and which when improved will bring up the efficiency factor of the division. No divisional factor can increase without bettering the system factor. If for instance the system factor is 60 per cent, the division one-tenth of the system, when the divisional factor is advanced from 65 per cent to 75 per cent, the system factor will advance to 61 per cent.

Records being available for each separate locomotive, each is investigated both as to performance and as to cost of maintenance. The efficiency engineer establishes new measures, new methods of comparison unknown either to operating officials or to accountants. He knows that repair costs per locomotive mile are, from an efficiency point of view, meaningless. One locomotive weighs 400,000 pounds, another only 40,000; one locomotive operates on 3 per-cent grades, another on level track. He therefore uses such measures as the tractive-weight mile, which compensates for weight and also, fairly well, for the difference between freight and passenger locomotives. He establishes a standard allowance of $1.00 of repairs per ton of coal burned, and on the basis of grade and service he establishes a standard of fuel allowance.

The measuring appliances and methods of the standard-practice engineer, innumerable in their variety, are invented and applied so as to test and gauge efficiency. As to all his own measures he seeks the co-operation of the accountant, without whose figures it is impossible to record definitely and reliably the progress made, or the reverse. As a general proposition those tabulated records, which involve, directly or indirectly, equivalency in money, will be maintained by the auditor; those records which involve other equivalents, foreign to the auditor's experience (as pressures or temperatures, or chemical analysis) will not be looked after by him.

The measures and methods of the efficiency engineer can be divided into two main classes, those that affect general conditions, and those that secure special results. General conditions are those that affect the good and the bad alike, as good equipment, good operating conditions and administration. Special results are secured only through high individual performance, whether the individual is a person, a machine, a material issue or an operation however complicated. The next essay will outline the specific methods and records evolved and used jointly by auditing and efficiency engineers to locate and eliminate wastes.

THE ECONOMY OF THE INDIVIDUAL MOTOR DRIVE FOR MACHINE TOOLS.

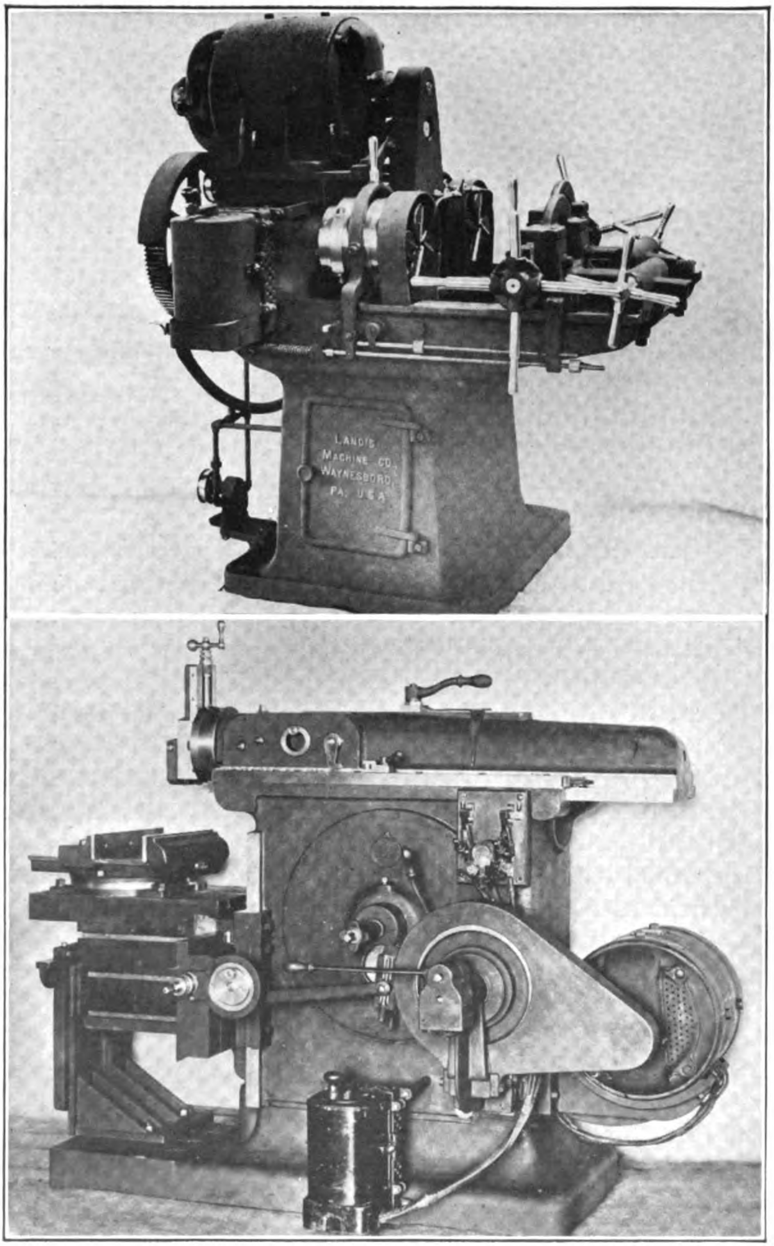
By Howard S. Knowlton.

Mr. Knowlton covers the argument for individual electric driving effectively, concisely, and as fully as possible without going too far into the intricate task of tabulating figures of cost-reduction in special cases. He points out, however, that electric driving permits the actual cost of machine operations to be determined and recorded, and enables remediable inefficiencies to be corrected, with a certainty and accuracy never before possible. As the machine-hour element of cost, in many cases of production, is one of the largest factors, an improvement like electric driving which increases the capacity of the machine has enormous potentiality for cost reduction.—The Editors.

NO one who follows closely the application of the electric motor to every variety of industry can doubt that the most striking tendency of this development is the advance of the individual method of machine-tool driving, in preference to the group plan. It has naturally been to the manufacturer's interest to encourage the use of separate motors as far as possible, but the results obtained in comparison with the best methods of group driving prove conclusively that when a company can afford the additional cost of separate motors, their use, in the great majority of cases, is the best solution of the problem.

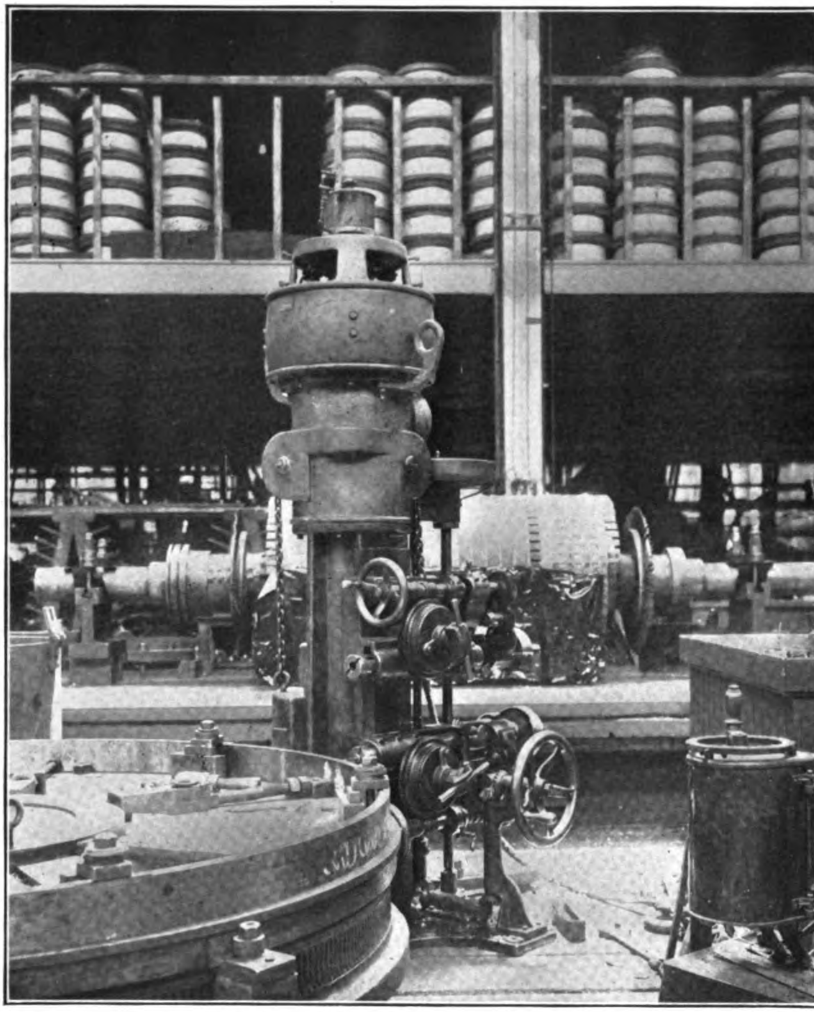
The group method of driving still has its field of usefulness, notably in industries where there are large numbers of small machines to be driven together at a constant speed on the same kind of work. Thus, in the shoe industry, in the modern textile plant, and in many other lines of trade where the stock handled is light, where the machinery in a given department consists of a large number of units operating in production multiple, as it were, and where overhead-crane and hoisting facilities are not needed, the group system is likely to find favor for some time to come. Sooner or later the advantages of the separate drive are certain to be felt, even in fields where at present the group drive has pre-eminence.

Unless each machine in a plant where speed control and tool capacity are important factors in the production is separately driven, the full advantages of the electric drive cannot be enjoyed. With a single motor per tool, the latter can at all times be run at its max-



GENERAL ELECTRIC MOTORS OPERATING INDIVIDUAL MACHINE TOOLS.

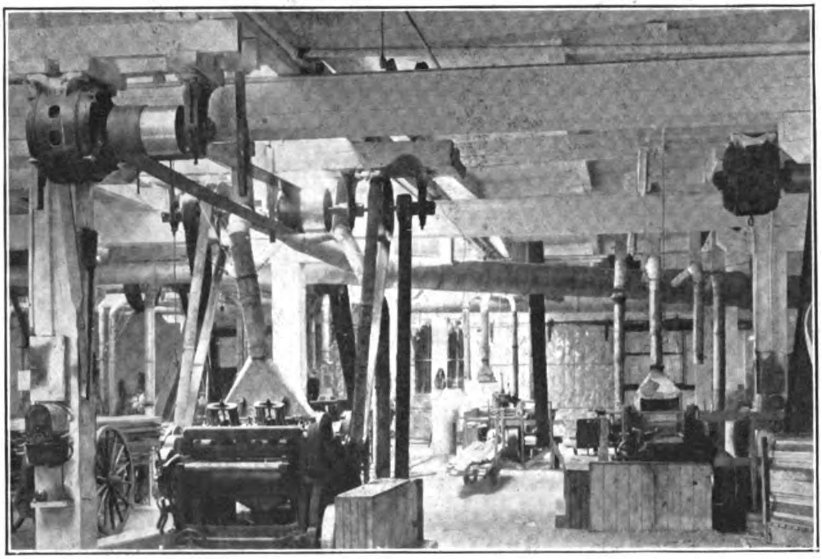
In the Landis bolt cutter, the 5 horse-power motor is mounted so as to save floor space; the Stockbridge 24-inch shaper is driven by silent chain, with automatic tightener, the motor being of 500 to 1,500 revolutions, placed out of the way of chips.



DRILLING MACHINE DRIVEN BY WESTINGHOUSE VERTICAL ENCLOSED MOTOR.

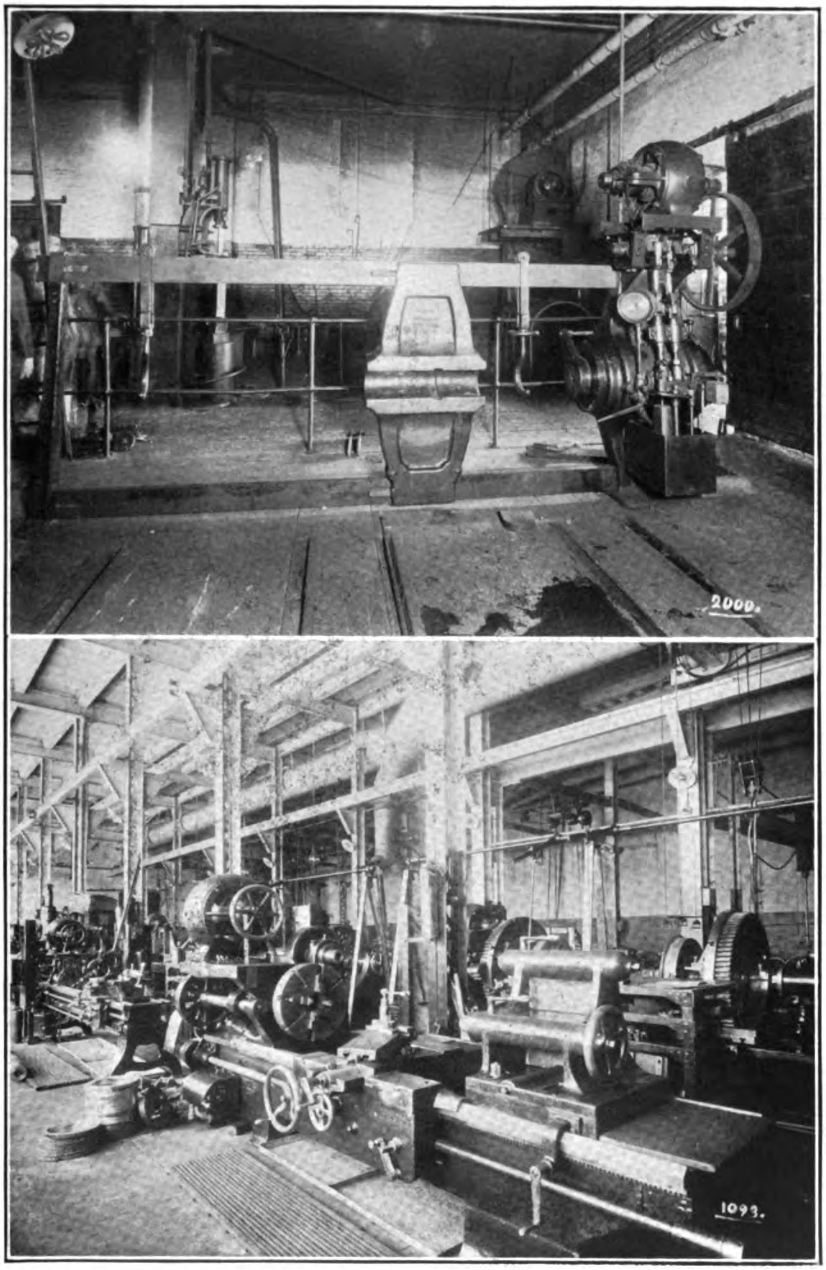
An example of direct application where compactness is vital to convenient service. The motor is enclosed to prevent injury by the work handled by the drill or by the cranes; it is controlled near the floor level.

imum cutting speed; and with direct connection, there is no trouble about securing the necessary pulling power. The latter point is of great importance in applying motors to old tools formerly belt-driven. An old tool can often have its speed of operation increased two or three fold by direct motor application, for the reason that the strains on the machine are those due to the torque required to make a given cut. With this given cut, the speed may be increased three and often four fold without producing any greater strains on the machine itself, because of the constancy of the torque. Of course, the power required increases in proportion to the speed, and this is the factor that limits the ordinary belted tool, whether driven by an engine and line shafting or by short runs of shaft and belts propelled by motors on the group-installation scheme. The belt simply will not transmit the necessary power without slipping.



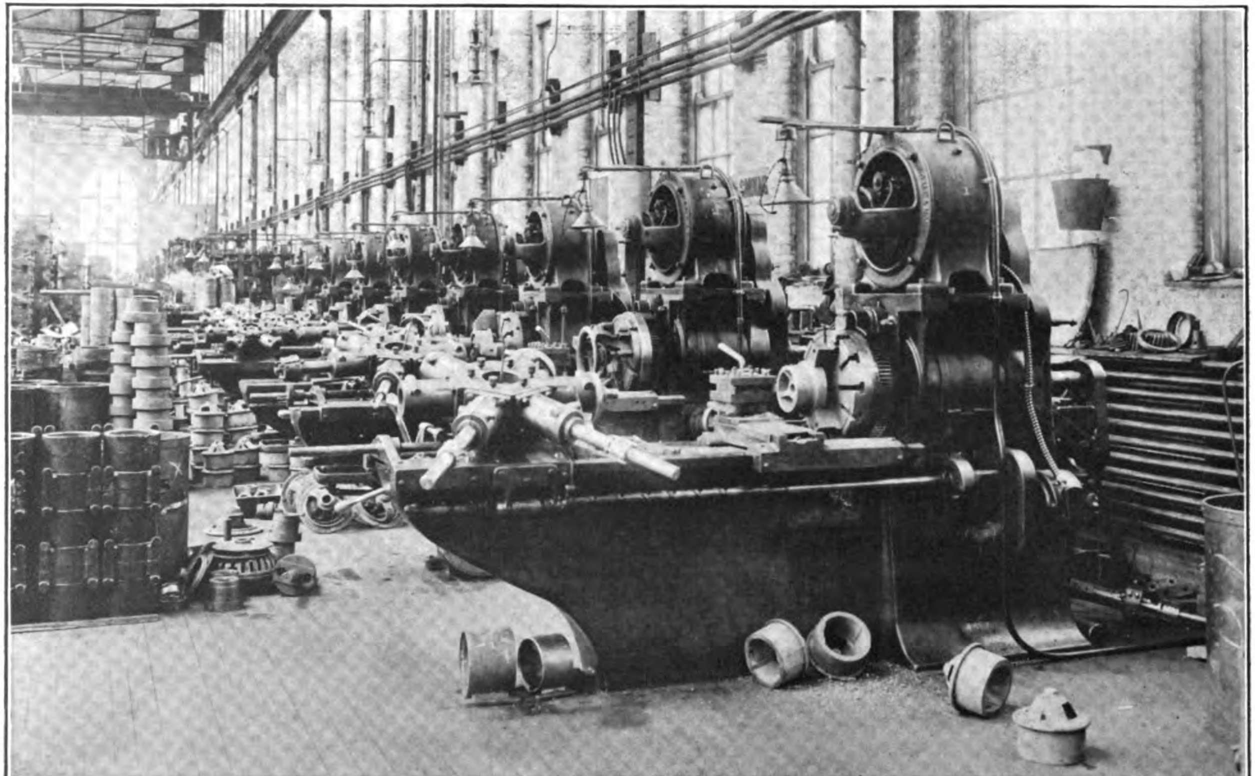
LUMBER MILL MACHINERY OPERATED BY ALLIS-CHALMERS INDUCTION MOTORS.
Fifteen motors are used in this section of the mill. The sticker and surfacer in the foreground are each driven by a 20 horse-power motor.

It is interesting to consider the advantages of electric driving from the standpoint of the direct-connected against the group-driven installation, and to note how much more the economies and improved conditions due to electricity are available in the plant using individual motors. In a mechanically driven plant of the old style, the belt and shafting equipment, when all the tools are in operation, may easily absorb from 25 to 60 per cent of the power developed by the engine. If only a few of the machines happen to be in service, the useful power required may be but 20 per cent or even less of the total generated power. In other words, four-fifths of the coal burned in such a plant for power purposes is thrown away in the friction of the driving apparatus, to say nothing of the time lost from production on account of stopping to take up belts. The reduction of the shafting by the installation of a group-driven system will greatly better this condition, but until all overhead belts are cut out and until there are no



NORTHERN ELECTRIC MANUFACTURING COMPANY MOTORS OPERATING INDIVIDUAL MACHINES.

The upper view shows a Watson-Stillman 150-ton wheel press; the lower one, a J. J. McCabe double-spindle lathe, 26 by 48 inches. Both are in the shops of the Transit Development Company, Brooklyn, N. Y.



BATTERY OF TURRET LATHES IN THE FACTORY OF THE WESTERN ELECTRIC COMPANY, HAWTHORN, ILL.

Each is driven by a separate Western Electric motor; maximum of light is secured, unimpeded by belts, rendering conditions perfect in point of visibility for production of work up to maximum capacity of lathe.

short lengths of countershafting to absorb energy, as in the group drive even under the most favorable circumstances, the conditions will not be at their best. The maintenance of even the simple line shafting and belts, pulleys, and countershafts required in a group-driven installation takes far more attention than is generally appreciated, and when it comes to the operation of overhead traveling hoists for more quickly serving individual tools, even the well designed group installation has its serious drawbacks on the score of danger and delay; in fact, it is often the case that a group-driven layout of tools cannot be provided with better hoisting facilities than obtained in the original engine-operated installation.

It was well said in a recent publication of the General Electric Company on the "Application of Small Motors to Machine Tools," that when the separate tools in a shop are each driven by an individual motor, the power used is so nearly proportional to the work done that the individual motors are all "piece workers," and "there are no gangs of shafts, pulleys and belts putting in their time while running idle."

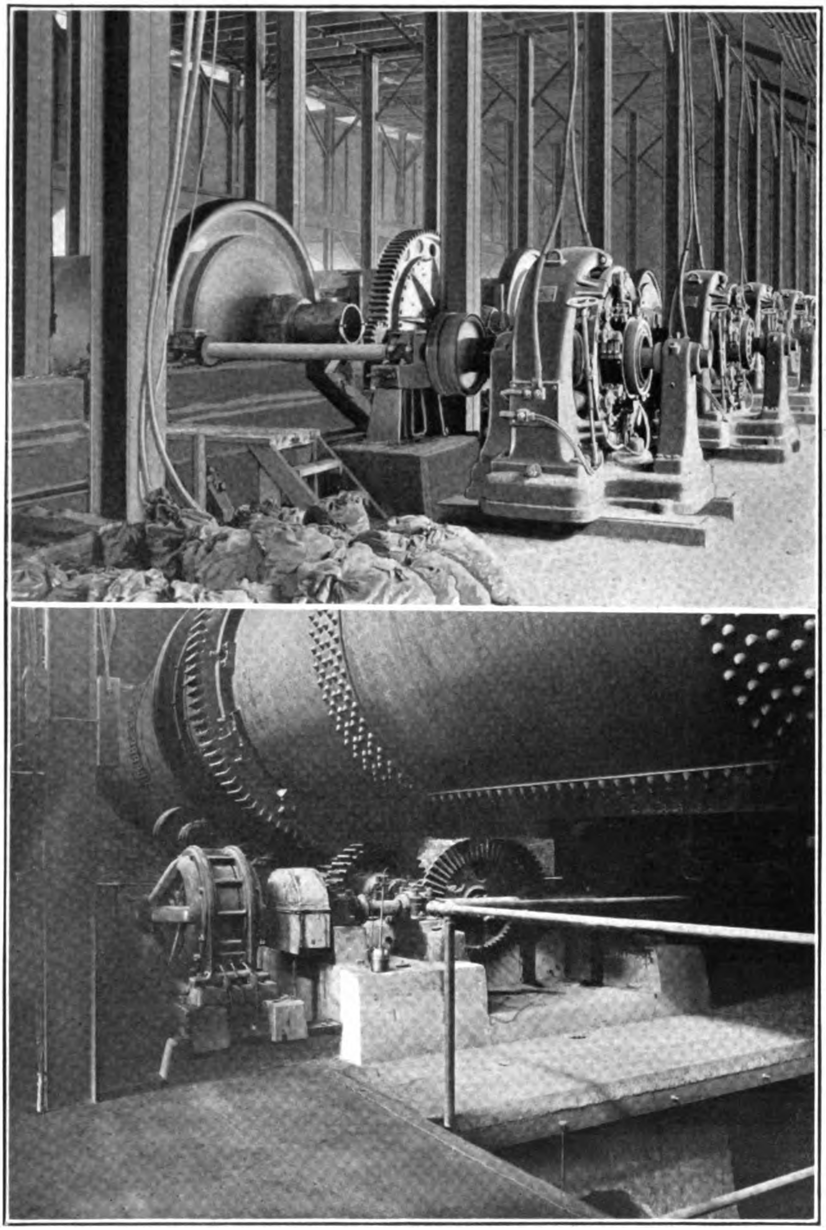
With the individual drive the speed control of the separate machines is far better than under the majority of group systems, and the tools can be better arranged. Just as the group drive is far more flexible than the old belt and shafting method, so is the application of a separate motor to each tool, in an increasing number of cases, better practice than any attempt (on the score of a saving of perhaps 25 or 30 per cent in first cost) to drive the equipment by a few large motors, which must almost always be placed overhead and take up room which would be available for other purposes under the direct-connected drive. It is not always the case that the original installation of motor-driven tools is the best after a service trial has been made, but if the system installed is on the group plan, it may be a difficult problem to make the necessary changes. Not as hard, of course, as with the old engine drive, but still troublesome enough sometimes to preclude the most efficient arrangement of the machinery with reference to the production process.

Another feature of the direct drive which commends itself in times of heavy output in manufacturing plants is the ease with which several motors direct-connected to tools can be set up temporarily in a distant part of a shop to handle some rush job that cannot be taken care of in the regular departments, particularly at times when a great deal of special work is under way. If the plant facing such a condition has to install a system of short belts and shafting on the group principle, not only is the time required greater, but the adjustment of the tools to the job and securing of the most economical speeds will prove a much more troublesome matter. In point of cleanliness, the direct drive is far ahead of the group system, as well as in safety to employees and improved appearance of the shop.

In regard to the equipment of old tools with electric driving, it is no doubt somewhat cheaper to use the group method, but the application of the individual drive to the old tool is now a comparatively easy problem, on its technical side, except where a very great range in speed is required. The recent development of the commutating pole motor enables most cases of forcing the production rate of old tools by separate motor application and the use of high-speed steel to be handled with success. It is sometimes thought that the use of individual motors on old tools is not worth while, but the increases in capacity that have resulted in innumerable cases prove the contrary.

The salient features of a number of recent applications of this character may be briefly touched upon to show the ease with which the matter has been handled. The design of small motors with a casting to carry a back gear enables such machines to be applied to a great number of tools by simply mounting them upon a bracket where they can mesh with the gearing of the old tool. These brackets can be had in all sorts of shapes and sizes and are easily attached and removed in case the motor is needed at some other point. The enclosure of both gear and pinion in such cases reduces to a minimum the chance of accident, and the mechanical stability of the motor and the tool are all that can be desired. Both direct and alternating-current motors can be provided, in small sizes as well as in the larger units, with special frames and back gearing with the same facility. No owner of a shop need hesitate to apply individual motors to his tools for fear that the arrangement of motor and tool will be mechanically unstable or in any sense a makeshift.

The individual drive can be applied in almost every necessary case so as to take up little or no more floor space measured by the rectangle included by the outlying corners of the driven machine tool. Often it is not at all necessary so to economize on space, and the motor can be allowed to overhang the tool slightly. In driving sensitive drills, for example, the motor can either be set upon the floor, mounted on the machine frame, or located on a bracket, according to the style of drill and the local space conditions in the shop. Sometimes a single motor can be geared to a pair of drills with the controller in the centre, and the resulting operation is simple provided no speed changes of any importance are required, outside the regular changes furnished by the cones. Where the direct drive is used the cost of the overhead structure is materially lessened if the plant is new, and



ABOVE, TUBE MILLS IN CEMENT WORKS DRIVEN BY WESTERN ELECTRIC MOTOR.
BELOW, ROTARY KILN DRIVEN DIRECT BY GENERAL ELECTRIC MOTOR.

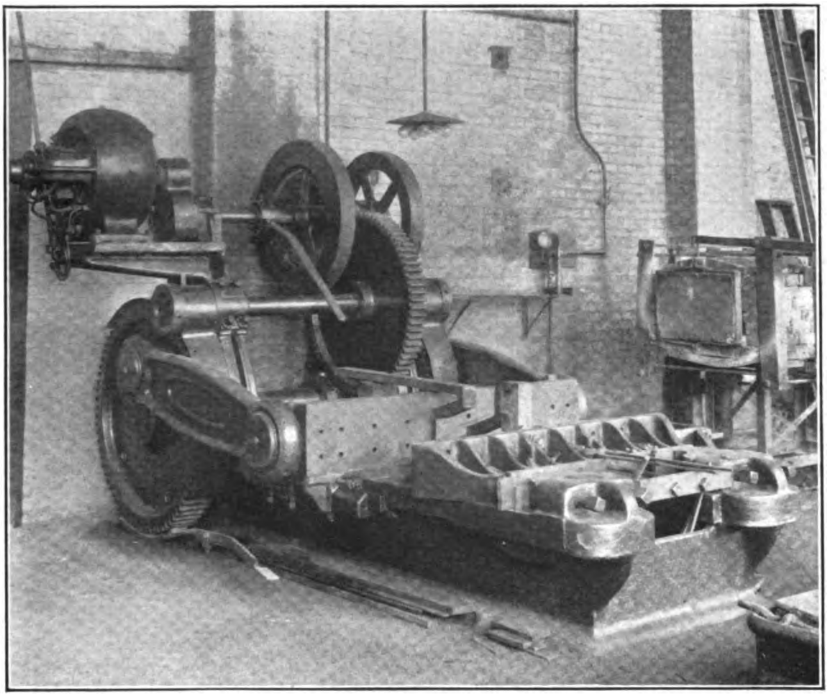
Mechanical driving in such cases is cumbersome and of low efficiency; group driving would be unduly costly in operation; both would increase the cost of building construction in a class of work where low fixed charges are especially desirable.

in an old plant changed over from belt to direct drive there is released additional structural strength, in a great many cases, which can be utilized in the readjustment or relocation of tools on certain ceilings and floors. In the group system these advantages are not so prominent, but the clear gain in building strength is a decided improvement in conditions in many direct-driven installations.

In some types of cutting saws the individual motor can be located on the braces of the saw frame, and thus be entirely out of the way. A cold saw driven by a small motor mounted on top of the machine tool itself is almost equally compact. Each make of tool needs special study by someone accustomed to the use of motors in all sorts of situations, for the best results. This is a field where the advice of the engineers of the district offices of the manufacturing companies is well worth securing, before trying to attach individual motors to old tools upon one's own responsibility.

An important advantage of the direct drive is the ease with which the controller may be applied to the machine tool, in cases where the speed must be varied in the cutting of a single job. In many cases of the attachment of motors to lathes, the controller is arranged to be operated from the apron, a special handle being provided for the purpose. The work is thus directly under the operator's hand. When few speed changes are required, it is even a simpler problem to locate the controller at some point near the working portion of the tool, and if on trial this point is not the best, the flexibility of the electric drive and supply of current enable a change to be made with very little trouble. Practically the same mechanical efficiency may be obtained in applying a motor to an old tool as is enjoyed in a new tool originally designed for motor driving on the direct-connected plan.

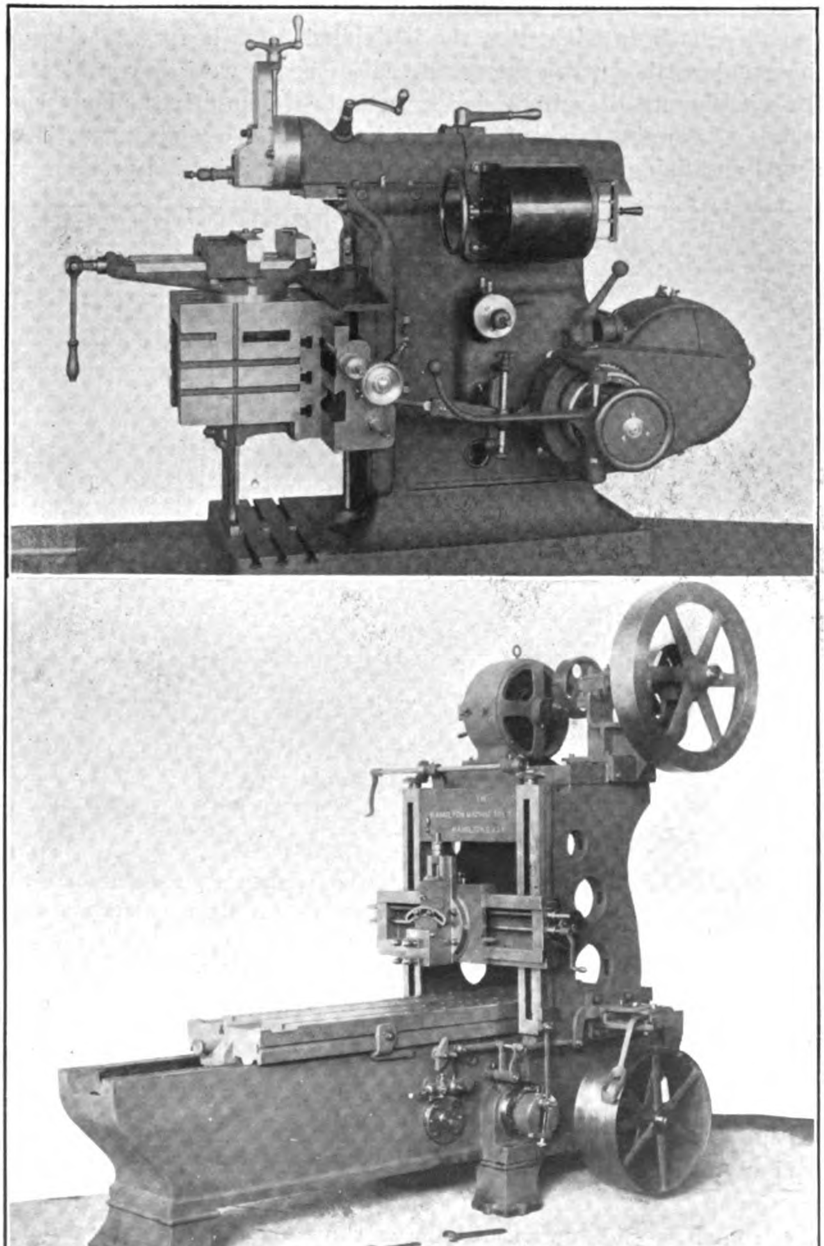
In the cases of very large and powerful tools there is a growing tendency to install more than one motor per tool in order to give the most flexible control. Thus, in the case of a large engine lathe, one motor may be installed upon the floor at the head end to mesh with the traverse gearing, and a second motor may be mounted on the lathe frame at the head of the carriage travel and meshed with the main driving gears. In the case of the turret lathe, the speed and feed conditions have been greatly improved through the use of two motors, one to operate the tool feed, and the other to run the spindle forward or backward. With automatic controllers the service that can be given by such a tool leaves little or nothing to be desired in speed range and feed adjustment. The separation of power and feed on planers has also been worked out with the most satisfying results. The close control of each factor enables every given job that the tool has to carry through to be done with the least delay, once it is set up, and there is little doubt that the individual drive is far superior to the group method when the setting up of heavy work is considered, for the absence of suitable hoists in some group-driven plants has slowed down the production rate of the whole establishment. The actual machining time is only one phase of the production process.



WILLIAMS & WHITE 45-INCH BULLDOZER DRIVEN BY NORTHERN ELECTRICAL MFG. COMPANY'S MOTOR.

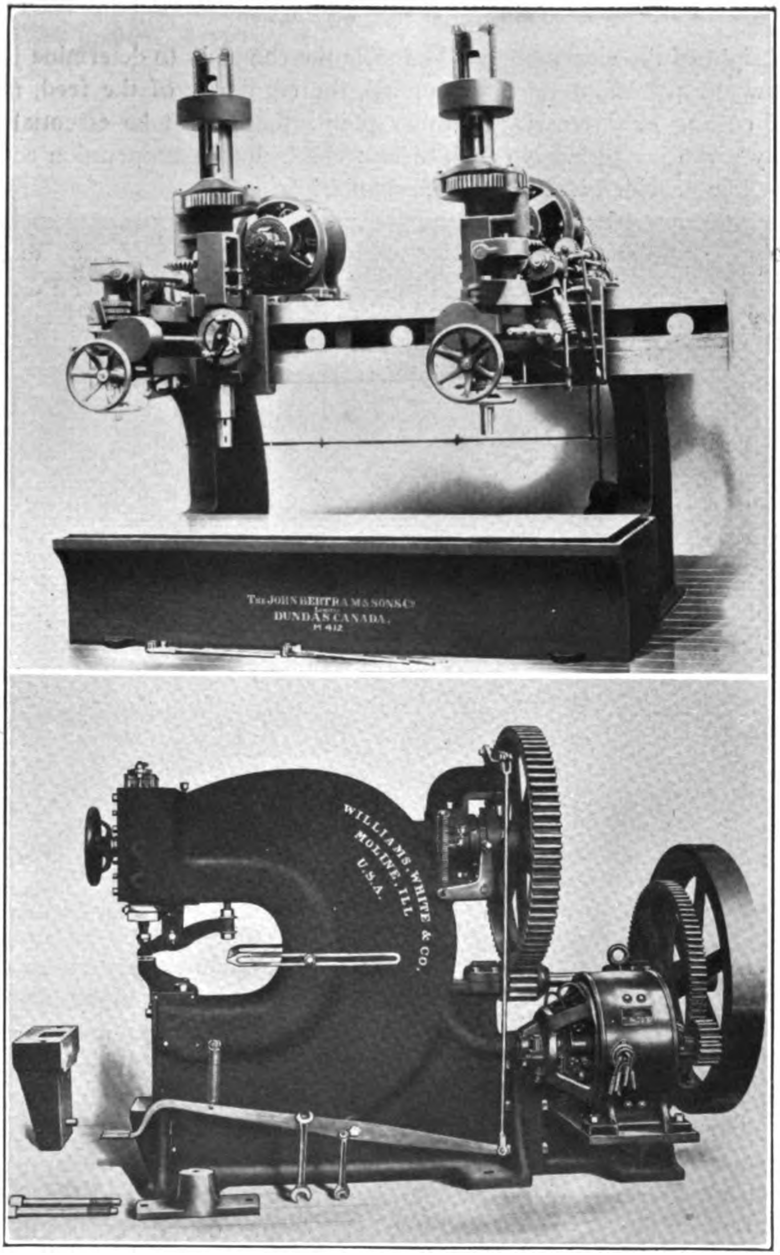
Installed at Transit Development Co. shops, Brooklyn, N. Y.

Continuous production is afforded by the direct drive in a way which few belt-driven installations can enjoy. Particularly in the driving of very large machine tools, it is being found advantageous to install separate motors to drive separate parts, such as feeds, the raising and lowering of cross rails, or the traversing of tool heads, each motor being independent of the driving motor. In this way the maximum possible output per tool can be secured, and if desired, a check upon the productivity of the workman can be made by the installation of meter recording instruments which will show the complete performance of the machine in any given period. Thus, a recording ammeter placed in the circuit supplying a machine tool, out



MACHINE TOOL INDIVIDUALLY OPERATED BY CROCKER-WHEELER MOTORS.

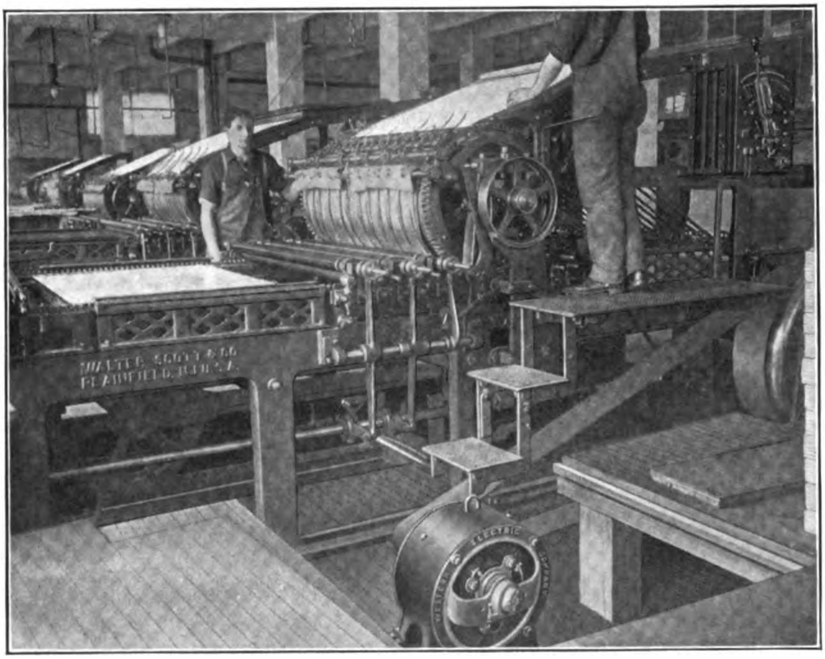
Above, a Gould & Eberhardt 16-inch shaper with 3 horse-power motor; below, 24 by 24 by 72 inch Hamilton spur-geared planer with 5 horse-power motor.



WESTINGHOUSE MOTORS APPLIED TO DRIVING OF STANDARD TYPES OF MACHINE TOOLS.

The Bertram two-spindle drilling machine is driven by a variable-speed motor; belt driving here would seriously impair the flexibility of operation. The Williams, White & Co. punch and shear is driven by 5 horse-power compound motor; this allows reduced speed when cutting and takes advantage of power-storage in the fly wheel to reduce the current demand. Lever control.

of sight of the workman, would enable the company to determine just how any particular job was handled, the regularity of the feed, rate of cutting or reversal, and other points that might be essential in any given instance. No such distant check upon the operation could well be provided with a mere mechanical drive.



SCOTT PRINTING PRESS DRIVEN BY WESTERN ELECTRIC MOTOR.
Prominent features are adjustable capacity, cleanliness, excellence of lighting conditions, and clear head room.

Since the individual drive increases the productive capacity of the tool it tends to cause a material reduction in many cases in the interest and depreciation charges against any unit of product which the machine turns out. In the case of a product where each piece is worth many thousands of dollars, it is easily possible for the time element as expressed by the machine-hour cost to offset or to be of even greater importance than the labor cost of handling the work in the tool. Very costly work tends to demand costly tools, and the fixed charges on the tool require a forced rate of production in order to insure a suitable profit. Pushing the matter still further afield, it is possible that a company equipped with individual drive, through its improved rate of production may be able to make a better delivery on a rush order than a company handicapped by the old-fashioned methods of belt and shaft driving. The only field for the group drive, is, on the whole, that where a comparatively small number of machines, each requiring a comparatively small amount of power, are kept in continuous operation on the same class of work.

In a paper and discussion before the National Association of Box Manufacturers at a recent convention, Messrs. F. M. Kimball and L. R. Pomeroy of the General Electric Company emphasized a number of points which have a direct bearing upon the general problem of electric driving, so that a brief reference to some of these may be consistent with the present survey. One point especially emphasized by Mr. Kimball was the ease with which a check can be kept upon the condition of the tools or machines when driven by direct-connected motors. Wood-working tools, in particular, when out of alignment or carrying dull cutters, may easily absorb 200 per cent more power than they normally require, and this excess power is not only wasted, but is absorbed in friction and strains which are damaging to the machine. Under such conditions the niceties of adjustment are disarranged and the performance of the machine is liable to permanent injury. By placing an indicating wattmeter in circuit with the motor and observing its reading when the driven tool is known to be in perfect adjustment and alignment, with the cutters in good order, and comparing that reading with subsequent readings from time to time, an abnormal use of power is at once made known, and corrective measures may be applied in time to prevent serious injury.

Mr. Pomeroy presented the following results from eight cases of electric driving:

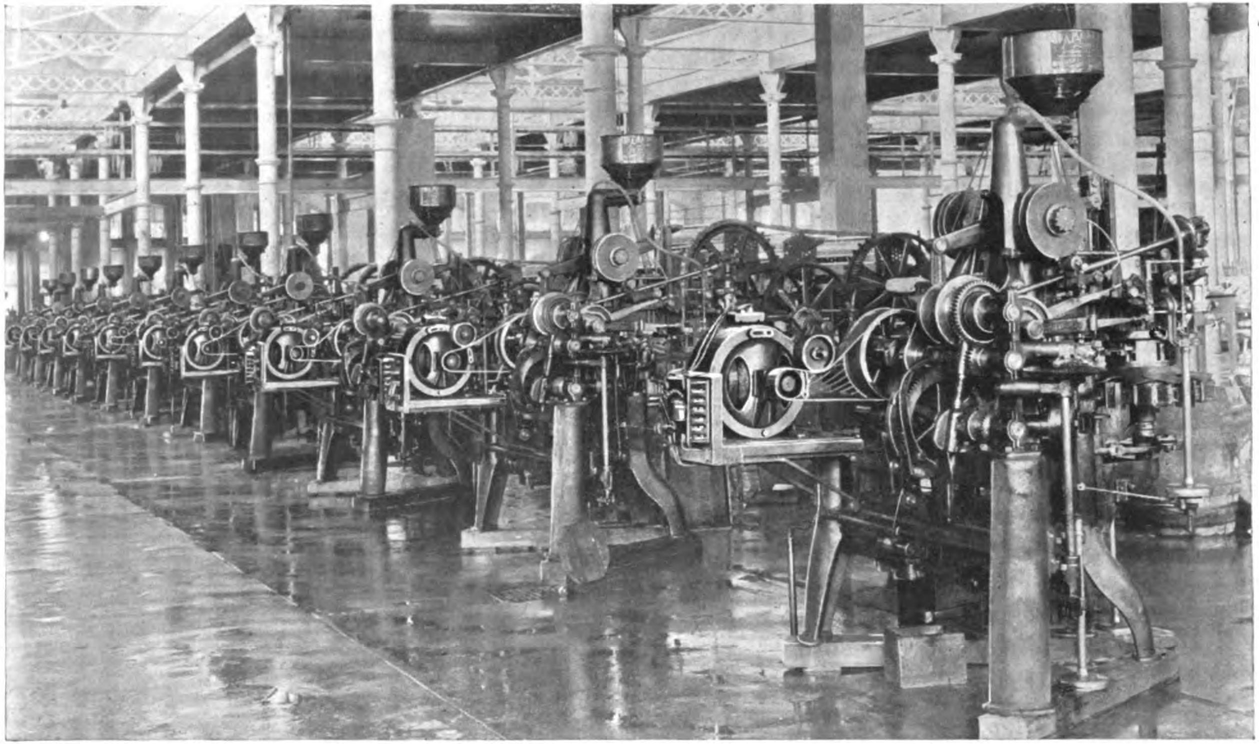
The difficulty of having at hand figures showing the direct advantage of the motor drive in dollars and cents, as applying to wood-working shops, is explained by the fact that so far, everyone adopting the electric operation of tools has taken opportunity at the same time to enlarge and improve the plants so that no direct comparison which previous conditions can be made . . . . the following facts and figures may have a relative bearing.

1. Operation-boring a cylinder.

Total time, 730 minutes
Less helper's time 215 minutes.

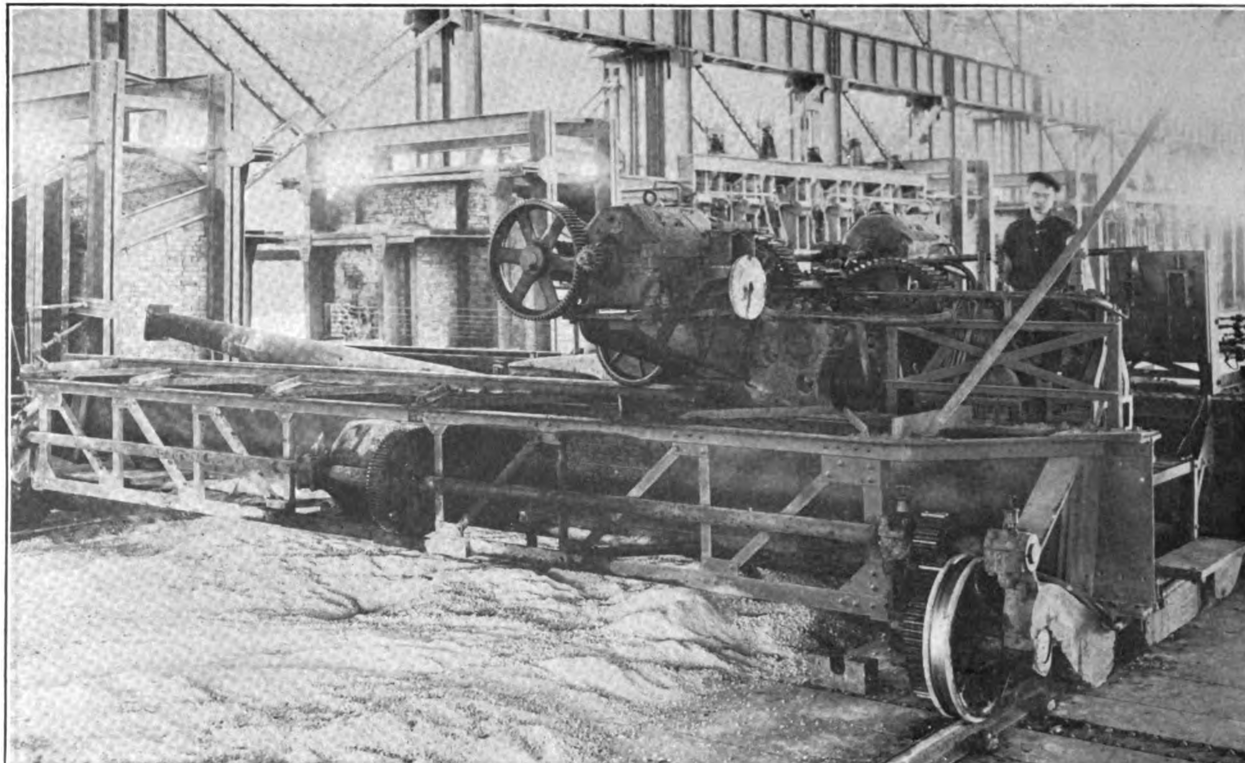
Net time 515 minutes.

Actual time cutting, 225 minutes, or 43.5 per cent—over 50 per cent non-productive time. If only 10 per cent of this time could be saved, it would result, for a $4 per-day man, in $1,200 per annum,



INDIVIDUALLY OPERATED BOTTLING MACHINES DRIVEN BY WESTERN ELECTRIC MOTORS.

The capacity is increased 100 per cent by individual driving, on account of the facility with which the speed of production can be adjusted to the need of the work in hand.



FURNACE CHARGING MACHINE BY THE MORGAN ENGINEERING COMPANY, OPERATED BY CROCKER-WHEELER MOTORS.
Four 25 horse-power motors; installed in the works of the Pennsylvania Steel Co., Steelton, Pa.

capitalized at 10 per cent. The logic of these figures is that we could well afford to spend $1,000 if only 10 per cent saving per day could be effected. A motor would save more than this in increased efficiency alone. The particular tool in this case would require a motor costing about $120. Add to this the proportion chargeable to the motor for power plant, i. e., $140, and we have $260, or the equivalent of saving capitalized at 45 per cent.

2. A certain shop located at Richmond, Va., installed an aggregate of 1,510 horse power in motors. The average load is 30 per cent, or 450 horse power. An engine-and-belt system could easily use up this amount in friction alone. The friction load is constant and is as much when one horse power of work is being done as when the plant is carrying full load. Per contra, with motor drive, the friction load is that of one motor—if only one is in operation—and the others in proportion. The friction load in machine shops runs from 40 to 80 per cent of the original power developed by the engine.

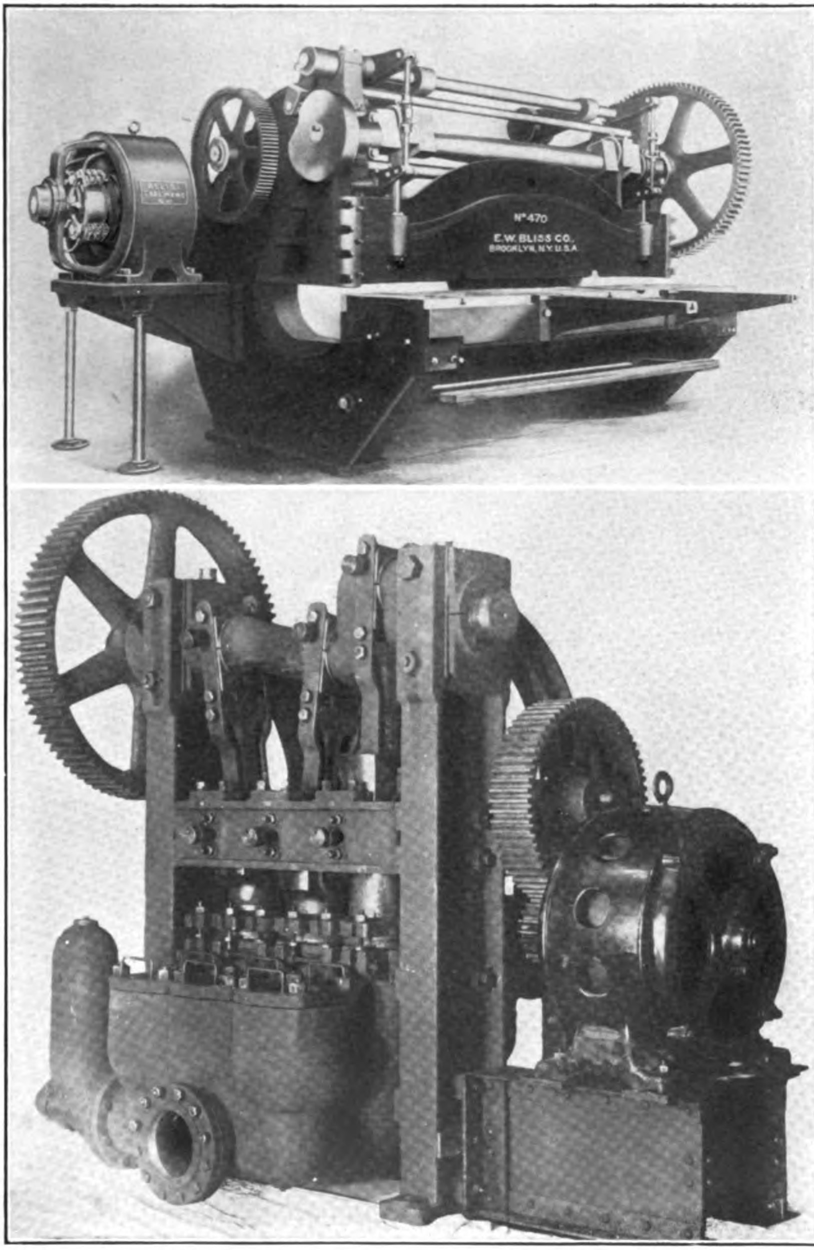
3. The annual cost for belting, for maintenance and repairs, amounts to 37 per cent of the initial cost each year. Mr. F. W. Taylor says that the average annual cost equals $6.90 per double belt per annum; say on an ordinary 40-foot double belt 8-inches wide, costing $30, the average charge amounts to $11 or 37 per cent of $30.

4. Mr. Harding, speaking of the Carnegie works at Duquesne, says that the intermittent operation of motors is carried from a central station by means of one-sixth the horse power required when individual engines were used.

5. Another large plant formerly driven by 30 separate engines, because of widely scattered buildings, saved 40,000 pounds of coal in 24 hours by adopting an electric drive from a central plant. A test from one department of this plant under the old conditions showed that the line shafts and loose pulleys consumed 61.75 horse power, or 30 per cent; machines and countershafts, 141 horse power or 61 per cent; machines cutting at normal rate, 210 horse power.

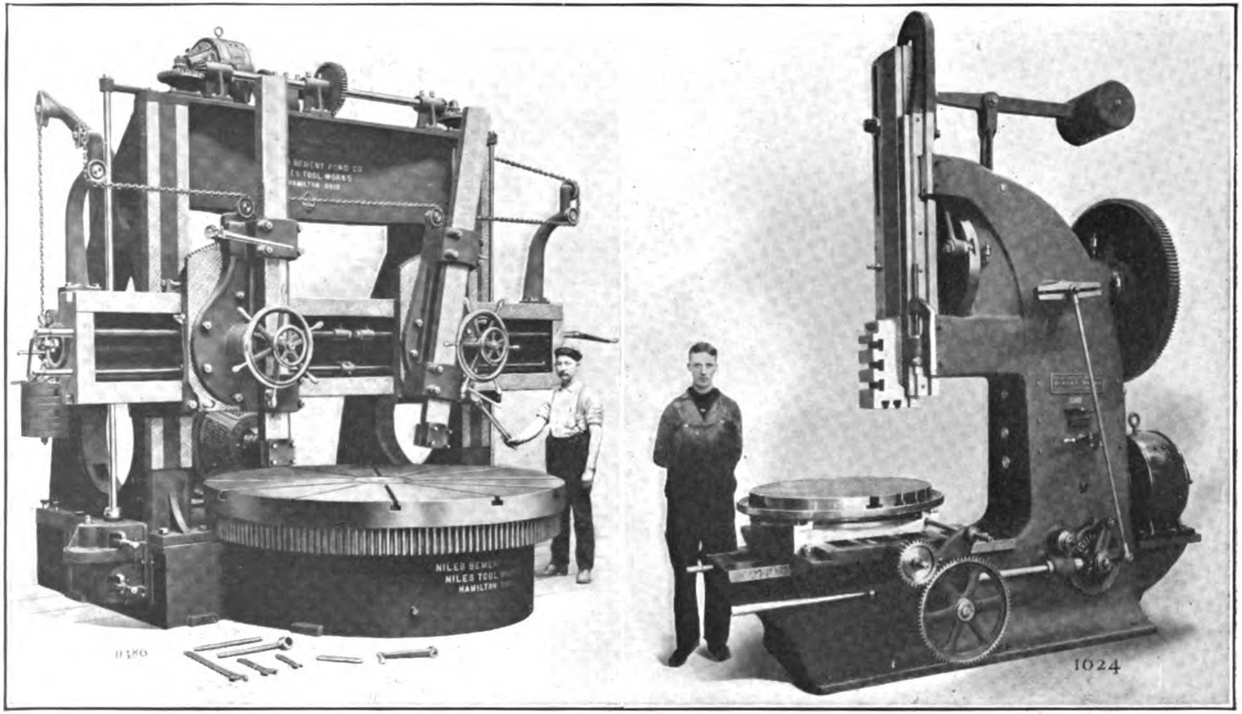
6. Mr. Vauclain, in discussing the electric drive in the Baldwin Locomotive Works, made the following statement.

> The application of electricity in the frame shop resulted in a reduction of the force of 60 per cent; while in the wheel shop the discarding of the shafting enabled the placing of one-third more wheel lathes on the same floor space. The electric traveling crane superseding the hand jib cranes reduced the common labor from 40 to 6 men, with 50 per-cent saving in power. Electricity was first introduced to drive two 100-ton cranes, resulting in an immediate saving of 80 men of the laboring force, a saving of 20 per cent in pay roll, and 40 per cent in shop area for a given product.



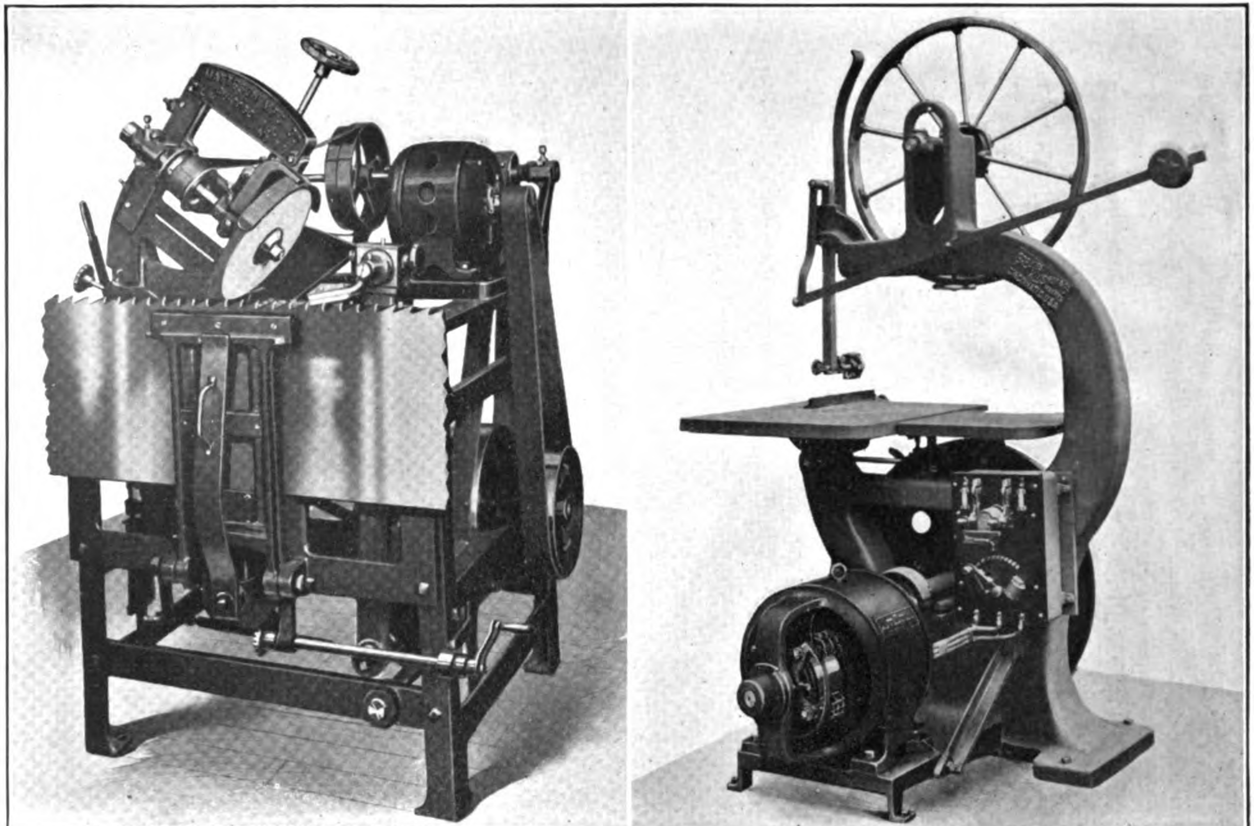
TOOLS AND MACHINERY INDIVIDUALLY OPERATED BY ALLIS-CHALMERS MOTORS.

Above, E. W. Bliss trimming and squaring shear; the motor is entirely out of the way of the stock, leaving free overhead space; below, Allentown Rolling Mills pump driven by induction motor. Adaptability of the mode of driving is illustrated by the method of supporting the motor on I beams, permitting adjustment.



LARGE MACHINE TOOLS INDIVIDUALLY DRIVEN BY WESTINGHOUSE MOTORS.

On the left is a Niles-Bement-Pond 100-inch boring mill; the two direct-current motors are out of the way of all operations but accessible for inspection and repairs. On the right is a 22-inch slotting machine by the same makers, with a 10 horse-power motor carried on a simple bracket but slightly extending the frame, and away from all probable interference with work, operations or adjustments.



MACHINES INDIVIDUALLY DRIVEN BY ALLIS-CHALMERS MOTORS.

On the left, an automatic band-saw sharpener by the Matteson Mfg. Co., driven by an induction motor; on the right, a 36-inch band saw by Greaves, Klusman & Co. The absence of belts is particularly advantageous to free handling of work.

Crane installation cost about $65,000. Sixty-five to seventy-five men would equal this amount in each year.

7. Belt drive as applied to most machines does not permit of running the tool to its limit, on an average job, while direct motor-drive does.

8. The C. M. and St. P. R. R. installed a motor on a turntable costing $550, which resulted in a wage saving of $1,600 per year.

The statement having been made that the expense for fuel in a box factory was nil, owing to the waste and shavings being utilized, figures were presented for the cost of power, entirely eliminating the fuel question on the basis of a 100 horse-power plant:

	Per horse power per year.
Labor, two men, engineer and fireman	$21.00
Water at 10 cts. per 1,000 gal	4.00
Repairs	5.00
Removing ashes	5.00
Interest and depreciation	6.00
Total per horse-power year	$41.00

Two cents per kilowatt hour at same rate (ten hour day) amounts to $45.00 per horse-power year.

There is one aspect of the individual-motor application which is still too much neglected by power users and by companies selling electrical energy. This is the keeping of accurate data in sufficient detail to furnish information of real value when problems in shop electrification come up. A recent inquiry among many central stations for engineering data in regard to individual applications of electric motors met with hearty co-operation, but unfortunately in many cases, the details of the drive were entirely unavailable without going in person to the installation where the motors were in service. It is not too much to urge that all central stations which conduct aggressive business campaigns for power take more care to secure full and complete data as to the motor applications on their circuits. The capacity and trade number and style of the driven machine are two important points to know, but in addition the size and number of teeth in gears and pinions, the size and distance between centres of pulleys, and the arrangements in force for speed control, with the range available, are all essential facts to be known in intelligently dealing with any commercial problem in the direct applications of electric motors.

RECENT DEVELOPMENTS IN MOTOR VEHICLES FOR INDUSTRIAL PURPOSES.

By Harry Wilkin Perry.

In a preceding paper Mr. Perry reviewed the most significant of the recent improvements in mechanical construction and in application of the motor vehicle to ordinary commercial transportation of merchandise. He now takes up adaptations to heavier duty, to *quasi* public service, and to peculiar and specialized purposes and uses.—THE EDITORS.

ENGLISH constructors have stuck consistently to the solution of the steam problem, and consequently are leaders in a class of vehicle that is confined almost entirely to the British Isles. This is the heavy steam wagon or "lorry," built for carrying loads of 3 to 6 tons and often supplemented by a trailer having a capacity of 2 to 4 tons. Among the many constructors of such steam wagons in England and Scotland are some of the leading engineering works of the Islands, including John I. Thornycroft & Co., the famous builders of torpedo-boat destroyers. Comparative low first cost and economy of operation are advantages of the steam wagon that offset its low speed. The prices of two such vehicles which were awarded gold medals for general excellence and performance in the British Commercial Vehicle Trials, in which they traversed 688 miles each, with loads of 11,200 pounds, approximate quite closely the sale prices of gas-engine trucks that carried loads of only 2,240 to 4,480 pounds for distances of 1,348 and 1,144 miles respectively. Gas-engine trucks capable of carrying loads of 5 tons cost fully double the selling price of the steam wagons. There is a difference in speed, however, of about 100 per cent in favor of the former, which can maintain a rate of 10 or 12 miles an hour as against the steam wagon's 5 or 6. By the use of coal or coke the cost of operation of the steam vehicle is brought down to the minimum, the consumption of coal by the Savage Brothers' entry in the British trials averaging 12.16 pounds per mile and the consumption of coke by the Yorkshire Steam Wagon Company's entry averaging 18.25 pounds per mile. The weight of these two wagons was approximately equal to the load each carried, a proportion that would hold true of most such vehicles.

There are, of course, many differences in construction between the various makes, but a brief description of the characteristics of one

YORKSHIRE FOUR-TON ENGLISH STEAM WAGON WITH TRAILER.

Photographed at completion of 40,000th mile of service.

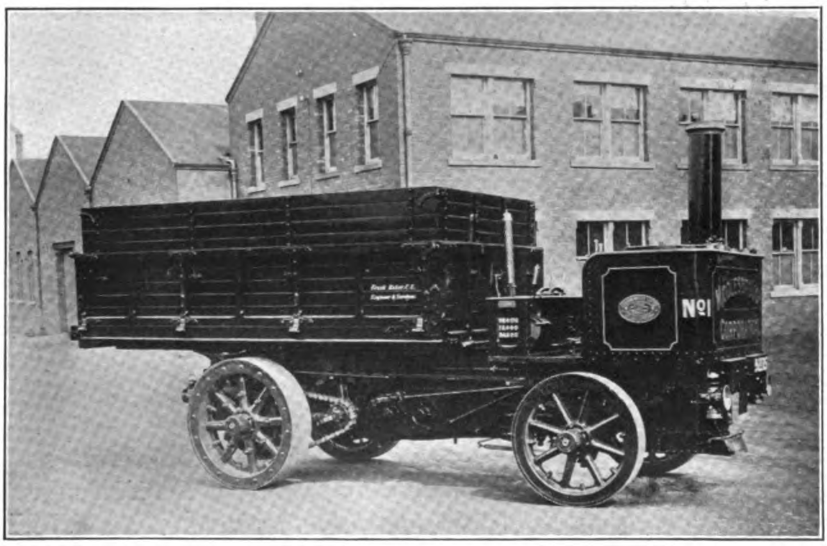
make will give a fair idea of this class of vehicle. The Leyland steam wagon has a vertical fire-tube boiler set at the extreme forward end and surrounded by the coal bunkers. The boiler has a working pressure of 200 pounds. The engine lies under the framing between the axles and is of the compound reversing double-acting type. All moving parts of the engine, together with a change-speed and reducing gear, are contained in an oil-tight casing to be partially filled with oil. There is a single speed reduction between the crank-shaft and the second motion shaft and the differential counter-shaft. The differential mechanism is so designed that it can be locked when one wheel rests in mud, sand, or on ice where its tractive effort would be wasted while the opposite wheel stood still. The boiler is fed from a water tank suspended from the main frame at the rear by a pump driven at constant speed, irrespective of the speed of the vehicle, by an eccentric on the first motion shaft. The engine cylinders are lubricated by a positive-feed lubricator. The rear wheels are fitted with weldless steel tires 10 inches broad. As this vehicle is built for municipal purposes the standard style has a tipping body, as illustrated, to be elevated at the front end by a screw mechanism that is operated with a crank from the side of the vehicle or can be arranged to work from the engine crankshaft.

Horizontal boilers are perhaps more generally employed in steam wagons than the vertical type, and are set either longitudinally or transversely, according to the preference of the designer. The engine and driving mechanism are universally placed underneath the frame where they are encased for protection. A cab usually is fitted to shelter the driver against the weather's severities.

That the item of depreciation is not excessive in the case of the steam wagon is indicated by the statement that the Yorkshire four-ton wagon and trailer, shown loaded with barrels and cases of bottled goods, has run considerably more than 40,000 miles and is still giving good service. The photograph was taken recently at the conclusion of the 40,000th mile.

Motor Road Trains.

In Europe Colonel Renard's road train has been demonstrated successfully in the military trials and manœuvres of France, Germany and other Continental countries. A more recent development in America is the Sampson road train designed and built experimentally by Alden Sampson 2nd, in Pittsfield, Mass., and exhibited for the first time at the Madison Square Garden automobile show last November. The Sampson train differs radically from the Renard train in utilizing the flexibility of electric transmission of power from the



LEYLAND STEAM TIPPING WAGON FOR MUNICIPAL WORK.

Cubic capacity of body, 6½ yd.; compound double-acting engine placed horizontally under body; vertical fire-tube boiler; overall length, 17 ft. 6 in., width, 6 ft. 9 in., height over chimney, 9 ft.; rear wheels, 42 in. diam., with 10-in. steel tires.

ABOVE, SAMPSON (AMERICAN) 20-TON ROAD TRAIN WITH ELECTRIC POWER TRANSMISSION; BELOW, RENARD (FRENCH) ROAD TRAIN WITH GASOLINE TRACTOR AND SIX-WHEEL TRAILERS.

The power plant of the Sampson train consists of a four-cylinder vertical gasoline engine driving an electric generator; each car independently driven by a pair of motors geared to center pair of wheels; steering interconnected.

power plant in the leading vehicle to each of several trailers coupled to it, whereas the French engineer conveys the power mechanically through jointed shafts and bevel gears to the drive wheels of the trailers. Both designers have adopted six-wheel support for their vehicles, driving to the center pair of each truck. The power plant of the American train consists of a four-cylinder vertical gas engine coupled by silent chain to an electric generator, both, with their attachments, mounted under a removable hood on the front of the "tractor." Cables lead the current through a suitable controller and switches to a pair of motors on the tractor and on each trailer. Sockets at each end of each vehicle enable connection to be made or broken at will. Each motor drives one center wheel by means of a short roller chain, and since motors and wheels are independent, no differential gearing is required.

Of prime importance in road trains of this character is the means whereby the wheels of each trailer are made to follow in the tracks of the one ahead instead of describing arcs of larger radius when turning corners. This is accomplished in the Sampson train by steering with all front and rear wheels, the two pairs being connected diagonally underneath each vehicle so that they turn in opposite directions to the same angle. The steering-knuckle connecting rod of the front wheels of each trailer is pivoted to a tongue which is bolted movably to the center of the axle and whose free end is coupled to the rear of the preceding car. Whenever the angle of this tongue changes with relation to the axle, it causes a corresponding change in the position of the steering-knuckle arms, and since the rear wheels turn in a direction opposite to the front wheels they follow the same tracks. The tongues do not sustain any pulling effort, since each car is independently driven by its own motors and a constant distance between the cars is maintained by draw-bars. The capacity of this train, consisting of tractor and two trailers, is 20 tons, of which the tractor carries 4 tons. It has speeds ranging from 6 miles an hour, with full load, on hard macadam, to 1½ miles an hour up a 10 percent grade on soft dirt road. By the use of long cables, the tractor can supply power for moving one of the trailers in any direction at a considerable distance from itself and in places where the entire train could not go. Connection between the cars can be made equally well at either end of each, thus facilitating the making up of the train. The entire train can be steered and controlled by one man, an important factor in reducing the cost of hauling large quantities of ore, coal, rock, grain, or manufactured products over considerable distances.

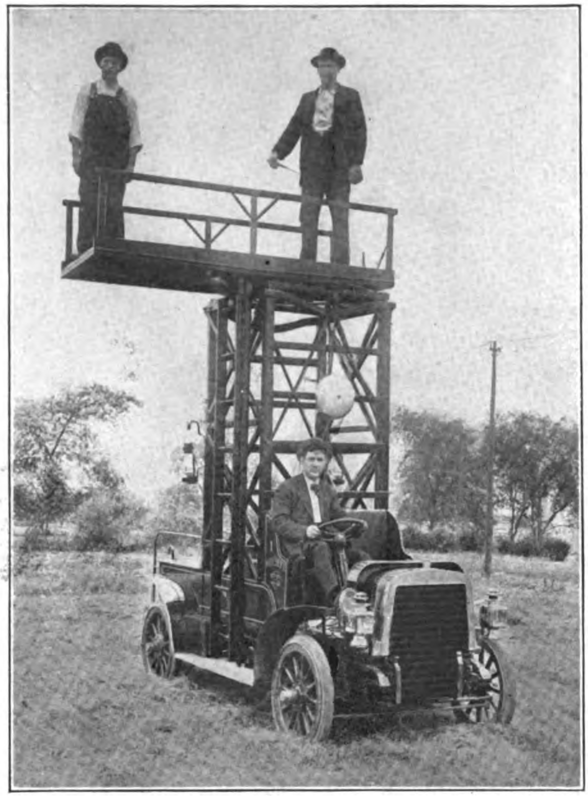
Motor Vehicles in Quasi-Public Service.

Electric trucks lend themselves readily to equipment for special lines of work, where a winch of great power is required, as in hoisting safes through the windows of the upper floors of high buildings and hauling electric cables through street conduits. In several of the larger cities, as New York and Boston, heavy electric trucks are in constant use in this latter work by the telephone and electric-light companies. They haul the drums of cable to the scene of operations and then draw it through the conduit, doing quickly and quietly and without interference with traffic the work that formerly required a heavy capstan and six or eight laborers. The geared winch is so powerful that care must be exercised to prevent the parting of the cable.

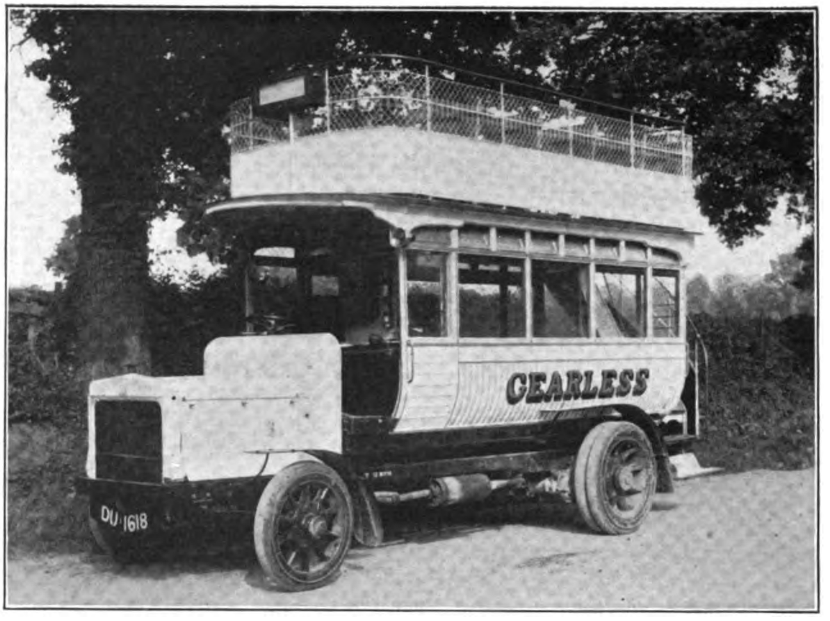
ELECTRIC 5-TON TRUCK WITH POWER WINCH FOR HAULING CABLE THROUGH CONDUITS.

Street-railway companies employ both electric and gasoline tower wagons for erecting and repairing their overhead feed wires, and thereby effect a great saving in time, which is of utmost importance when a tie-up occurs, particularly in the rush hours. The United Railways Company of St. Louis, for example, is using a gasoline tower wagon which was built in its own shops last year. This has the advantage over the tower trolley car that it can be used when the power is off and that it does not stop the operation of cars until the repair is completed. It is easier to handle than horses on crowded streets and can be used for work on transmission lines that extend across country.

The greatest use of motor vehicles by public service corporations is in the carrying of passengers. In London alone more than one thousand motor omnibuses are now regularly in service, operated by fourteen companies and individuals, of whom eight operate from twelve to nearly four hundred each. These run on many regular routes that thread the heart of the capital and extend out into the suburbs, several lines being as long as 20 miles. The 'buses are run on a regular schedule like street cars, at intervals of only a few minutes, and carry several million passengers annually—so many that the effect is felt keenly by the "tram" roads and underground railways, which last year reported a serious decrease of passengers. Many of the earlier omnibuses that were put in service from three to five years ago were so badly or indifferently designed and built that they were refused licenses by the police because of noisiness, inefficient brakes, top-heaviness, or inadequate prevention of dripping oil. But great improvement is shown in the later additions to the equipment of the companies. Practically all of the vehicles are fitted with double-deck bodies similar in character to the European horse-drawn 'buses. They seat sixteen passengers inside and eighteen on the upper deck. Approximately 95 per cent of the machines are driven by internal-combustion engines utilizing gasoline or kerosene for fuel, and about 75 per cent are of the Straker and Milnes-Daimler makes, almost equally divided. The Metropolitan Steam Omnibus Company, however, operates a score or more of Darracq-Serpollet



GASOLINE TOWER WAGON BUILT AND USED BY UNITED RAILWAYS COMPANY OF ST. LOUIS.
Weight with load about 4,500 lb.; speed, 20 miles an hour; double-cylinder opposed Buick engine, 25 horse power; height of tower when elevated, 19 ft.



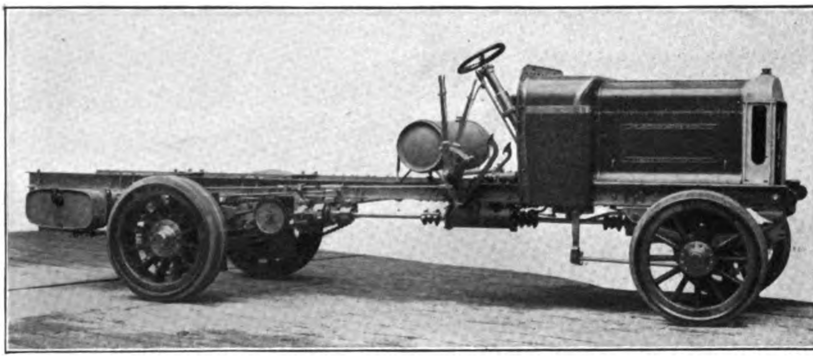
DAIMLER PETROL-ELECTRIC OMNIBUS.

MILNES-DAIMLER OMNIBUS IN SERVICE IN LONDON.

Seating capacity 16 inside, 18 on top; vertical four-cylinder 28 horse-power combustion motor; speed about 18 miles an hour.

omnibuses driven by 30 to 40 horse-power engines using super-heated steam generated in a flash boiler.

An interesting recent development in the steam-car class is the Critchley-Norris chassis which can be fitted with omnibus or merchandise body. In general appearance it is much like a gasoline car, as indeed are nearly all steam cars with the exception of the locomotive type of heavy steam wagons for loads of 4 to 6 tons. The engine is carried at the forward end under the hood and is of the single-acting type. It has three cylinders and is rated at 30 to 40 horse power. It stands vertically and has inlet valves on one side and exhaust valves on the opposite side of the cylinder heads, like many internal-combustion engines. The three cylinders are cast in one block. The steam generator is in a compartment between the engine space and the dash. A condenser occupies the usual position of the radiator.



CRITCHLEY-NORRIS ENGLISH THREE-TON STEAM CHASSIS FOR TRUCK OR OMNIBUS BODY.

Three-cylinder single-acting steam engine, vertical, with inlet and exhaust poppet valves on opposite sides of cylinder heads; cylinders 4½ by 5 in.; steam generator in compartment between engine hood and dash.

Several attempts have been made in America and elsewhere to build gasoline-electric vehicles for passenger service and for heavy freighting. In most cases the weight has been found excessive and the complication too great for dependability. One of the latest examples is the gasoline-electric omnibus built under the name Gearless by the Daimler Motor Co. Ltd., of Coventry, England. It embodies several radical departures from the usual practice. Under the hood in front is a gasoline engine of sufficient power to drive the vehicle with load under ordinary conditions. This is connected with an electric generator which is wired to a motor that drives the differential countershaft. Drive from the countershaft to the rear wheels is by encased spur gearing. Rear axle, countershaft, and motor are rigid with relation to one another and the rear portion of the main frame rests directly upon the axle without the interposition of springs. But the front end of the frame, to which the engine and dynamo are bolted, is supported on springs mounted on the front axle. The side members of the frame are designed to permit a certain amount of twisting. The omnibus body is set upon a supplementary frame that rests on long side springs on the sub-frame and is pivoted at the front and anchored to the lower frame at the center of the rear cross member.

In ordinary running with load the vehicle uses approximately all the power developed by the engine and dynamo, but when running light the excess electrical energy generated is automatically directed into a storage battery of the Planté type. This battery is wired to the controller so that when the generator becomes unequal to the task of driving the 'bus up a grade or through heavy going with seats filled, the reserve energy accumulated by the battery is released and assists in carrying the load. Of course, the electric current is also used for lighting purposes.

Kerosene is used to a considerable extent in English motor omnibuses as well as in some heavy vans and freighting wagons as a matter of economy. In Paris, where a high duty is charged on petroleum oils entering the city, a similar economy is effected by using denatured alcohol for fuel. A service of Brillié 'buses which was started in July, 1906, and had grown to a total of one hundred and forty vehicles at the end of 1907, has been run continuously on a mixture of equal parts of alcohol and gasoline, at an estimated saving of $60,000. The 'buses had been run a total of two and a quarter million miles on this fuel, and no erosion or pitting of the valves had been noticed. It appeared to be as effective as gasoline although there was some difficulty in starting the engines in cold weather, which was overcome by priming with gasoline. The engines heated less than with gasoline.

Within the last two years the automobile taximeter cab for public service has come into common use in leading European cities and is now being introduced rapidly in America. Between three thousand and four thousand are probably in use in Paris, London and Berlin, while New York will have more than one thousand by the time this appears in print. The taxicabs, as the little machines are called for short, are light, fast gasoline machines with landaulet bodies. The more typical cars built for this service are driven by either two-cylinder or four-cylinder vertical engines of from 8-10 to 12-15 horse power and have a maximum speed of about 18 to 20 miles an hour. They are short enough to be turned readily in an ordinary street

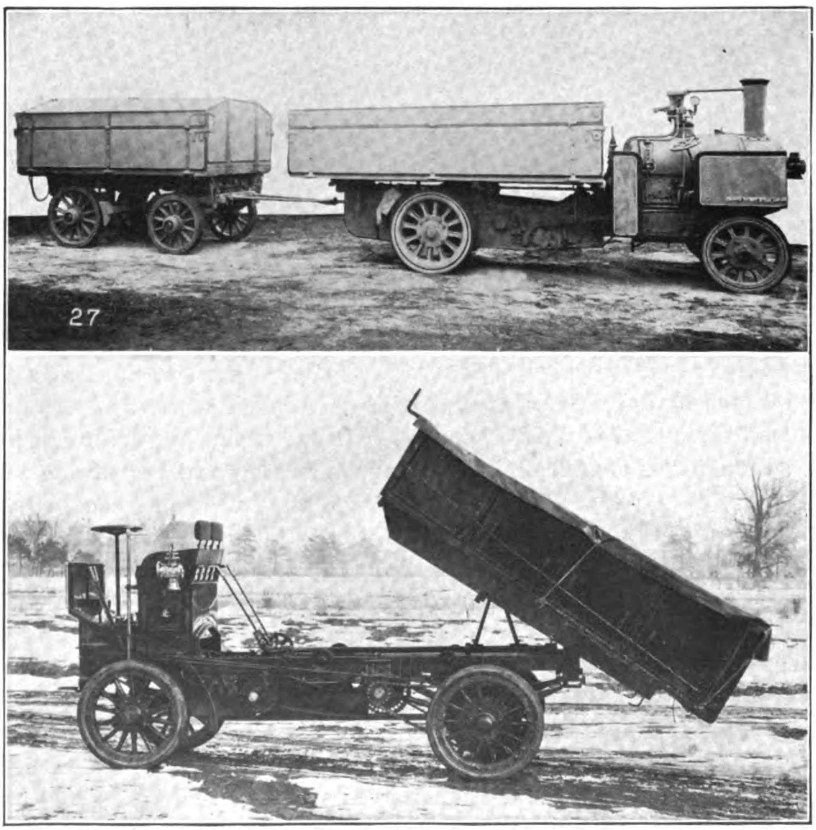
DELAHAYE FRENCH TAXIMETER CAB IN PUBLIC SERVICE IN NEW YORK.
Weight, without body, 1,300 lb.; capacity, five passengers; speed, 21 miles an hour; twin-cylinder vertical engine, 8-10 horse power; wheelbase, 101½ in., tread, 48½ in.; three-speed sliding gear transmission.

without reversing and will accommodate two passengers on the permanent rear seat and two others on folding inside seats. A fifth passenger can sit with the driver. Drive is by shaft to the rear axle and then by live axle or spur gearing to the rear wheels. A feature of all these cabs is their equipment with the taximeter, a foreign invention for automatically calculating, indicating and registering the amount of fare to be paid, the mileage traversed and other information needed by the operating company. The mechanism is driven by the road wheel through a flexible shaft when the vehicle is running and by clockwork when the car is waiting while engaged.

American manufacturers have rushed to put taximeter cabs in the field during the past year after observing the success that followed their introduction abroad and in New York. The first to produce such a vehicle designed throughout for this special and very exacting service was the Thomas company, whose cab is notable for the casting of all four cylinders of the 16-22 horse-power motor in a single block, with integral water jacket encasing the exhaust valves and pipe as well as the cylinders. Construction is simplified as much as possible in the power plant in other ways, also, as placing inlet and exhaust valves all on one side of the cylinder heads and operating them by one camshaft, and by depending upon thermo-siphonic action for circulating the cooling water, as in the Renault cabs which are most extensively used in the European capitals.

Motor Vehicles for Municipal Work.

Heavy steam and gasoline vehicles are used extensively by the street departments of a number of municipalities for special work such as garbage removal, street sprinkling, street sweeping, road building. The corporations of Liverpool and Chelsea, England, for example have had steam wagons and trailers in regular daily service for ten years and have increased the number several times. In a report on the performance of the Liverpool vehicles made by the engineer of the

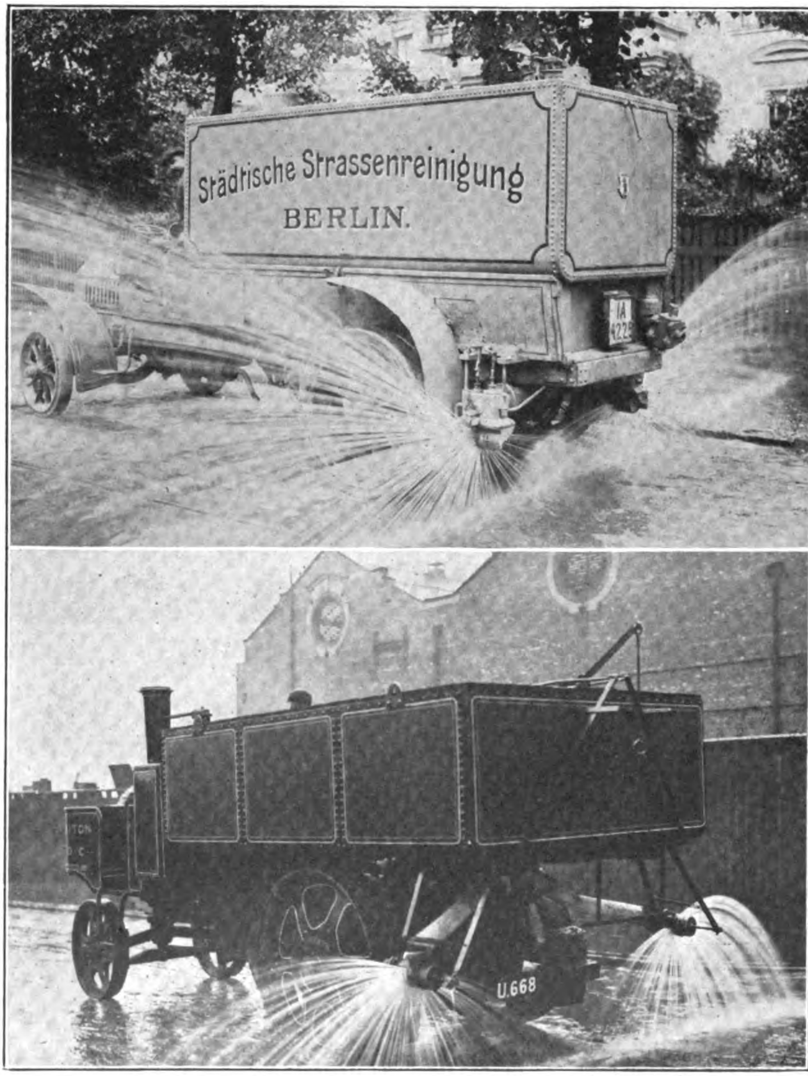


ABOVE, MANN'S STEAM SCAVENGING WAGON AND TRAILER; BELOW, KNOX (AMERICAN) 3-TON GASOLINE GARBAGE WAGON WITH TIPPING BODY.

department, he stated that they are used chiefly for collecting refuse, street sprinkling, and hauling crushed stone and other material used in repairing the streets, the vehicles having bodies of different types that are interchangeable so that a wagon which is used for sprinkling in summer can be employed in hauling materials during other seasons of the year. Some of the self-emptying bodies are built to tip to either side and others to tip to the rear. The steam wagons have a carrying capacity of 4½ tons. They are worked 20 hours a day, by two shifts of men, each wagon covering about 100 miles a week. The total annual cost of operation of each wagon is about $2,000, which represents a saving of 15 per cent over the cost of doing the same work with horses, as shown by the records that have been carefully kept.

EUROPEAN COMBINATION STREET-WATERING AND SWEEPING MACHINE.
Capacity of tank, 655 gal.; width of water distribution, 25 ft.; 12 horse-power combustion motor under driver's seat.

Municipal authorities in America have shown little interest in special motor vehicles for street work. Cincinnati, however, purchased four gasoline wagons for garbage disposal last year. These have tipping bodies mounted on standard Knox chassis of 6,000-pounds capacity fitted with double opposed air-cooled engines suspended horizontally under the frame. Tipping of the body is accomplished by means of a slide on the under side of the bed secured at the apex of a pair of short rods attached at their lower ends to two traveling nuts. These nuts move on a long rod with a slow-pitch thread



ABOVE, "N. A. C." 2-TON SPRINKLING WAGON USED IN BERLIN; BELOW, MANN'S (ENGLISH) STEAM-DRIVEN STREET-SPRINKLING WAGON.

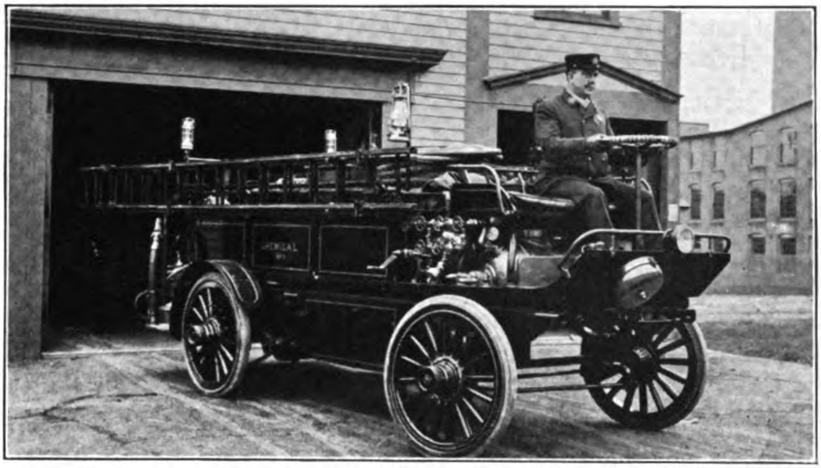
The German wagon has a width of water distribution of 65 ft., uniform pressure being maintained by compressed air; capacity, 1,320 gallons; vertical four-cylinder engine of 18 horse power.

extending longitudinally of the frame and journaled at its ends. Bevel gears are provided at the front end of the rod by means of which the rod can be revolved in either direction by a transverse shaft driven from the engine crankshaft by chains and sprockets. There are two special levers, one for engaging and disengaging the bevel pinions and the other for controlling a clutch between the crankshaft and screw mechanism so that the latter can be operated or not when the engine is running.

Steam, gasoline and electric vehicles have all been adapted to street sprinkling work. The Mann's sprinkler is a typical example of the English steam watering cart. Practically the entire vehicle is built of steel and iron, including the wheels and tires and all parts of the body. The body is interchangeable with other types. A very different class of German watering wagons is in service in Berlin where it has shown its superiority to the older forms of sprinkling apparatus. The tank and spraying apparatus, which are of a type used in many Continental cities, are mounted on a chassis of the standard type having pressed steel frame, solid rubber tires and propelled by a 16-18 horse-power internal-combustion engine of the four-cylinder pattern. The tank has a capacity of 1,320 gallons and is made air-tight. By means of an air pump driven by the gasoline engine, a constant pressure can be maintained on the water whether the tank is full or nearly empty and the sprinklers can throw the water to a distance of 32½ feet to either side of the center. The tank is divided vertically into three compartments by bulkheads to prevent hammering of the water when the wagon is in motion. A hand-wheel similar to the steering wheel regulates the distance to which the water is thrown, and the water can be shut off from either of the inner or outer sprays at will. Tests made in Berlin, Hamburg, and Kiel showed that a distance of 1½ kilometres could be sprayed the full width of 65 feet from one filling of the tank, showing a great economy notwithstanding the high first cost of the machine and the fact that a special attendant, in addition to the driver, is required to manipulate the apparatus.

In Boston and Worcester, Mass., sprinkling tanks mounted on gas engine chassis are in use, while Hartford, Conn., uses electric sprinkling wagons.

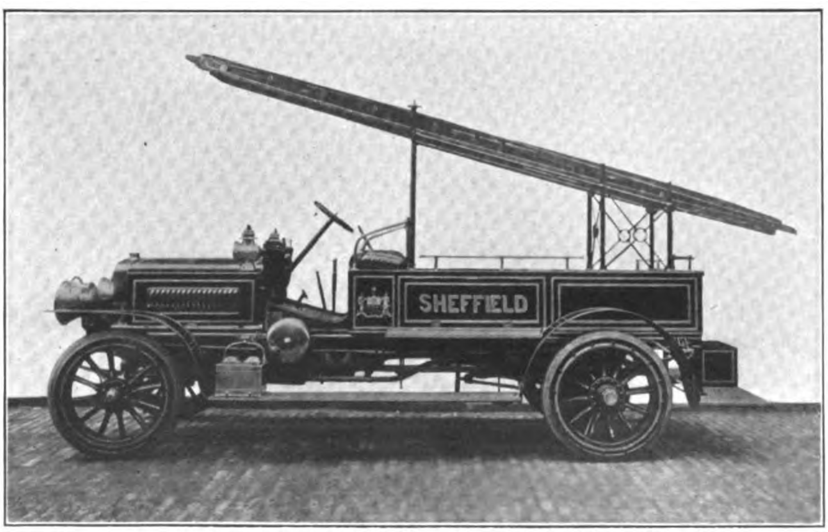
A combination street sprinkler and sweeper invented by F. G. Muller de Cardevar has been given numerous tests in Paris, London and other cities. It is driven by a 12 horse-power gasoline engine carried under the driver's seat. The tank holds 555 gallons and has a discharge pipe under the wagon besides a pair of spray distributors at the rear. A revolving brush under the center of the vehicle is independently driven by the engine, and is adjustable by levers at the side of the machine. Water discharged from the pipe in front of the brush lays the dust. The rear sprays can sprinkle a path 25 feet wide.



COLUMBIA ELECTRIC CHEMICAL AND HOSE TRUCK IN USE IN HOPEDALE, MASS.

Self-Propelled Fire Apparatus.

In no other field of service are the speed and power of motor vehicles so obviously of advantage as in fire fighting in cities. Fire chiefs and fire commissioners have been quick to recognize the possibilities of motor fire apparatus in arriving at the scene of a fire with the least possible delay, and also to appreciate the fact that there is economy in using a power which consumes no fuel or feed while standing in the station house. As a consequence such apparatus has



ARGYLL EXTENSION LADDER TRUCK USED BY SHEFFIELD (ENGLAND) FIRE DEPARTMENT.

been installed within the last year or two in many cities in the United States and Canada and in Germany, England, France and Italy. Special attention has been given to the development of combination chemical and hose wagons, which are made in a variety of types in both gasoline and electric classes. The Columbia electric combination truck used in Hopedale, Mass., is a fair example. It is equipped with a pair of copper tanks under the seat, with ladders, chemical hose and standard water hose, hand extinguishers, nozzles, and a complement of hand implements. With batteries already charged, it needs only the insertion of a plug switch and movement of the controller handle to get under way. Its superior speed enables it to arrive at a fire well in advance of the steamer and to have the chemical stream trained on the blaze and the water hose stretched before the steamer has coupled to the hydrant.

WEBB AMERICAN GASOLINE FIRE ENGINE.

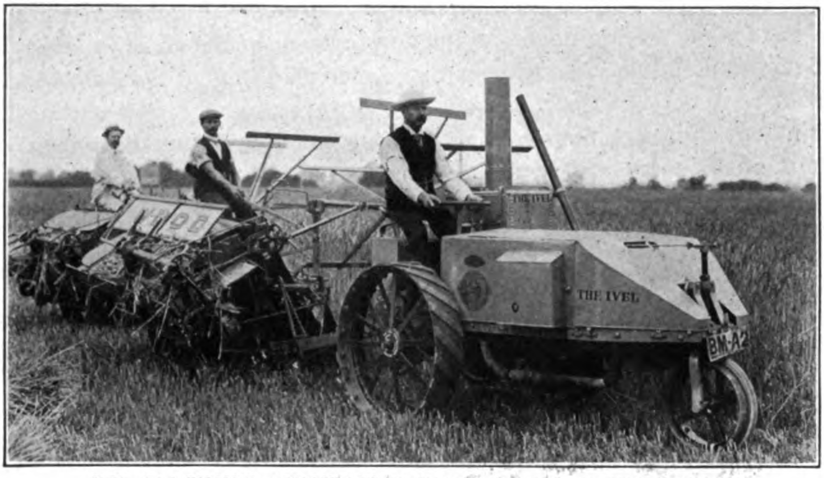
Rotary water pump mounted on 40 horse-power touring-car chassis and driven by vehicle engine.

The Knox gasoline combination truck which has been supplied to a number of cites and which has a body and equipment very similar to those of the Columbia, is equipped with two 25-gallon chemical tanks and 1,000 feet of water hose. It carries ten men and has a maximum speed of fifteen miles an hour.

For English and German fire departments the foreign motor-car builders have evolved various types of extension-ladder and scaling-ladder trucks, the European peoples evidently looking upon the saving of life as a matter of first consideration. The gasoline ladder wagon supplied to the Corporation of Sheffield by Argyll Motors, Ltd., is a fair example of the British practice. The chief officer of the Sheffield Fire Department reported last December that this ladder truck had attended more than forty fires without a hitch and was running splendidly.

The most recent development in fire apparatus is the self-propelled pumping engine. A number of these have been produced in the United States by at least half a dozen different builders. A notable one is the Webb pumping engine brought out last fall in Joplin, Mo., and given severe tests. The pump is mounted on the chassis of a Thomas touring car of 40 horse power for which a special body was designed. The rotary water pump is bolted to two cross members of the frame and can be connected through spur gearing with the transmission of the car by means of a special lever. The shifting of the pump gear into mesh upon arrival at the scene of a fire automatically cuts off the radiator from the engine which is then supplied with cooling water by a separate feed from the rotary pump. With the small pump used on the experimental engine a stream of water was thrown over a three-story factory building in tests made before officials of the Buffalo Fire Department.

A pumping engine along lines similar to the foregoing has been built in the shops of the St. Louis Car Company after designs by W. A. Wagenhals. A rotary pump with capacity of 600 gallons a minute is mounted on the rear end of the chassis of a 50-horse-power American Mors four-cylinder touring car capable of a maximum speed of sixty-five miles an hour. The pump is geared direct to the engine by a single shaft carrying a gear with which a sliding pinion on the transmission shaft between the clutch and gear box can be thrown into mesh when the regular gear shift lever is in neutral position. The engine is self-starting by means of a drum on the end of the crankshaft and weighted cable which is automatically released when the alarm sounds. To insure certainty of action a small quantity of gasoline is automatically introduced into the cylinders at the same time. Vibration of the body on the running gear when pumping is prevented by means of two vertical screw rods that can be screwed down quickly through blocks on the sides of the frame until their lower ends rest upon the front axle and take the load off of the springs. In tests before representatives of the St. Louis Fire Department this pumping engine has thrown a 1½-inch stream to a

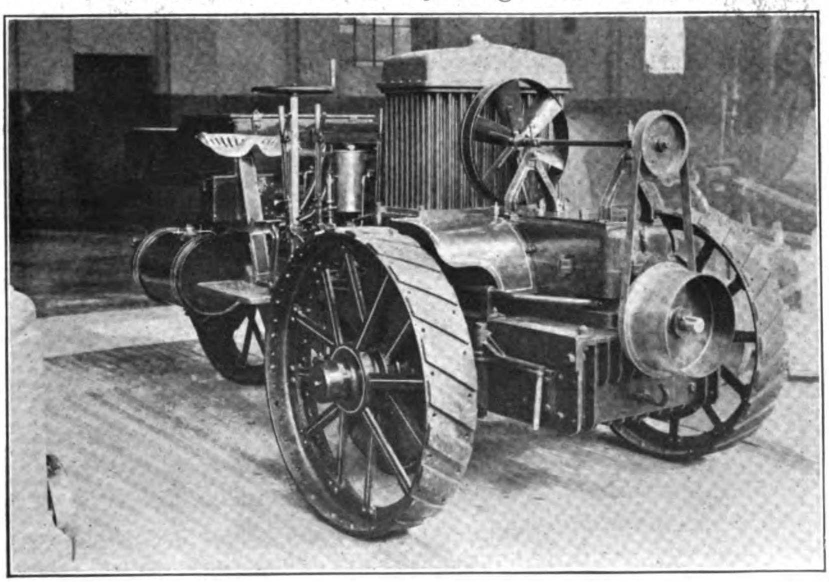


IVEL GAS-ENGINE AGRICULTURAL TRACTOR HAULING TWO REAPERS.
Weight, complete, 3,584 lb.; engine, double-opposed, 18-20 horse power, disposed longitudinally; consumes gasoline, kerosene, or alcohol.

horizontal distance of 210 feet with a pressure of 150 pounds per inch.

Motor Tractors for Agricultural Work.

The horse is being driven even from his last stronghold on the farm by the motor vehicle, which is proving far more efficient in plow-



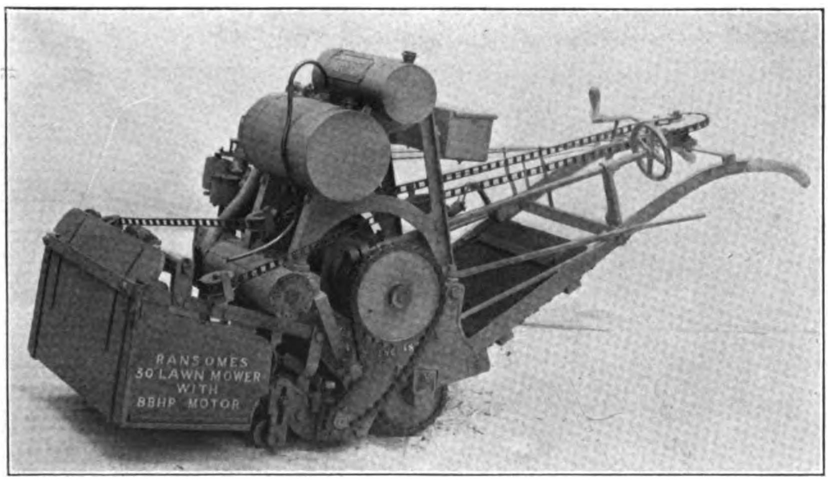
SAUNDERSON 50 HORSE-POWER GAS-ENGINE FARM TRACTOR.

ing, harrowing, reaping, and threshing. Curiously, England appears to have made more progress in the development of the small internal-combustion engine farm tractor than America, although thousands of small stationary and portable gas engines are used for feed cutting, grinding, churning, pumping, and sawing wood on farms throughout the United States and steam traction engines are common. The first of the successful light gas-engine tractors was the Ivel, brought out in

BARFORD & PERKINS WATER-BALLAST MOTOR ROLLER.

England in 1902. This can be operated on gasoline, kerosene, or alcohol and has won twenty-six gold and silver medals in plowing matches and other competitions before agricultural and other societies in different countries. Complete, the machine weighs 32 hundred weight (3,584 pounds). Motive power is supplied by an 18-20 horse-power double-cylinder opposed engine disposed longitudinally in the frame and protected by a metal cover. A pulley is fitted for stationary work such as threshing, grinding, and driving a dynamo. Hauling a three-furrow plow, the tractor has plowed 6 acres in 9 hours to a depth of 7 inches on a consumption of 20 gallons of gasoline or kerosene and one gallon of lubricating oil. One user, after two years' experience, claimed to have done with it daily on an average as much plowing as he could do in the same time with three teams of three horses, three men and three boys—that is, 2¼ acres of heavy soil to a depth of 6 inches. With one 6-foot reaper and binder attached, 2½ acres of grain could be cut in an hour on a consumption of 2¼ gallons of gasoline and one pint of oil. Two small binders can, however, be hauled on suitable ground. Another user found that it would easily drive a 60-inch double-blast threshing machine and at the same time a straw trusser. More powerful tractors are built for plowing and reaping on a more extensive scale, such as the 50-horse-power Saunderson Universal motor, also built in England. Like the Ivel, it is a three-wheeled machine, but it drives by a pair of front wheels and is totally different in construction and appearance, the engine standing vertically between the front wheels. The builders are now bringing out two smaller tractors of 20 and 30-35 horse power which will have four wheels and drive by the rear pair.

Even lawn mowers and turf and road rollers are now operated by gas engines. Water-ballast rollers driven by one and two-cylinder vertical engines using either gasoline or kerosene as fuel are built in England for light and heavy work. They are made in a variety of models for special purposes and range in weight from 2½ to 8 tons. empty. When filled the weight is increased from ½ ton to 1 ton. In addition to filling their special mission as rollers, they can be employed as stationary engines for a variety of work.

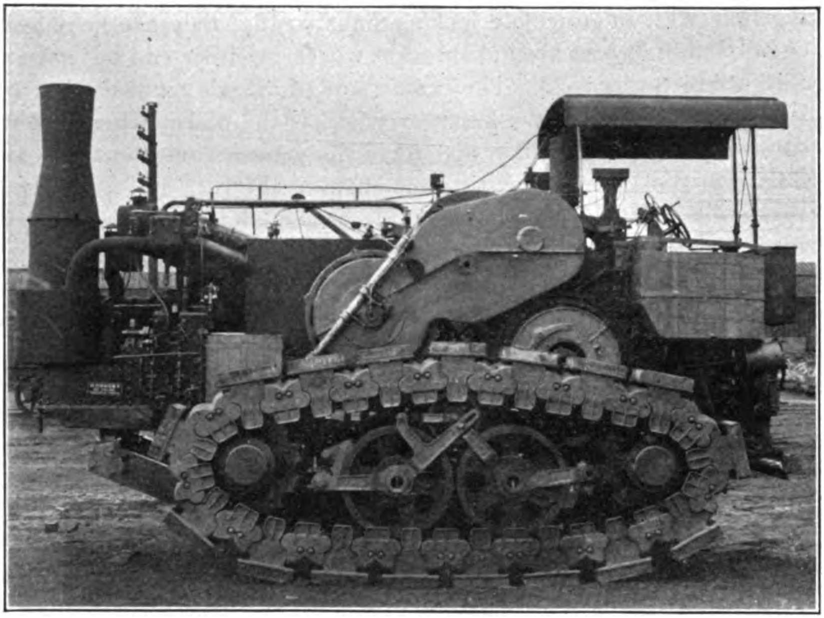


RANSOMES 30-INCH LAWN MOWER WITH 6 HORSE-POWER MOTOR.

The Ransomes English lawn mower has a 30-inch revolving cutter and is driven by a 6-8 horse-power engine. The operator walks behind, guiding the machine by a pair of downwardly curved handles and emptying the hopper in front by the crank and long chain. The end doors of the hopper are hinged at the top and are pushed open by the cut grass as the chain moves a diaphragm that slides transversely on a rod above the hopper. The engine is on the right side of the machine, where it stands in a vertical position and drives a flywheel in the center of the machine. Rods for controlling spark and throttle are carried back to small levers within reach of the operator. The propelling roller is driven by a chain with suitable reduction and the cutter is run at high speed by a similar chain geared up by a large sprocket. The radiator is at the rear between the shafts of the guiding handles, while the muffler is in front where the gases will not offend the operator.

The Coldwell American lawn mower, built in Newburgh, which is used for cutting the grass on the White House grounds in Washington, and on large private estates, has a comfortable seat on which the operator sits, steering with a tiller. The seat is on a platform supported at the rear end by an extra roller. Two sizes of these machines are built, one having a cutter 35 inches wide and the other a 40-inch cutter. The former weighs 1,200 pounds and is driven by a single-cylinder 4-horse-power engine, while the latter weighs 1,500 pounds and has a twin-cylinder 8-horse-power engine. The over-all length of both machines is 6½ feet and the driving rollers are 15 inches in diameter. The engine is water-cooled, the radiator standing vertically in front. When not in use, the cutter can be raised high above the ground.

FRENCH ARMORED MILITARY CAR WITH RAPID-FIRE GUN.



HORNSBY MILITARY "CHAIN-TRACK" OIL ENGINE.

Vehicles for Military Service.

Although many motor wagons have been especially constructed to meet the requirements or the approval of the war offices of the European nations and the United States, the two machines here illustrated are probably the most unique. One is an armored fighting machine which conceivably would be very effective in dealing with the street mobs that give concern to the military of Continental and some Asiatic cities. A rapid-fire gun is mounted in the rear and the barrel projects from a turret on the roof. The car can be entirely shut up for complete protection of driver and gunner, and all vital parts, including the radiator, are protected. The driver enters by a door at the left of the seat and the gunner by a door in the rear. On either side is carried a metal trough on which the wheels can run in crossing narrow trenches, ditches, and holes. Power plant and driving mechanism do not differ materially from customary touring-car practice.

The very latest production for military work is the Hornsby "chain track" tractor for hauling transport wagons and drawing guns into position over ground where no roads or railroads are available. The invention is essentially an oil-burning internal-combustion traction engine whose wheels run on endless tracks formed by chains. These chains are made of a number of feet or bearing blocks linked together with intermediate locking links so that they are flexible in one direction to pass around sprocket wheels at either end but present a rigid arc to the road. The center pair of wheels on each side are weight-carrying wheels. The rear wheel is the power wheel, whose sprockets engage the chain and force the vehicle along on the chain tracks, at the same time lifting the chain at the rear and carrying it forward over an idle wheel above the center wheels. Some remarkable results have been obtained at Aldershot with an engine equipped with this chain-track device. Obstacles that would be impassable to the ordinary traction engine or even to horse-drawn wagons have proved no barrier to it. It has descended and ascended the clay banks of a stream having an inclination of 1 in 2 and 12 feet high, has traversed deep loose sand and drawn a loaded trailer also fitted with chain tracks, and has crossed bogs in which horses became hopelessly mired. In crossing a narrow ditch the engine advances from one side until it projects nearly half way beyond, when it plants the "feet" at the front on the opposite bank and proceeds without descending to the bottom of the ditch.

Promise of the Future.

It has been possible in these articles to give only a few typical examples of important classes of motor vehicles for various industrial purposes, yet they will suffice to indicate the wonderful variety of work to which such self-propelled vehicles can be applied with economy and efficiency. They can do certain kinds of work that no other power or vehicle can do as quickly, well, and cheaply. Engineers are devoting much effort to solving the fuel problems, so that it may be expected confidently that in a very few years at most it will be possible to operate heavy commercial vehicles with entire satisfaction on kerosene, denatured alcohol, and producer gas. Already experiments in the application to the heavy motor car of gas producers using coal or coke have met with some success that augurs well for the future, and in experimental work in the shop a 15-horse-power stationary engine has been run at full load continuously from a portable producer plant weighing only 180 pounds. This experiment, carried out by M. Louis Fornas, a Parisian engineer, showed a consumption of slightly more than one pound of coke and about one quart of water per horse power per hour.

It is evident, then, that while there is an excellent foundation in many fields upon which to work, industrial motor-vehicle development is still in comparative infancy and there is ample opportunity for study and original work.

MEANS AND METHODS FOR HEATING THE FEED WATER OF STEAM BOILERS.

By Reginald Pelham Bolton.

I. GAIN OR LOSS BY FEED HEATING.

In a series of three articles, of which this is the first, Mr. Bolton makes a careful examination of the actual economy of feed-water heating, working out the heat balance in a most interesting manner and presenting, in the later parts of his discussion, very useful and suggestive diagrams showing the results or indicating arrangements with various dispositions of the feed-heating equipment. The second part or his series will take up the use of live steam, and the third will examine the economy of heating by used or waste steam.—The Editors.

THE ad-heating of feed-water is a subject of concern to steam users, and the interest aroused in the subject of late years has brought about the development of a number of ingenious appliances and methods, some of which have proceeded beyond the point of the utilization of waste or rejected heat for this purpose and have entered upon the diversion of otherwise useful heat, raising the question as to how far such a process can be desirably or economically carried.

Bold assertions are made to the effect that the ad-heat of feed water brings about an increase not only in capacity but in efficiency of the boiler, and the credit for indirect advantages such as the reduction of strains by large inequality of temperature, and the elimination of deleterious substances, is assumed to be applicable to additions of temperature which require the use of otherwise usable heat.

The question as to how far the process may be carried with economic effect, and where the dividing point occurs at which loss results instead of gain, is one that has been to a great extent lost to sight, as is the fact that if any useful purpose can be served by waste heat, capable of showing an advantage superior to that of ad-heating the feed water, its use in the latter process may result in reduced instead of increased economy.

Tabulations frequently published in the interest of appliances for ad-heating feed water purport to show gains proportioned upon the relation which the heat thus added bears to the difference between the

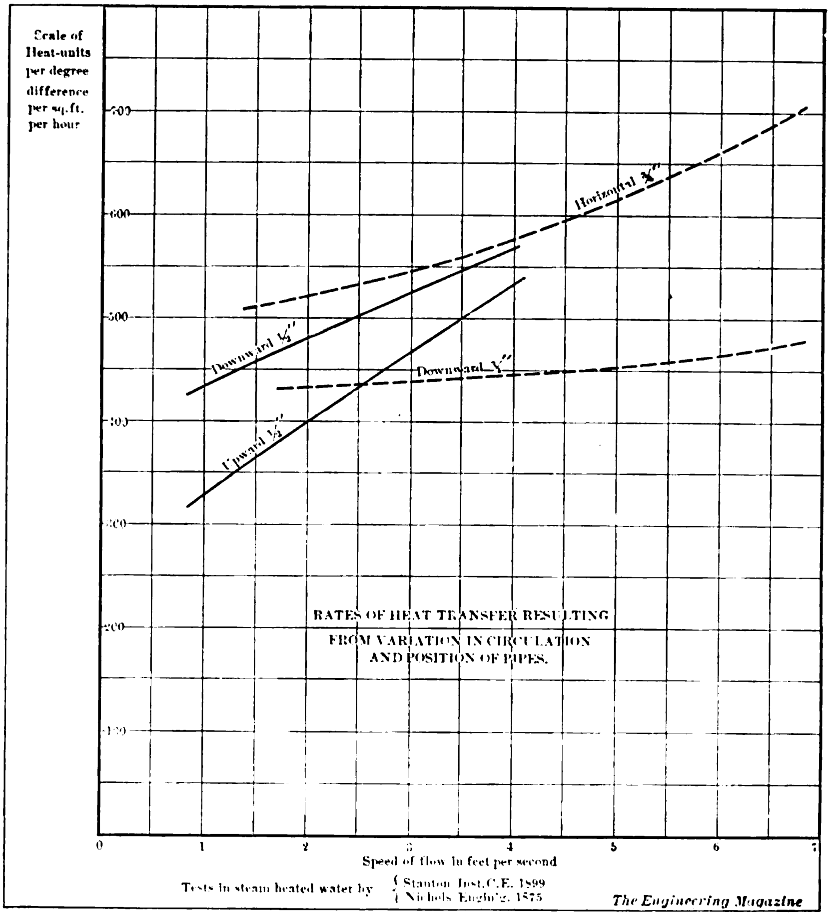


DIAGRAM OF VARYING RATES OF HEAT TRANSFER RESULTING FROM VARIATION IN CIRCULATION AND POSITION OF PIPES.

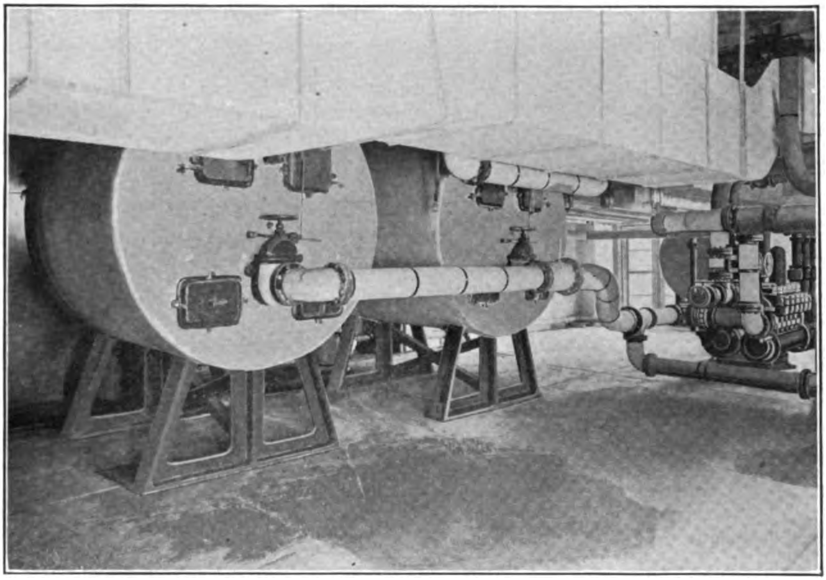
feed, not so heated, and the heat in the steam at boiler pressure. This relation is brought out by the rule:

$$\frac{h^2 - h^1}{H - h^1}$$

in which H = heat in steam.
h^1 = heat in feed water.
h^2 = heat in feed after ad-heating.

The rule is commonly extended to the assumption that the ad-heat, being a contribution which is effected outside the boiler to the work of steam raising, will be represented by a corresponding reduction in the fuel for an equal output in steam.

These computations, however, are reliable only to the extent of the proportion which the ad-heat bears to the total difference between feed water and steam, and do not take into account the effect upon the boiler and furnace operation which the alteration of that difference of temperature may bring about.



INSTALLATION OF WEBSTER HEATERS IN THE POWER PLANT OF THE WANAMAKER BUILDING, PHILADELPHIA.

Showing two of the four 1,500 horse-power heaters. Warren Webster & Co., Camden, N. J

It does not follow that the mere introduction into a boiler of its feed water at a higher degree of temperature will result in a commensurate reduction of the fuel, nor in a proportionate increase in the output of steam, unless there be some established condition in either the furnace or the boiler, and their relation to one another, which is to be benefitted by the lessening of the difference between the entering feed and the departing steam. In fact, unless the heat-receptive qualities of the one, and the heat-imparting ability of the other, are very nicely adjusted to the new conditions thus established, the increase in temperature may cause a less efficient transfer of heat from the fuel to the boiler contents.

In every form of boiler there is a rate of circulating flow of the water which, in combination with a certain difference between the external temperature and the average internal temperature, will result in the best results in transfer of heat.

The lower the temperature of the introduced feed, the greater will be the average difference between the flame and the water, and the greater the rate of heat transfer. If the ad-heat in the feed is to overcome this condition and show superior results, it must be by so affecting the process that the speed of the water over the heated surfaces is accelerated to an extent sufficient to restore the rate of transfer per unit of surface.

It will perhaps seem, to some who have not given this view of the subject much detailed attention, an extraordinary proposition that the increase of feed temperature, with a fixed furnace condition, may result in a reduction of efficiency and even of the output of a boiler; but with certain boilers, under equal conditions, this is the case, as shown by the following records of tests in which a difference of feed temperature existed.

H. M. S. SHELDRAKE.

Water-tube Boilers.			Official Trials.	
Feed temperatures	115°	114°	70°	70°
Gas temperatures	550°	600°	550°	600°
Coal per sq. ft. of grate	20	26.19	22.5	24
Evaporation, f. & a. 212°	11.6	11.52	12.72	12.12
Efficiency, per cent	74.3	73.5	81.2	77.4

STEAMSHIP CRESCENT CITY.

Water-tube Boilers.	J. F. Hayes—W. D. Hoxie.	
Feed temperatures	243°	181°
Coal per sq. ft. of grate	20.16	20.83
Evaporation per lb. of coal	9.69	9.72
Evaporation, f. & a. 212°	9.93	10.62

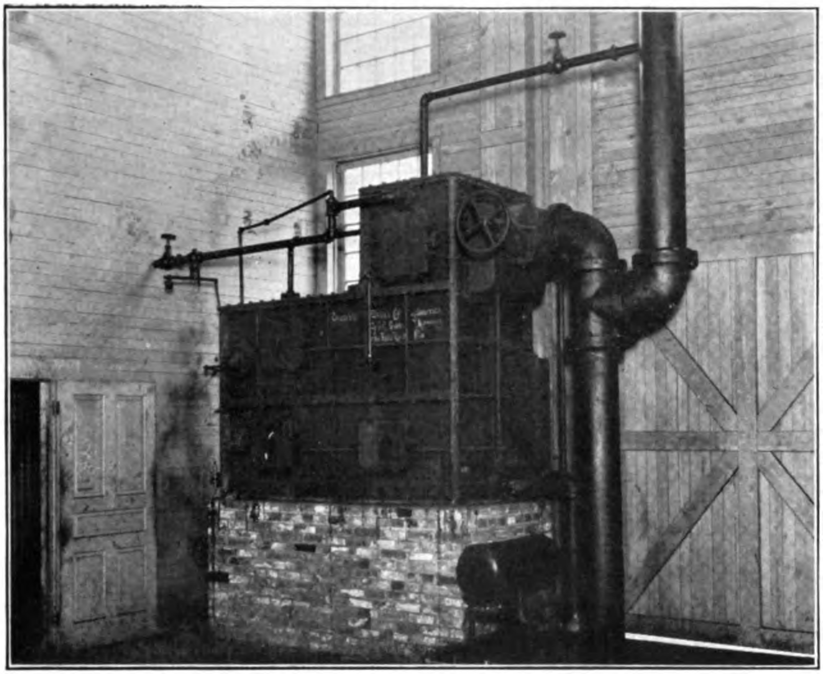
TESTS ON ONE HORIZONTAL RETURN TUBULAR BOILER.

	Prof. J. A. Denton.	
Feed temperature	199°	176°
Gas temperature	529°	550°
Combustible per sq. ft. grate	12.3	12.17
Evaporation per lb. combust	11.13	11.18
Efficiency, per cent	60	68.7

2 TESTS VERTICAL WATER-TUBE BOILERS.

	G. H. Barrus.	Prof. Wagner.
Feed temperature	123°	38.6°
Steam pressure	63.9	99.
Superheat	.....	3.7°
Gas temperature	495	312.7
Coal per sq. ft. grate	19.79	21.33
Evaporation per lb. coal	7	7.255
Efficiency, per cent	66.1	70.5

The mere increase of temperature of feed water therefore does not necessarily represent a gain in fuel; but, if it be accompanied by an equivalent rate of increase in the speed at which that feed water passes over the heat-transferring surfaces, then its value may be realized in coal saved.



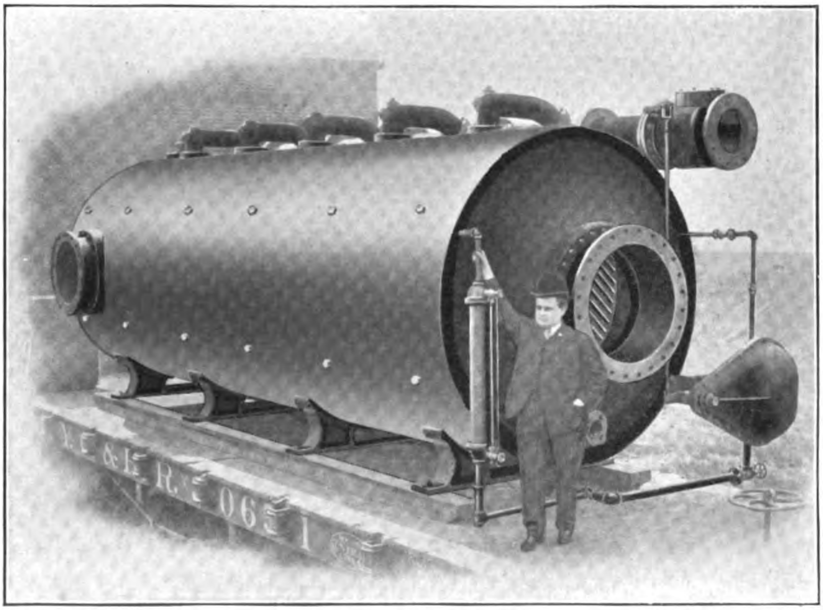
HARRISON SAFETY BOILER WORKS HOT-PROCESS SYSTEM OF WATER PURIFICATION, CRUCIBLE STEEL COMPANY OF AMERICA.

Advantage is taken of the necessary heating of boiler feed to precipitate carbonates in an open heater, thus dispensing with the use of lime and soda. A single reagent then removes sulphates and chlorides, thus reducing complexity of parts and amount of attention needed for operation. The apparatus performs all the functions of an open heater.

Several experimenters have demonstrated the effect of increasing velocities with fixed differences between the water inside a tube and steam outside the same tube, and have shown that this varies considerably with the position of the tube, its size, its character, and the direction of flow, as would be the case with the numerous forms of boiler constructions, the positions and sizes of their tubes.

Reported gains in economy or fuel reduction by the use of increased temperature of feed water are thus traceable to internal contributory causes, the chief feature of which is some acceleration of the speed of travel of the water, or in other words, its circulation over the heat-transferring surfaces. And it will follow that in the case of boilers in which the design and furnace conditions are such as to have already established the best conditions of flow and of heat transfer, no gain, but perhaps a loss, will result; while a boiler in which a more active circulation may be promoted by the heated feed, and which may thus absorb some of the heat of the fire it has hitherto failed to receive, will show a gain in output, and sometimes in economy.

Of such forms of boilers as may receive special benefits, the internally-fired types are probably most conspicuous, because the large amount of water they contain, and the location of much of their contents below the fire level, renders them particularly liable to inactive or partial circulation, and a higher temperature of feed water introduced at a low level will promote an active disturbance of the dead water, and start an upward current over the heated surfaces.

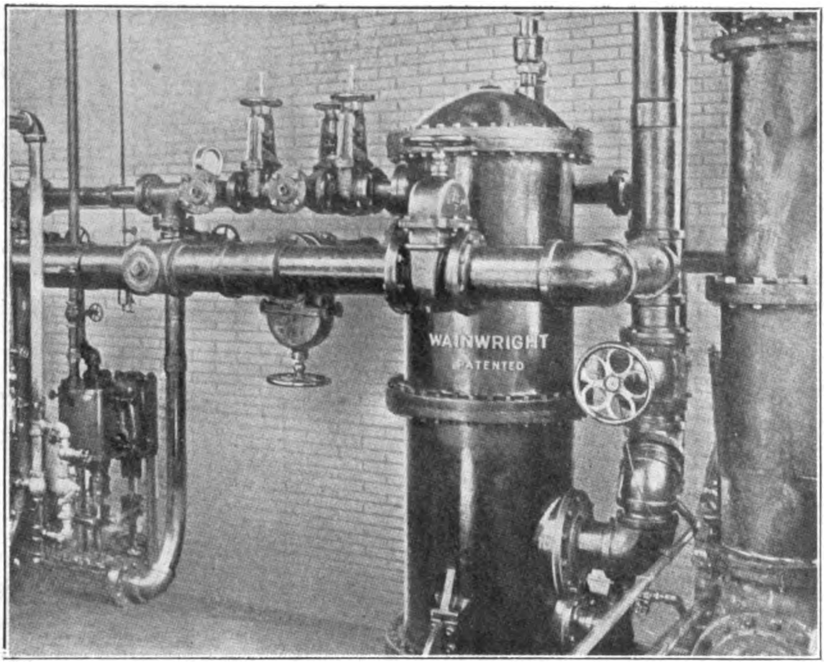


A 20,000 HORSE-POWER HOPPES FEED-WATER HEATER.

The water flows over trough-shaped pans, overflowing the edges and following the under side in direct contact with the exhaust steam. The scale-making solids are deposited on these pans, especially on the under side. The flow of water to each tier of pans is controlled by the orifices from the main feed line. This system of distribution makes possible the use of large units and the operation of two or more heaters in parallel. Hoppes Manufacturing Co., Springfield, Ohio.

A similar effect may be brought about in the locomotive pattern, by aiding a more rapid circulation of the water from the bottom of the fire-box shell space, though it is more likely that any gain in this class of boiler is due to the following cause.

An increase in feed temperature, with proper appliances, conduces

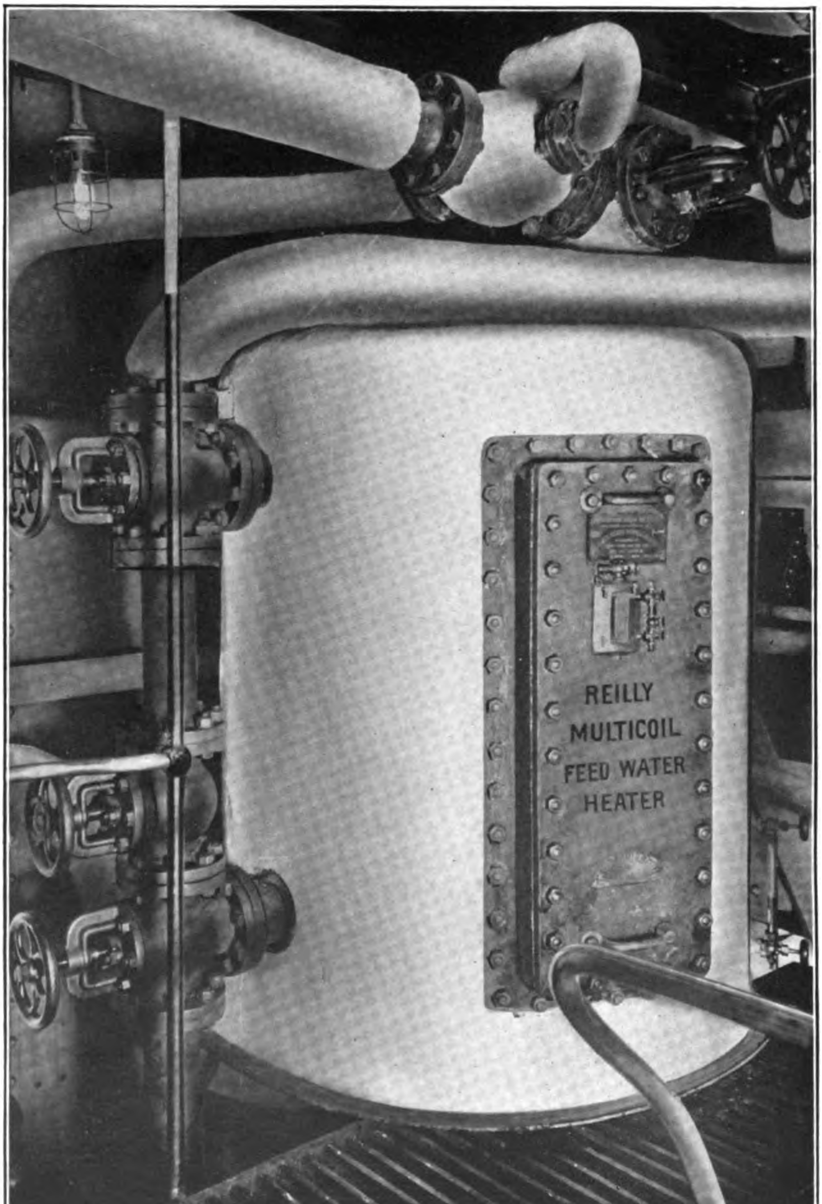


A 2,000 HORSE-POWER WAINWRIGHT HEATER INSTALLED IN A NEW ENGLAND FACTORY.
Alberger Condenser Co., New York.

to the more complete separation, from the feed-water, of the deleterious and disturbing element of contained air and gases, especially where the fluid is drawn from a fresh supply, as is the case in non-condensing plants, locomotives, and general land practice. My own observations of the internal performance of locomotive pattern boilers, made and described in 1891, brought under my vision the operations of bubbles forming upon the surface of the heated plates, the action of which is an alternate expansion and contraction, prior to their release from the plate, evidently using up heat in the kinetic process, and meanwhile occupying the heat-transferring space which should have been covered with water. If by any deficiency in circulating arrangements such a bubble-covered surface is not relieved of its incubus, the result must be very largely to affect the efficiency of the heated plate as an agent of heat transfer.

The effect is cumulative:

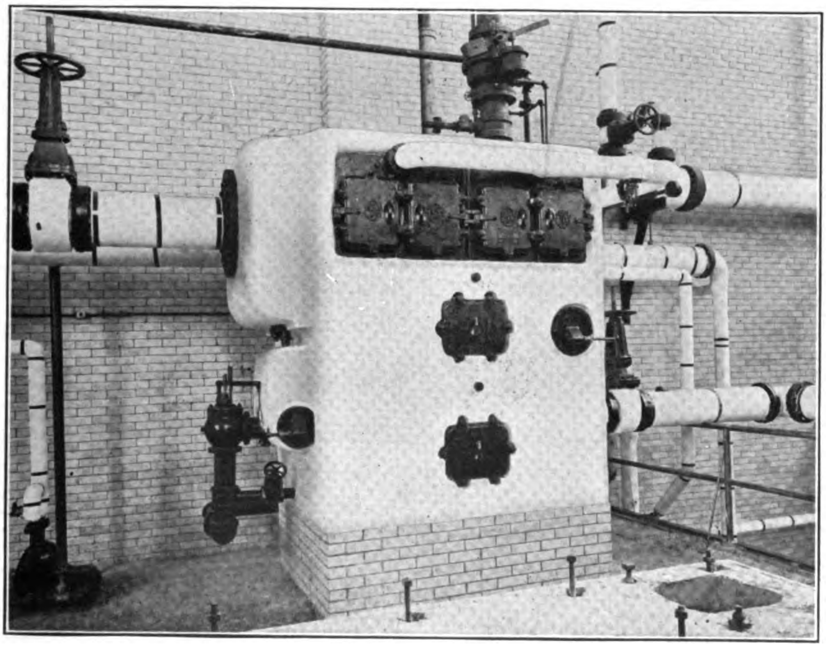
"Small bubbles of air expelled from the water on boiling attach themselves tenaciously to the heating surfaces. The oxygen therein commences to attack the metal—pitting follows—forming ideal resting places for the air-bubbles to collect in, and presenting increased area for attack."



INSTALLATION OF THE REILLY MULTICOIL FEED-WATER HEATER IN MUNICIPAL FERRY BOATS, N. Y. CITY.

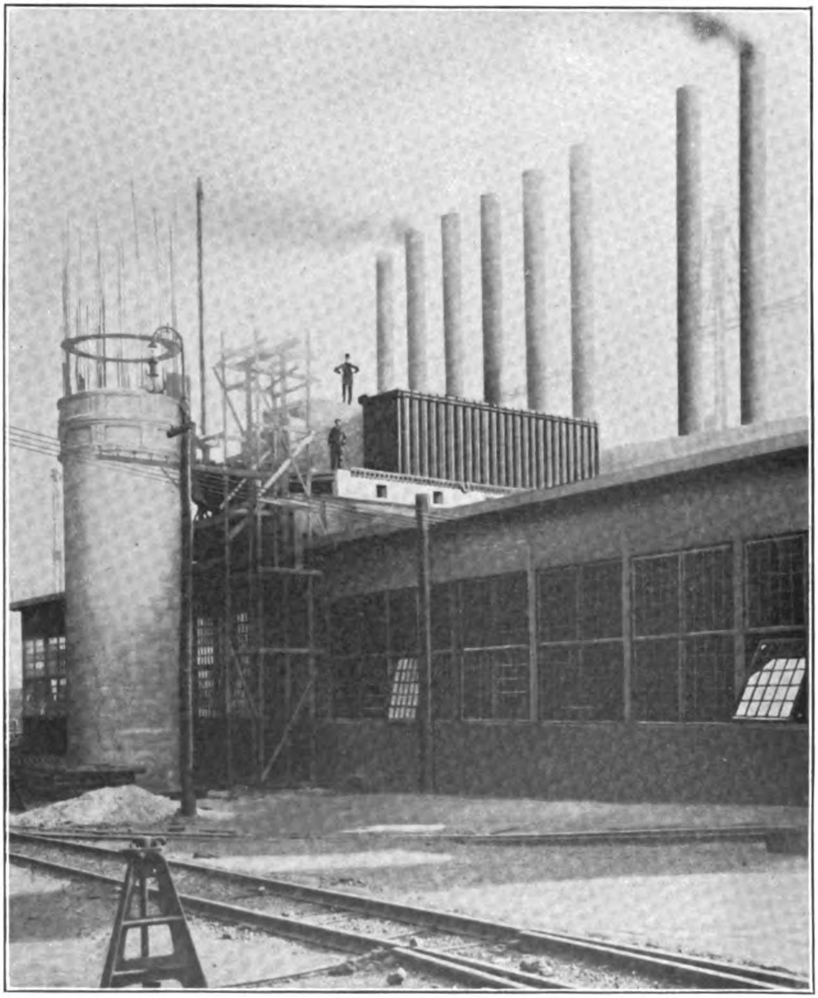
The exhaust steam from the auxiliaries is used, and gives a feed temperature of 220 degrees. The heater is provided with magnesia covering. The Griscom-Spencer Co., N. Y.

The locomotive boiler, when in practical use, is subjected to a continual shaking and mechanical motion of its contents, which is highly beneficial in detaching from its heated surfaces the bubbles that its constant supply of fresh and aerated water is bringing into existence. It is explicable why a locomotive boiler, when removed from active service and placed in a stationary position, will "never make anything like the same quantity of steam, nor with the same efficiency that it did on the rails," even with ad-heated feed, for, over and above its loss of the mechanical motion above referred to, its chimney work becomes radically different, and in place of its originally designed induced draft, automatically increasing with the demand for steam, it is provided with an unvarying draft suited only to the burning of a certain amount of fuel upon its rather restricted grate area. The rate of steam production in the locomotive boiler affects very considerably the speed of circulation of the contained water, and a reduction of fuel consumption is followed by a reduction in steam output, with reduced circulation and resultant fall in economy.



COCHRANE HEATER AND RECEIVER, PACKARD MOTOR CAR COMPANY'S POWER PLANT.

The open heater utilizes the exhaust steam to preheat the boiler feed, and conserves the steam so used. The Cochrane type acts as a receiver for all returns and drips, skims and filters the feed water, and removes carbonates precipitated by heat. Harrison Safety Boiler Works.



STURTEVANT ECONOMIZERS, PLANT OF THE AMERICAN STEEL & WIRE CO., WORCESTER, MASS.

If, in boilers affected by the foregoing conditions, as internally-fired boilers are, a system of feed supply be introduced by which, in company with a higher temperature, the air and gases therein will be wholly removed, a beneficial result may be due as much to one cause as the other; and it is to be noted that such a removal of the air-gases may be effected by the use of suitable apparatus without a greater degree of heat than is found in exhaust steam.

An incidental advantage which may be secured by a higher degree of heat may be that of thoroughly clean plates, free from deposition of scale, and such a relief to the heat-transferring surfaces may even justify the cost of utilizing high-pressure steam, or of burning otherwise unnecessary fuel to produce, in the live-steam purifier or the economizer, that temperature at which the scale-making materials are separable from the feed water.

Heating by Waste Gases.

The value derivable from the addition of heat to feed water prior to its introduction into steam boilers has been a good deal confused by assumptions that the heat so added increases the economic performance of the boiler, and it has consequently led to arrangements for increasing the temperature of the feed water by methods which involve a sacrifice of otherwise useful heat.

The addition of heat to the feed supply of a boiler does not, however, justify the application thereto of heat which can be utilized to greater advantage in other parts of the operation of the apparatus, nor does the mere addition of heat in the feed supply add to the efficiency of the boiler as a heat-transferring apparatus, though it may indirectly affect the result by improving certain interior conditions.

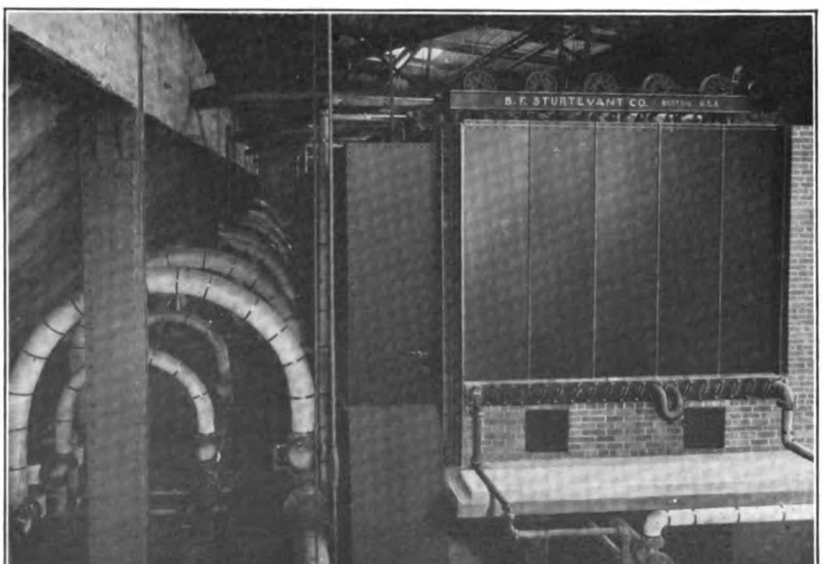
Thus, the heat in the gases leaving a boiler and entering the base of a chimney is commonly regarded as an entirely waste product, whereas if the fuel be properly burned, and if the operation of the boiler be such as to release the products of combustion with only that amount of heat necessary to produce the effect of levitation in the chimney, the gases are really occupied in effecting useful work by the production of necessary draft, which would otherwise have to be brought about by some expenditure of power.

The performance of the combination of a furnace, a heat receiver, and a draft producer, should be credited with as much of this heat in the fuel (over and above that which may be absorbed by the boiler) as may be required to produce and maintain the air draft upon which the action of the furnace depends; and were this commonly done, a much better understanding would probably prevail upon the subject of furnace and boiler relations.

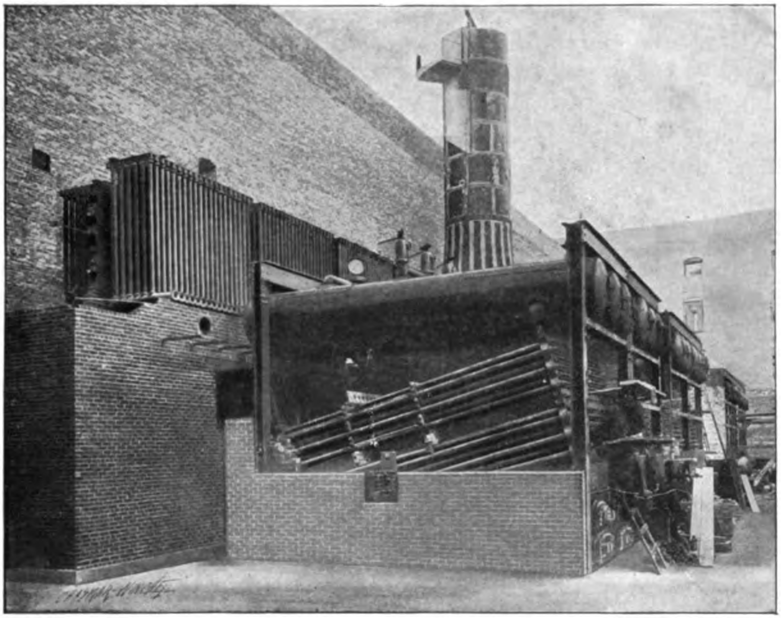
Modern combinations of steam-raising apparatus now commonly include an extension of the steam portion of the boiler in the form of superheaters, and these, under certain defective furnace conditions, may be extremely effective and yet be acting merely as a means of making up some discrepancy between the heat in the furnace and the absorbing capacity of the boiler. Methods applied in other ways to bring about a due relation would show equally beneficial effects, in heat delivered by the boiler.

Similarly, the economizer, which is really a surface feed-water heater, placed in the line of passage of the gases passing from a boiler or boilers, is an effective appliance for the transfer of the heat in the gases to the feed water and has the advantage of a considerable difference in temperature between the two elements. But in cases where the gases are unduly heated, the economizer becomes a practical extension of the boiler, which is deficient in capacity for transferring the heat generated in the furnace to its contents. In other cases, where unsatisfactory furnace conditions result in an excessive volume of gases, the economizer becomes a partner of the furnace, breaking up and utilizing, more effectively than would an increase of boiler surface, the unduly large travelling body of heated gas given off by the furnace. In either case, the economizer is operating as a corrective of a defective condition in the furnace and boiler combination, which need not properly exist.

Further, in cases where part of the heating of feed-water could be economically effected by waste heat discharged from the steam appliances, it is manifestly an economic error to be doing the whole of the work in an economizer, if any other means exist by which the



STURTEVANT ECONOMIZER, AT WORKS OF THE INTERNATIONAL PAPER CO., HAMILTON, OHIO.

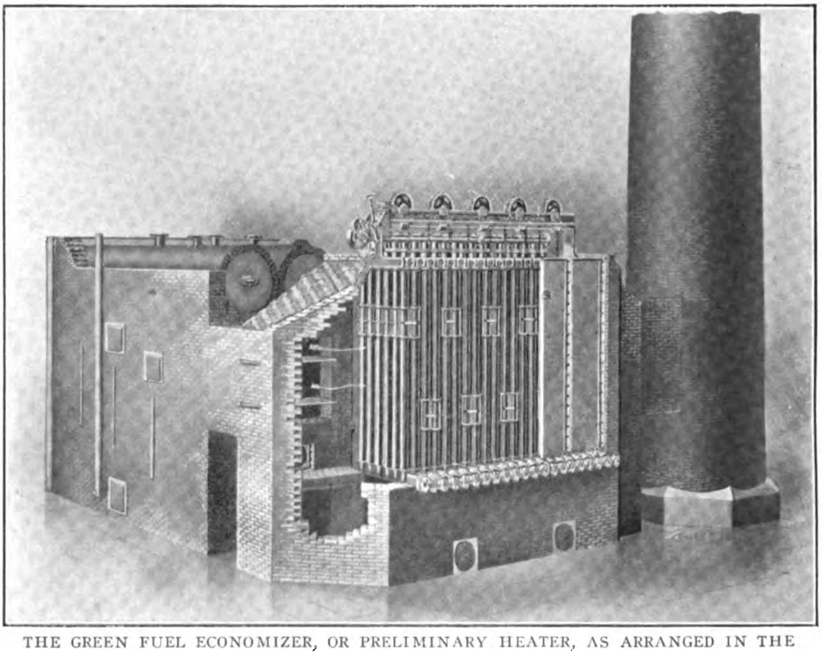


GREEN FUEL ECONOMIZERS IN AN ELECTRIC LIGHT AND POWER COMPANY'S PLANT.
The Green Fuel Economizer Co., Matteawan, N. Y.

surplus heat in the gases of combustion can be economically reduced, or put to use in improving the conditions of combustion.

In a multitude of such cases the economizer has shown its ability to make a more or less effective use of the established deficiencies, but its true value comes into prominence when it is adapted to utilization of heat absolutely unnecessary in the general functions of the apparatus. In combination, therefore, with mechanical draft, which corrects furnace conditions and properly proportions the air supply and resulting gas volume, the economizer finds its proper justification. In further combination with air-heating apparatus, by which the surplus heat in the gases may first be utilized to pre-heat the air supply to the furnace, although the process may leave less material with which the economizer may deal, and less to be accomplished by its use, it is then dealing with, and usefully utilizing, a true waste product.

The air supply to a furnace being at 60 degrees Fahrenheit, and the fuel being Pennsylvania anthracite at 12,800 heat units per pound, the theoretic quantity of air for combustion is 12.79 pounds per pound of fuel. Under good conditions of draft, the air supply would become about 19.18 pounds, or 265 cubic feet, being 50 per cent excess, and under those conditions, the furnace-boiler combination might be expected to discharge 542 cubic feet of gaseous products of combustion, at a temperature of about 500 degrees. The cold-air supply would have been heated at a cost of about 2,200 heat units, or about 17 per cent of the fuel heat.



THE GREEN FUEL ECONOMIZER, OR PRELIMINARY HEATER, AS ARRANGED IN THE BOILER FLUE.

If an air heater were installed in the "waste" gases, raising the air temperature 200 degrees by heat abstracted from the gas on its way to the chimney, the result would beneficially affect the furnace temperature, as the raising of the air from 260 to 500 degrees would require on the part of the fuel only 1,200 heat units. The gases however would have lost this heat, reducing their volume and lowering their temperature to about 380 degrees, and reducing the chimney draft in a 100-foot stack by nearly 2/10 of an inch of water. By reducing the size and increasing the height of the stack, the draft could be restored and the efficiency of the furnace increased by approximately 8 per cent, thus adding to the capacity of the combination. The evaporative effect of the boiler would be advanced, as the mean temperature of the fire would be hotter, and we might expect an increase of its efficiency of probably 5 per cent, which would make a heat saving in fuel of 1,000 heat units and a gain in steam of 415 heat units, or a total of 1,415 heat units.

Now, if for the above an economizer be installed to absorb the same "waste" heat into the feed water, we should have available, per pound of fuel, 1,000 heat units as the equivalent work of heating 265 cubic feet of air from 60 degrees to 260 degrees. This heat is now to be applied to raising the temperature of the feed water corresponding to the one pound of fuel, which taken under conditions of 60 degrees entering temperature, steam at 100-pounds pressure, and boiler efficiency of 65 per cent, equals, say, 7 2/10 pounds of water per pound of fuel. The available heat would therefore, raise the temperature of 7 pounds of feed-water, $1{,}000 \div 7 = 143$ heat units, which would bring the feed to a temperature of 192 degrees, or the additional heat put into the boiler would be $1{,}153 - 1{,}020 = 133$ heat units per pound $\times\ 7.2 = 957$ heat units.

The superior advantage would thus be in favor of the air-heating process, because of the beneficial effect upon the furnace and boiler economy, and any greater volume of excess air supplied to the fire than that of 50 per cent would show relatively greater effect in economy, by the pre-heating of the air supply, rather than by ad-heating the feed-water supply.

The effect of air heating is well described by Seaton, as follows:

"The various beneficial effects of the heated air are not to be measured only by the direct recovery of so much heat that otherwise would be lost, but also by their effect in increasing the average temperature of the furnace, which again not only adds to the evaporative efficiency of the boiler, but also allows of a more facile and rapid union of the oxygen of the air with the gaseous products and the carbon of the fuel, so that actually less weight of hot air than of cold is required to effect the combustion of an equal amount of fuel in a given time. This further raises the degree of evaporative economy and power of the furnace, making an economy and rate of combustion possible, which otherwise would be unattainable."

It will be evident, that if the element of chimney draft be eliminated, and a sufficient and proper air supply provided by a steam-driven fan, (the exhaust of which is condensed, but the exhaust and the heat therein mainly returned to the boiler), it would be possible for the economizer to effect much more work in feed heating, even in combination with the air heater, for it could reduce the temperature of the gases to the greatest practicable extent and transfer its heat to the feed water, so that both furnace and boiler would be relatively advantaged by the combination.

The conclusion is that waste furnace heat should be first economized by its return to the source of waste, rather than to continue the prime cause of the waste and effect by its means an economy in another appliance.

THE DEVELOPMENT OF THE SMALL STEAM TURBINE.

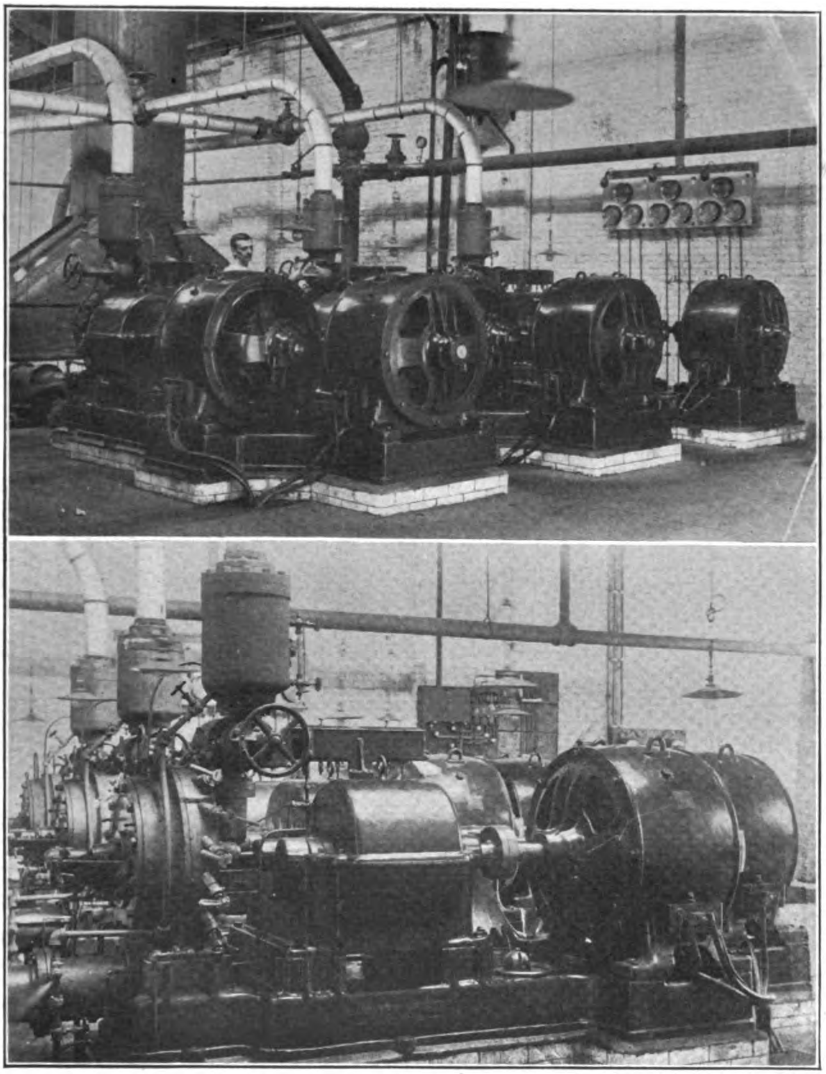
By Chas. A. Howard.

In the following pages Mr. Howard describes the prominent features of design and construction of the leading types of steam turbines of small capacity used in the United States. In an article to follow next month, he will discuss the various applications to which small steam-turbine units are adapted.—THE EDITORS.

AS a means of transformation of the heat energy of steam into useful work in the form of motion, the discovery of the steam turbine dates back centuries before any form of reciprocating engine was known. About 120 B. C., Hero, an Egyptian philosopher of Alexandria, discovered the basic principles of the reaction turbine. This was in the form of a hollow sphere containing water and mounted over a fire, the exit of the steam from the sphere being through a bent tube so that the reaction of the jet revolved the sphere in precisely the same manner as our modern reaction lawn sprinklers revolve. This was undoubtedly the first steam motor in the history of the world, so that it can be seen that the evolution of the heat engine began in its simplest form, the turbine.

In the year 1629, Giovanni Branca, an Italian, made the next important move in the development of the steam motor, by the invention of the impulse form of turbine, which, as produced by him at that time, consisted of a small tank of water placed over a fire with a nozzle projecting from the side of the tank. The jet of steam from this nozzle impinged on a wheel having a series of blades projecting from its periphery, thereby causing the wheel to revolve at very high speed. This, it will be seen, involves all of the fundamental principles of the De Laval turbine which was put into practical use for the first time in 1883. The multi-stage turbine (which is the only commercial machine on the market at the present time) is not so very new either, as in 1827 Real and Pinçon in France designed a thirty-one-stage impulse turbine which involved the basic principle of the modern Curtis turbine. The multi-stage reaction turbine was first brought forth by Tournaire in a paper presented to the French Academy in 1853.

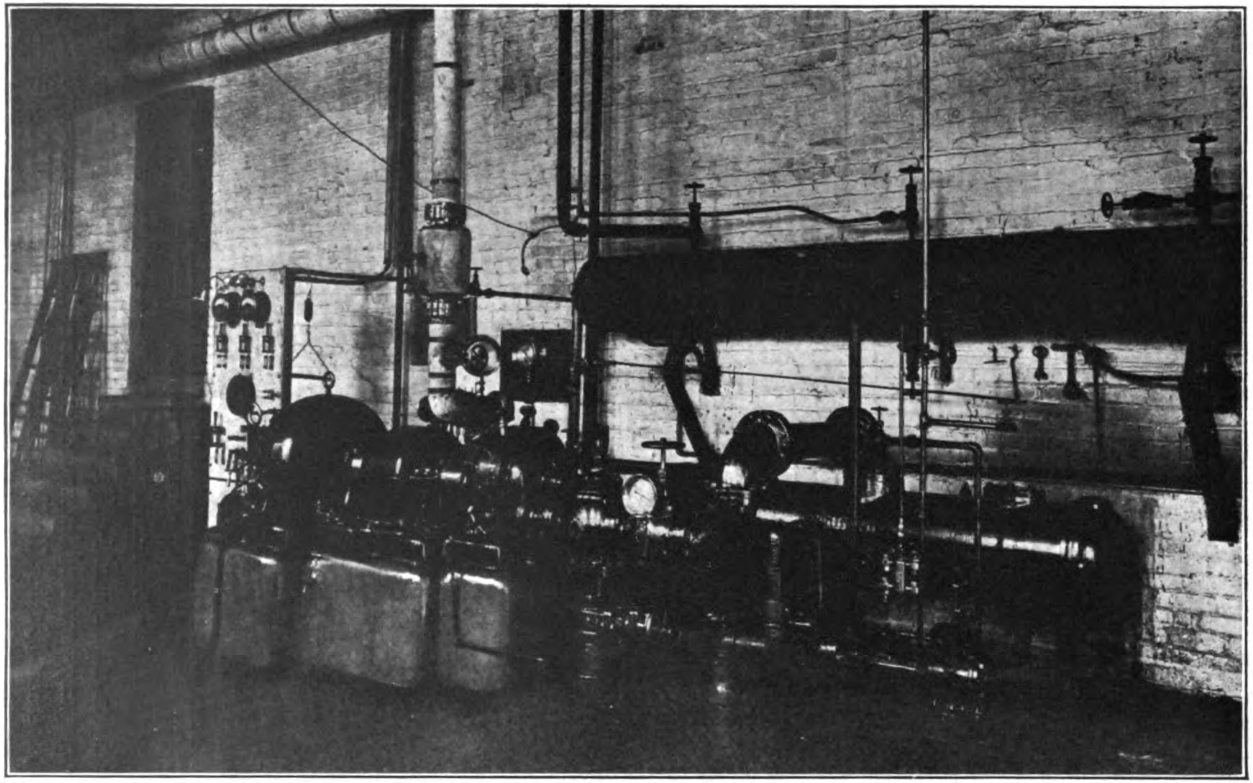
As a commercial machine, the turbine was first built by De Laval as a single-stage impulse wheel in 1883, and shortly after by Parsons



THREE 150 HORSE-POWER DE LAVAL TURBINES, POWER STATION OF THE AUTO-TRANSIT COMPANY, PHILA.

De Laval Steam Turbine Co., Trenton, N. J.

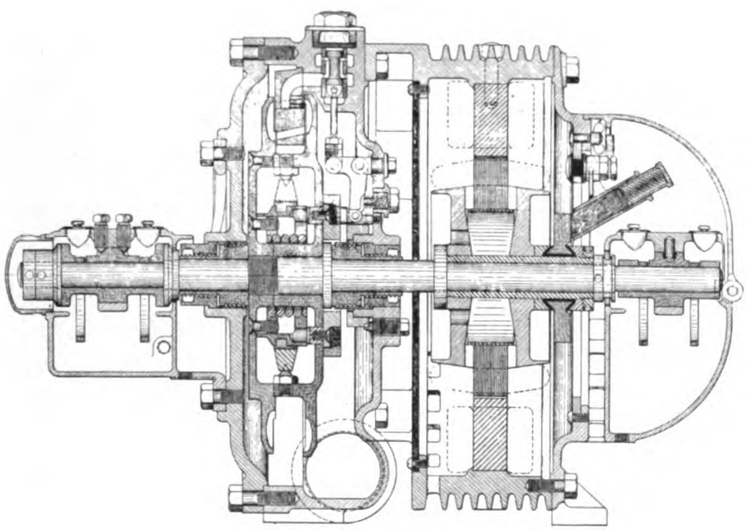
in the form of the multi-stage reaction turbine in 1884. From this time on, many new and improved machines have been developed by Curtis, Rateau, Riedler, Zoelly, and many others. Most of the designs of the small turbines on the market to-day and in the present process of development, that is of say 300 horse power and under, are an evo-



INSTALLATION OF 20-KILOWATT 125-VOLT DE LAVAL TURBINE GENERATOR, PLANT OF THE McJUNKIN-STRAIGHT DAIRY COMPANY, PITTSBURG, PA.

lution of the Riedler-Stumpf principle, which involves allowing the steam expanding from the nozzles to impinge directly upon the buckets on the turbine wheel; then after exit from the buckets, the steam is conducted through guide passages and strikes the same wheel again, this cycle being repeated a number of times.

The turbines most in use of this small size in the United States are the Kerr, the Terry, the Curtis, the Sturtevant, and still to some extent the De Laval. The Westinghouse is generally constructed only in larger sizes. For the usual speeds required for driving generators, centrifugal pumps, fans, blowers, etc., all the above machines with the exception of the De Laval are run direct-connected. Besides the ones noted above, there are several others of these small turbines which have been placed on the market very recently to a limited extent, and many more still in the process of development by many machinery manufacturers.



A SMALL DAKE-TURBINE GENERATING SET.

The first turbine commercially manufactured and sold in the small sizes in America was the De Laval. This is fundamentally the turbine of Branca, designed and constructed to suit the prevailing conditions as well as possible, and consists essentially of a series of nozzles from which the steam jets impinge upon blades fixed on the periphery of a wheel. The principle upon which this machine works is as follows: the steam entering the turbine through the throttle and governor valve under high pressure passes through a series of expanding nozzles where its energy in the form of pressure is transformed into velocity. The velocity of the steam on issuing from the nozzle is very high, as will be shown by the following calculation. With steam at 165-pounds absolute, expanding adiabatically through a nozzle to 18-pounds absolute, the velocity may be deduced as follows:

From the energy equation of a liquid and its vapor, the condition of an adiabatic flow is represented approximately by the equation:

$$(1) \qquad \frac{AV^2}{2g} = x_1 r_1 + q_1 - x_2 r_2 - q_2$$

where

A = the heat equivalent of work $\frac{1}{778}$
V = velocity of the jet in feet per second.
X_1 = moisture in steam at start.
X_2 = " " " " finish.
r_1 = heat of vaporization at start.
r_2 = " " " " finish.
q_1 = " " liquid " start.
q_2 = " " " " finish.
g = acceleration due to gravity, 32.2 feet per second.

In order to find the condition of the steam after exit from the nozzle, it must be remembered that in an adiabatic expansion the entropy remains constant. Hence if we solve the entropy equation, the value of X_2 may be obtained:

$$(2) \qquad \frac{x_1 r_1}{T_1} + y_1 = \frac{x_2 r_2}{T_2} + y_2$$

where y_1, and y_2 are the entropies of the liquid at the entrance and exit pressure respectively. Considering the steam dry at the initial pressure, we have

$$\frac{855.6}{826.5} + .5230 = \frac{958.5}{683.1} x_2 + .3282$$
$$1.037 + .5230 = 1.402\, x_2 + .3282$$
$$x_2 = .877$$

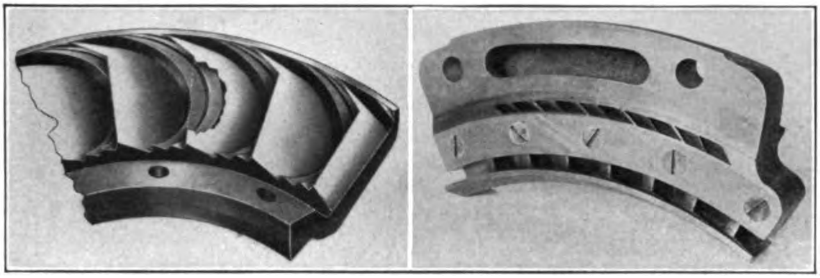
Substituting in equation (1) we have

$$\frac{V^2}{778 \times 64.4} = 1193.6 - .877 \times 958.5 - 191.3$$
$$V^2 = 778 \times 64.4 \times 161.3 = 8{,}082{,}000$$
$$V = 2840 \text{ feet per second}$$

The best efficiency of the De Laval wheel occurs when

$$V = \frac{C}{2 \cos a} \text{ where}$$

V = the linear velocity of the wheel,
C = the velocity of the steam,
and a = the angle between the nozzle and the plane of the wheel.

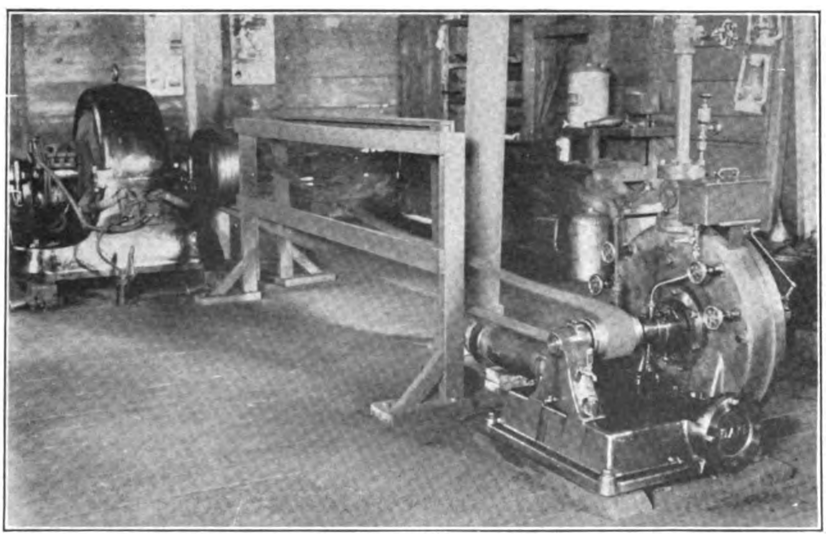


FEATURES OF CONSTRUCTION OF THE DAKE STEAM TURBINE.
On the left, segment of bucket ring, showing steps and end delivery of the buckets; on the right, nozzle and deflector vane block.

The angle *a* must be different for all speeds so that the steam may enter the blades without shock. This angle for the speeds at which this turbine ordinarily operates is from 17 to 20 degrees, so that the speed for the best economy under the steam conditions previously assumed, will be

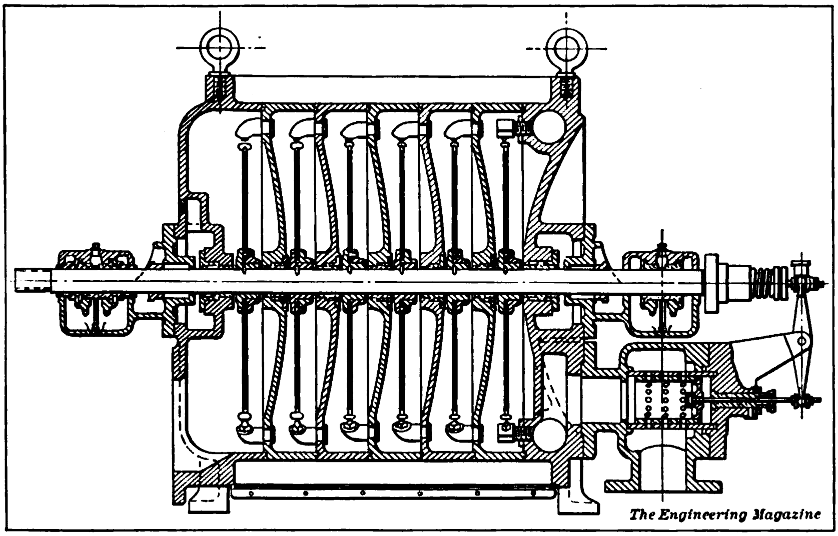
$$v = \frac{2840}{2 \times .9397} = 1510$$

feet per second where the angle between the nozzle and the plane of the wheel is 20 degrees. This speed, which is over 17 miles per minute, is altogether out of practical reach, both for constructive reasons,



SINGLE-STAGE DAKE TURBINE BELTED TO 65-KILOWATT GENERATOR.
Taken when generator was running at 8,750 revolutions; coal consumption stated to be 1,800 lb. per 10 hours. Dake American Steam Turbine Co., Grand Rapids, Mich.

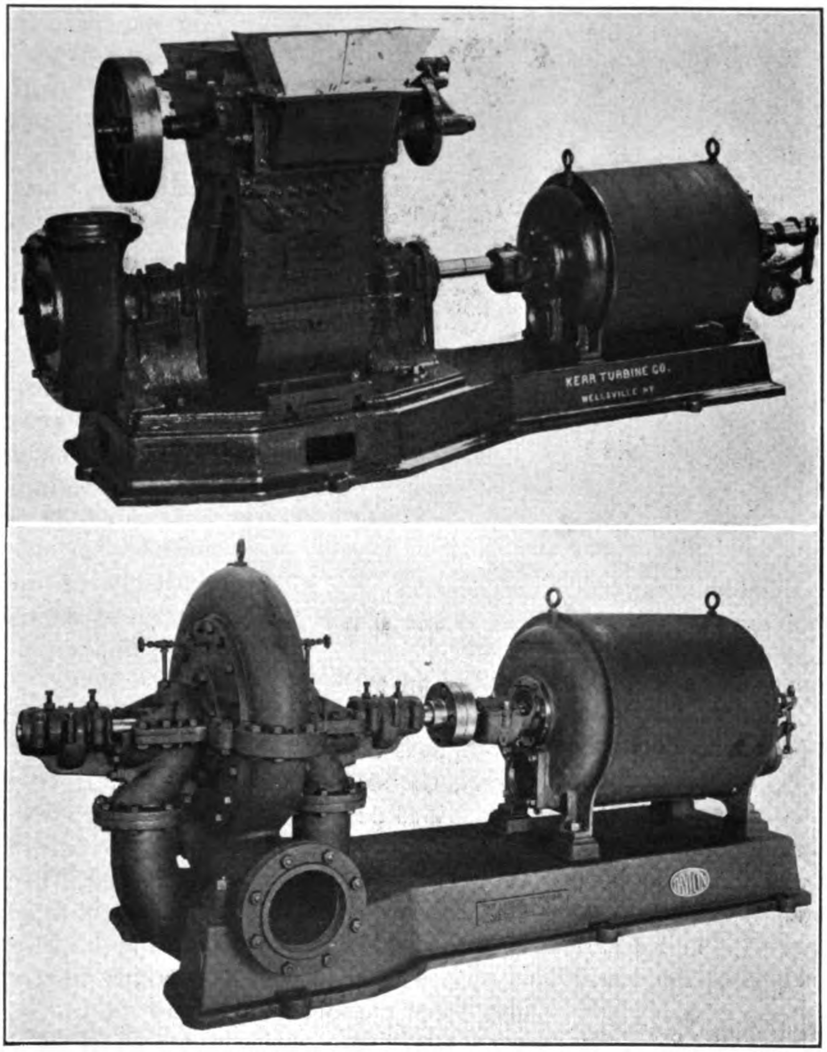
and on account of the inability to apply such tremendous speeds to any of our commercial machines without the use of gears; this, together with its excessive speed, is the undesirable feature of this turbine. In practical installations, however, the speeds are cut down considerably from these figures and of course the economy suffers accordingly, but the speed is never reduced to a point where the machine could run direct-connected in small sizes at say about 2,000 revolutions per minute, as the steam consumption under these conditions would be out of the question or else the diameter of the wheel would be prohibitive.



THE KERR STEAM TURBINE.

In order to get the speed of this turbine down to where it can be utilized for driving machinery, such as generators, blowers and centrifugal pumps, gears are resorted to, giving a reduction in speed of ten to one in most cases. The teeth of these gears are of the herring-bone type, set in two rows at 90 degrees to each other, partly to insure quietness of running and also to avoid the necessity of a thrust bearing. It might be imagined that these gears running at the terrific speeds which they do would make an unbearable noise, but though they could hardly be called quiet, the noise is very much less than would be supposed, as these gears are cut with the greatest care and accuracy on a special automatic machine used only for this work.

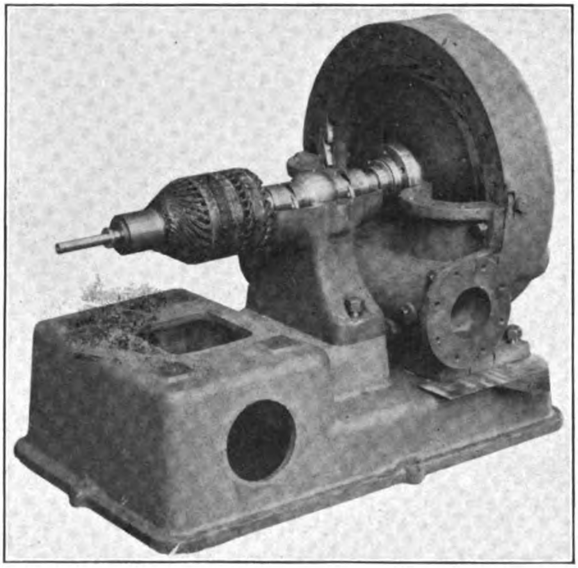
The balancing of the shaft and wheel of these turbines, some of which run at over 30,000 revolutions per minute, would be practically



INSTALLATIONS OF THE KERR STEAM TURBINE.

Above is a 25 horse-power turbine, 3,000 to 3,200 revolutions, coupled to Raymond pulverizer and air separator; below is a seven-stage 18-inch turbine coupled to turbine volute pump of double-suction high-speed Dayton type, capacity 1,200 gallons and speed 2,000 to 2,400 revolutions a minute. Kerr Turbine Co., Wellsville, N. Y.

impossible and is not attempted. The turbine wheel is mounted on a very small flexible steel shaft, supported by two bearings on the turbine proper which are so constructed that they will align themselves with the shaft. On the outboard end of this shaft, supported by two straight bearings, is the pinion which meshes with the gear or gears



STURTEVANT 3-KILOWATT TWO-BEARING GENERATING SET.
Cap of bearing and part of casing removed to show moving parts.

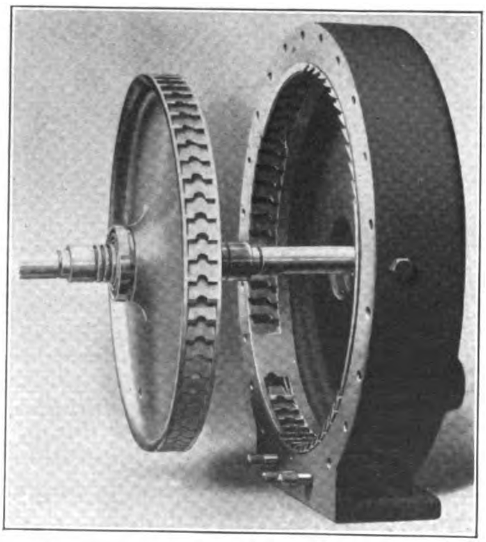
for the speed reduction. This flexible shaft, which is very slender, allows the turbine wheel, after it passes its critical speed, to revolve about its true center of gravity, instead of about its geometrical center as it does below this speed. The critical speed is a function of the flexibility of the shaft and occurs at a point considerably below the normal speed of the turbine wheel.

The turbine wheel itself, which is really the most important part of the machine, as far as strength is concerned, is made from a steel forging. In the smaller sizes, the shaft passes through a tapered bushing which is set in a hole drilled through the center of the wheel, but in the larger machines the wheels are made solid with the shaft in two pieces screwed into the flanges on the face of the wheel. The buckets, which are drop forgings, are made with a bulb shank fitted into slots milled parallel to the axis in the rim of the wheel. This method of construction makes it a comparatively easy matter to take out damaged buckets and insert new ones when occasion requires.

The speed regulation of this turbine is sufficient for all practical purposes and is accomplished by a governor valve which throttles the steam supply. This governor valve is a double-disc balanced valve and is actuated by a bell-crank lever from the governor shaft. The governor itself consists of two small weights which are pivoted on knife edges and held in position by a spiral spring. When the speed rises above the normal, these weights spread apart by the centrifugal force and push forward the governor pin which acts on the bell-crank lever, closing the governor valve. If the turbine runs condensing, when the load is very suddenly thrown off, so that merely closing the governor valve will not take care of the speed fluctuation, a vacuum breaker is connected to the governor so that when the speed has increased above the normal to a pre-determined point, this valve will open to the atmosphere, breaking the vacuum.

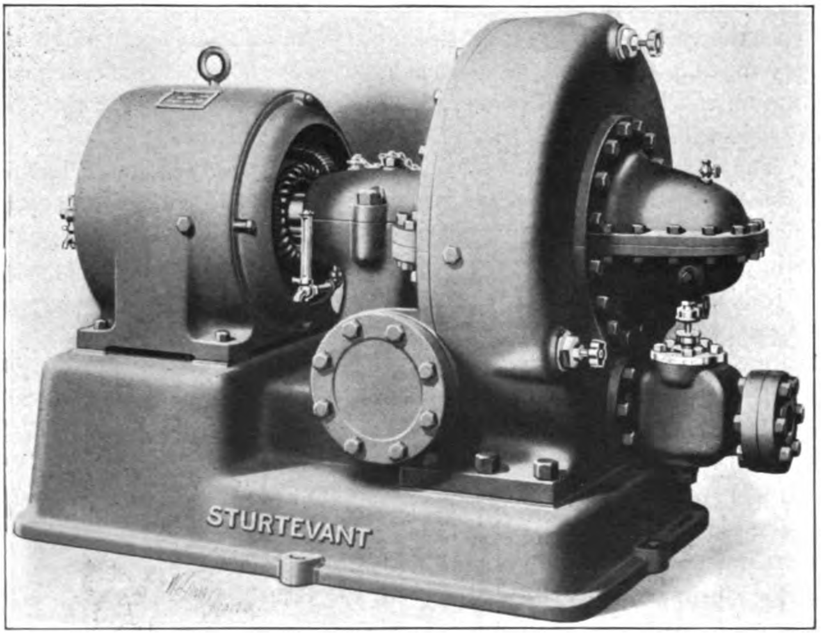
The Kerr turbine, which is being installed in large numbers for various kinds of service, is practically (if it may be called so) a multi-stage De Laval. It is purely of the impulse type and does not utilize the reaction of the steam in any way whatever. Perhaps the simplest description which can be given of it is to say that it consists of a series of Pelton water-wheels on the same shaft, so placed that the steam issues from the nozzles of the first stage and impinges upon the buckets of the wheel where it gets a complete reversal, and then passes through the second nozzle onto the buckets of the wheel in the second stage, and so on through the machine. By this means of dividing the turbine up into several stages, the drop in pressure per stage, and hence the velocity energy to be taken out of the steam at each stage, is very much less than when only one stage is used, so that the speed of rotation can be made very much lower for the same economy than is possible with single-stage machines of the same diameter.

The nozzles of this turbine, in contrast to those of the De Laval turbine, are convergent, as these have been found to give the greater efficiency; this is partially on account of the type of bucket used; but mainly because a high velocity of the steam jet is neither necessary or desirable. Since several stages are used, the velocity of the steam jet on leaving any of the nozzles can be kept in the neighborhood of 400 to 500 feet per second, while in the single-stage or De Laval turbine, the velocity of the steam jet is around 2,500 to 3,000 feet per second. The linear velocity of the buckets in this turbine should be approximately one-half the velocity of the steam jet for the best economy, which is approximately 200 feet



BUCKET WHEEL, REVERSE GUIDE RING AND CASING, STURTEVANT STEAM TURBINE.

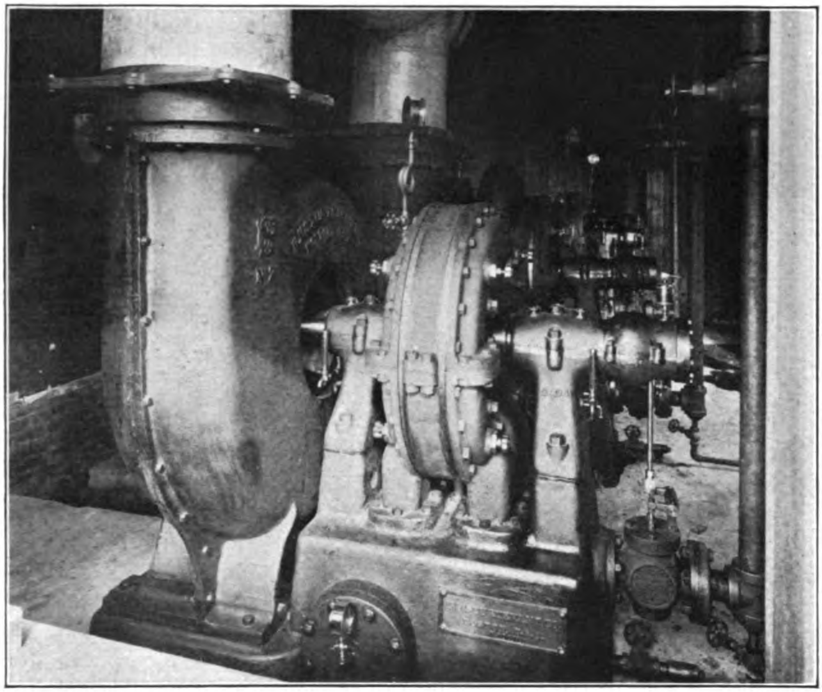
per second. For a 24-inch-diameter wheel, this would correspond to 1,900 revolutions per minute as the speed for the lowest steam consumption. It can be seen of course that this figure varies with the initial steam pressure and temperature as well as with the back pressure, and it should also be noted that the speed given is for the lowest possible steam consumption. When the speed is lowered, the horse power falls off proportionately; and since the amount of steam which passes through the turbine depends only on the pressure outside of the first nozzles and the back pressure, when the load is sufficient to keep the governor valve wide open, the amount of steam which flows through the turbine is constant as long as the initial steam and final exhaust pressures remain the same, irrespective of the speed at which the machine is running. This means that the steam consumption increases in inverse proportion to the speed at which the turbine is run.



STURTEVANT TWO-BEARING GENERATING SET.

Made in sizes from 3 to 75 kilowatts, especially for marine work and for service where space is limited.

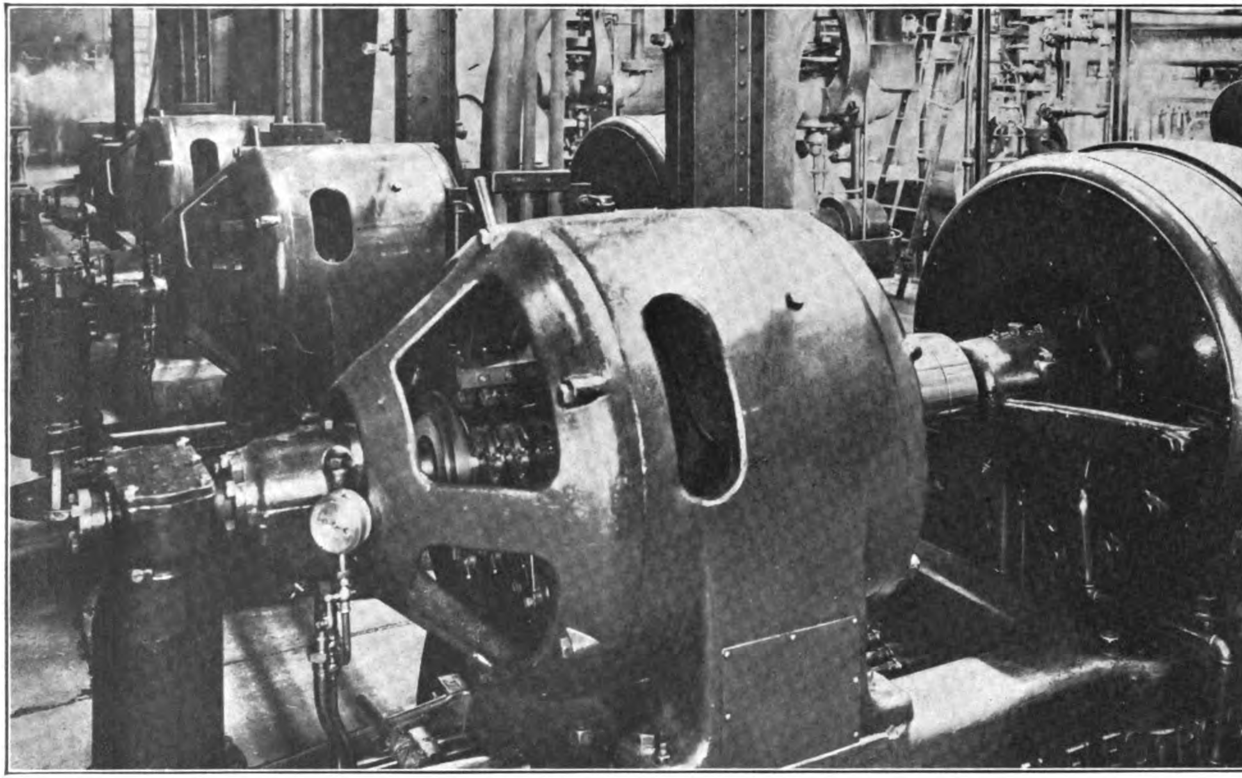
The Kerr turbine rotor consists of a series of wheels on the shaft, one wheel for each stage. The number of wheels which are necessary depends on the steam and exhaust pressure, the diameter of the wheels, and the number of revolutions per minute, at which the turbine is to run. These wheels or discs carrying the buckets are made from sheet steel and slotted around their circumference to receive the drop-forged steel buckets, which are each provided with a bulbed shank that slides into these slots on the discs and is then riveted over on both ends. The buckets are of the well-known Pelton type and are designed to give a complete reversal of the steam. The bucket wheels are each mounted upon a split hub and held in place by a cast-iron ring threaded into this hub, the hub itself being keyed to the shaft.



STURTEVANT TURBINE GAS BLOWERS, NORFOLK GAS COMPANY, NORFOLK, VA.

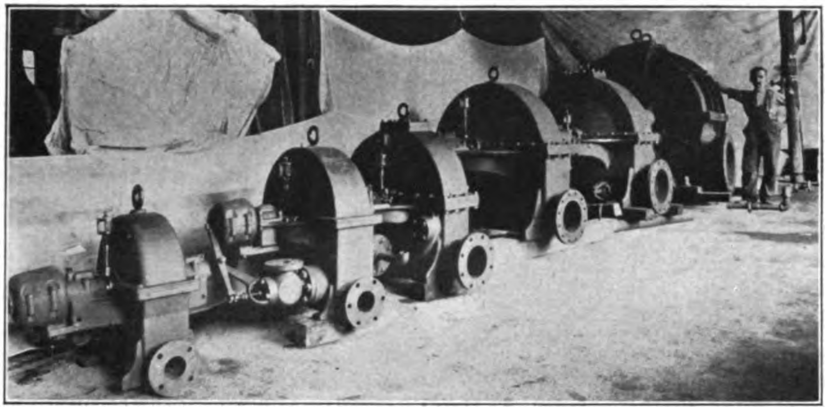
The governor is very similar to the one used on the De Laval turbine, but the governor valve and the system of levers which operate it are considerably different. The governor is located on the main shaft and acts directly on the governor valve through the medium of a rocker arm only. The valve is of the sliding-piston type, throttling the steam as the load demands. The centrifugal force of the governor weights is balanced by a spiral spring, and by varying the tension of this spring, the speed may be adjusted as desired.

Outside of the Kerr turbine and the De Laval, most of the other small turbines are developments of the Riedler-Stumpf turbine. This



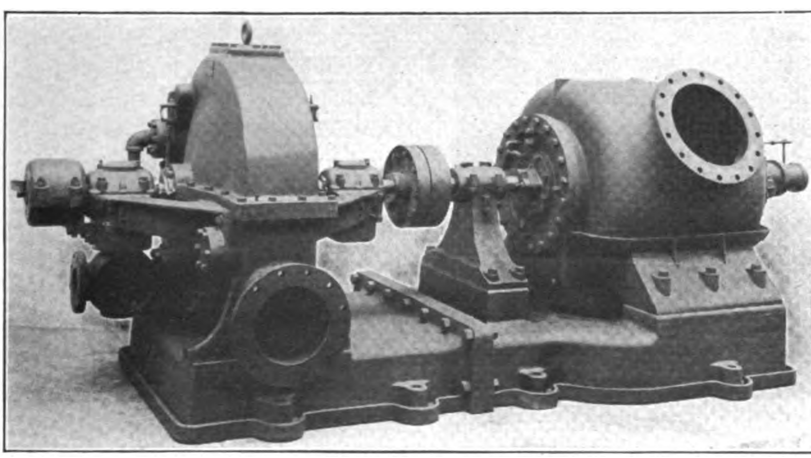
CURTIS STEAM TURBINES, INSTALLED FOR THE WEST JERSEY & SEASHORE R. R., WESTVILLE, N. J.

The turbines are coupled to 75-kilowatt 125-volt generators at 2,400 revolutions. The General Electric Co., Schenectady, N. Y.



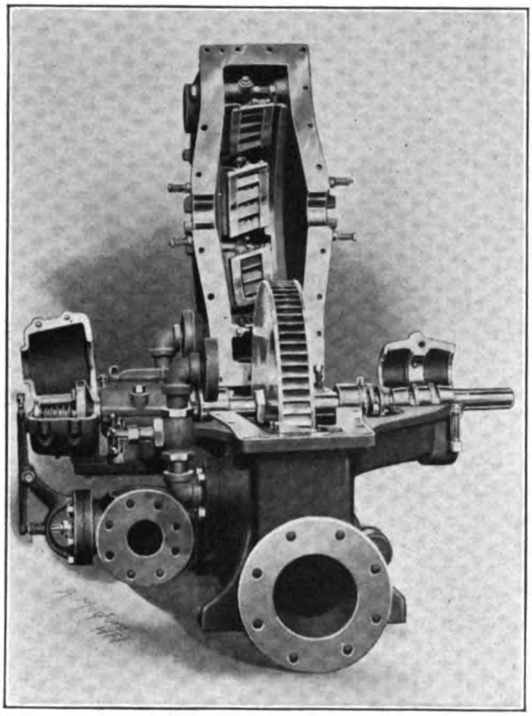
A ROW OF TERRY STEAM TURBINES, FROM 10 TO 600 HORSE POWER.

is a low-speed impulse machine, and in the fundamental principles of its operation does not differ to any great extent from the Kerr turbine. In the Kerr turbine, the steam is passed through a series of nozzles and a part of its energy of pressure is converted into velocity, leaving at the exit side of the nozzles in the first stage still considerable pressure, while the velocity of the jet is imparted to the wheel. From this pressure, the steam passes through another nozzle into the second stage and so on through all stages, so that the pressure is reduced from the initial pressure to the exhaust by as many successive steps as there are stages, and at each one of these steps the energy due



TERRY TURBINE-GENERATOR PUMPING UNIT.

Consists of a 150 horse-power turbine direct-connected to centrifugal pump; at 1,600 revolutions has a capacity of 9,500 gallons per minute against a lift of 40 feet.

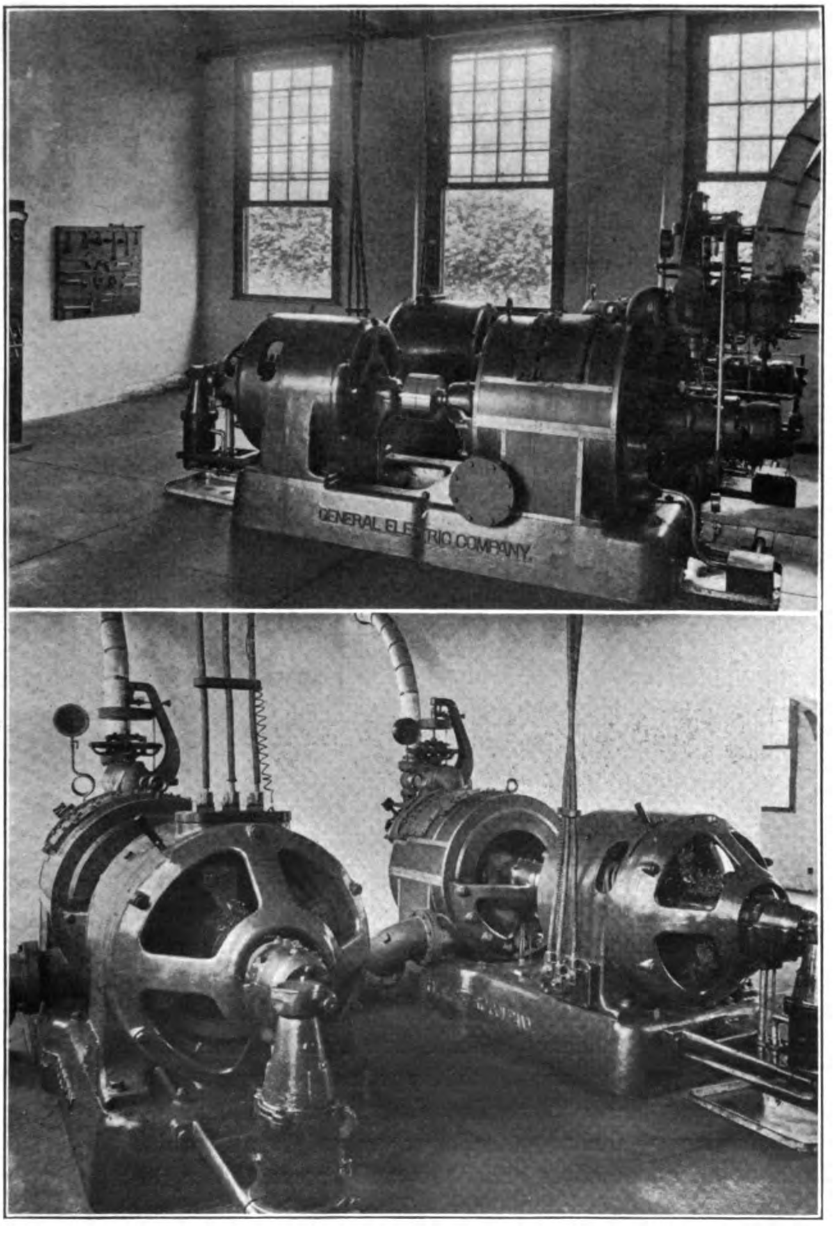


THE TERRY STEAM TURBINE WITH CASING OPENED.

The unit photographed is of 100 horse power. Terry Steam Turbine Co., Hartford, Conn.

to the loss in pressure is imparted as velocity to the wheel. The Riedler-Stumpf, on the other hand, passes the steam through only one series of nozzles, whence it impinges upon the buckets of the rotor, which are very similar to single Pelton buckets; and after exit from the buckets, it passes through guide passages and then strikes the same wheel again, and so on for several times. In practice, some of the machines are so designed that the whole pressure energy of the steam is converted into velocity in the nozzles, so that the pressure does not change in the guide passages, and others are so proportioned that the pressure falls in the guide passages so that they serve the purpose of nozzles. When built in this manner, the only difference of any account from the Kerr turbine is that the steam is used over and over on the same wheel in the Riedler-Stumpf, while the Kerr uses a separate wheel for each stage.

The most used machines of this type at the present time in this country are the Sturtevant and the Terry turbines. The Sturtevant turbine has one feature about it that is different from any other turbine, and if not of any great value is certainly unique. This is in the construction of the rotor, which is made out of one solid steel forging, with the buckets milled out of the solid metal. While this construction is no doubt stronger than that in which the blades are inserted, it is doubtful if the gain is worth the extra cost of this type of wheel. Among the small turbines, which we are considering, none has had the least trouble from buckets working loose or coming off.

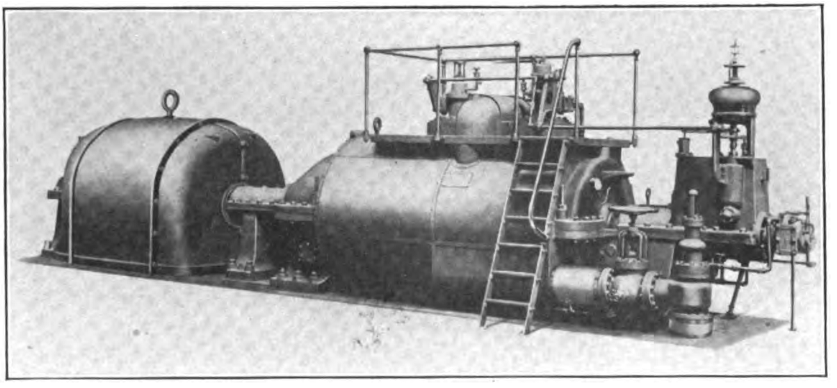


INSTALLATIONS OF CURTIS STEAM TURBINES IN SERVICE.

Both views are taken in the plant of the Ferracute Machine Co., Bridgeton, N. J. The turbo-generators are of 75 kilowatts, 2,400 revolutions, 250 volts.

The buckets in the Sturtevant turbine are generally milled on the two sides of the wheel with reversing guide passages on each side of it. The action of the steam is precisely the same as previously explained in the general Riedler-Stumpf type of turbine, of which this is a representative. The speed of this machine is governed by a centrifugal governor composed of three revolving weights, whose centrifugal force is opposed by a spiral spring which can be adjusted to regulate the speed at any fixed rate. The governor valve is a throttle valve actuated from the governor spindle by a rod and lever.

The Terry turbine on the whole is very similar to the Sturtevant and differs only in the details of its construction. The buckets are inserted on the wheel and held in place by keys riveted over at each end, so that they are practically as rigid and solid as if all in one piece. These buckets are placed on the face of the wheel instead of on the side, as in most of the Sturtevant turbines.



WESTINGHOUSE-PARSONS 300-KILOWATT TURBINE-GENERATOR UNIT.

There are several other turbines which have just entered or are about to enter the market. Most if not all of these machines are designed on the Riedler-Stumpf idea, like the Terry and the Sturtevant, and differ from each other principally in the details of construction. The Curtis turbine is used to some extent in the small sizes and differs from the larger machines of this type in the fact that it is horizontal, which necessitates constructive changes in the details, but on the whole it is very similar to the large vertical Curtis turbine which has been described so often and is so well-known that a description of the smaller unit is unnecessary. The Westinghouse turbine, which upon its advent in the American market some years ago gave a strong impetus to the development and use of this type of motor in place of reciprocating engines, as already stated, is built almost exclusively in units of larger size than are contemplated in this article.

THE USE AND CONSERVATION OF WATER POWER RESOURCES.

By H. Von Schon.

III. TYPICAL CASES AND DEFINITE PROGRAMMES FOR THEIR TREATMENT.

In two preceding articles on this subject the needs and effects of the conservation of the rivers' flood run-off were clearly set forth, not only as regards the influence upon the water-power resources, but also in relation to re-forestation, flood prevention and inland navigation; it was stated that the present available water power may be more than tripled by a storage programme the cost of which could readily be borne by this enhanced water-power asset while all the other benefits would come as collaterals without charge. Furthermore the author asserted that the conservation of water powers would be accompanied by the rapid development of the now unutilized opportunities to their fullest economical output capacity, and that all generated current would find ready employment, that every community might enjoy the advantages accruing from economical electric energy, that transportation by rail and inland navigation would be moved largely by electric energy, and that thus the problems of the future industrial development would find more radical solution than any other practical scheme can promise.

In this, the closing article of the series, endeavor will be made to substantiate these various propositions by analyzing some typical cases of rivers as to their present water power status and the development of the obtainable conditions and their influences, by a discussion of practical conservation programmes.

THE illustrations of typical, concrete conservation problems which I shall present in this article are chosen for the purpose of covering the extremes of hydraulic and industrial conditions; they would be classified as private, State and Federal conservation programmes, dealing with rivers in northern and southern States; the localities include those whose rail-transportation facilities are of the best, and those which have none—sections from which staples are drawn, and others where they are manufactured; finally, they cover river systems which may be best conserved by corporations in co-operation with the State, or by the State or the United States. All these include re-forestation, inland navigation and flood prevention, and the important collaterals of soil protection and water clarification. The facts as quoted in connection with these are taken from State and Federal records, as well as from data collected by me in the course of personal examination of power sites on the rivers presented.

Before entering upon the analysis of these typical rivers it may be pointed out that the major benefit of flood control will be experienced by water-power opportunities of low or medium head; the high-fall powers, not already developed, are, with few exceptions, found near the headwaters of streams where the contributing catchment area is not extensive and the benefits from flood control are correspondingly limited. Normal river slopes are one foot per mile and greater, and water powers may therefore be developed at intervals of fifteen to twenty miles—not, however, under the present conditions of uncontrolled flow, as these developments would be prohibitive in cost if not impracticable—but realizable with a conservation programme in existence. This will be clearly demonstrated in the case of one of the rivers to be discussed. In Europe many important water-power developments have been and are now being carried out with heads of six and four feet and at least one, on the Rhine, with a still lower fall.

It is furthermore interesting to note that a recent advance in transmission voltage, by the placing in service of a 110,000-volt line in Michigan, is a clear indication of the rapid elimination of distance as an obstacle to electric-current service. The Bay County line in California transmits current 208 miles with a voltage of 80,000; the Muskegon line above referred to employs a voltage 35 per cent greater which, correspondingly applied to distance, would make the coast line 280 miles long; and there is no doubt in my mind that the day is not distant when 200,000-volts and 500-miles transmission will be entirely practicable. That long-distance transmission however is available only for correspondingly large outputs goes without saying; but it is quite feasible to put the current outputs of a number of successive plants along the same river on one trunk transmission line so that the power developed from a considerable reach of a river may be transmitted over long distances. With the present price of copper, lines can be put up for $1,500 to $2,000 per mile, and with proper balancing of voltage and current the transmission investment need not exceed $25 per kilowatt delivered, making the annual charge due to transmission including interest, maintenance, depreciation and operation, about $5 per kilowatt, or less than two-tenths of a cent per kilowatt hour on 3,000-hour service.

The first river to be analyzed is in a northern State where flow fluctuations are of the smallest, speaking relatively of the rivers of the United States—a river which is entirely within the borders of one State, on which considerable power is developed; in fact, it would probably be correctly classed as one of the best developed power streams in the country. No navigation exists at present. This river belongs to that large class embracing the important tributaries of the Missouri and the upper Mississippi, of the Great Lakes drainage areas, and of many of the rivers of the New England States and of the North Atlantic Coast. This is a class of rivers which it might be thought could not be very greatly benefited by conservation of flow, since the flood run-off is not excessive, most of these rivers having their source in lakes and extensive swamps while their headwaters remain, in part, well forested. These rivers have served the lumbermen and the grist-mill operator in the past and they are now available for hydro-electric developments. The Wisconsin River belongs pre-eminently to this large class; its catchment area of 12,280 square miles lies in the State which is named after it. The total descent of the Wisconsin aggregates 1,046 feet in a length of 428 miles; its run-off is from 0.8 to 3.0 cubic second feet per square mile of drainage area. January, February and December are the low, April, May and June the high-flow months. Power development for continuous output may be based on an available flow of one cubic second foot per square mile of contributory catchment area.

The practical power sites, the fall which can be utilized at each, and the continuous power output in electrical horse power, based upon the aforesaid available flow, are given in Table 1, which is compiled from a recent report of the Wisconsin Geological and Natural History Survey, Mr. A. E. Bridge, Director.

TABLE 1. POWER DEVELOPMENT DATA OF THE WISCONSIN RIVER.

Site.	Fall.	Drainage area.	Horse power.	Developed.
Prairie du Sac	20	9,500	15,000	none
Kilbourn	17	8,400	11,500	8,000
Needah	10	7,000	5,600	none
Old Barnum	10	6,000	4,800	none
Neekoosa	75	5,800	34,000	12,000
Grand Rapids	25	5,700	11,500	7,500
Biron	12	5,650	5,200	3,000
Stevens Point	40	5,600	18,000	6,500
Battle Island	14	4,800	5,000	none
Mosinee	20	4,400	7,000	50
Rothchild	18	4,200	6,000	none
Wausau	25	3,500	7,000	1,800
Brokaw	45	3,300	11,500	4,000
Trapp Rapids	20	3,000	4,800	none
Merrill	20	2,900	4,500	3,200
Bill Cross Rapids	20	2,600	4,000	none
Grandfather Rapids	85	2,500	17,000	4,000
Grandmother Rapids	17	2,300	3,200	none
Tomahawk	15	2,100	2,500	2,000
Pine Creek Rapids	20	1,800	2,800	none
Whirlpool Rapids	28	1,300	2,900	none
Hat Rapids	20	1,200	2,000	1,400
Rhinelander	70	940	5,200	3,000
Rainbow Rapids	10	700	600	none
Otter Rapids	16	500	640	none
Total	672	....	192,240	56,450

The river's power capacity with unconserved flood run-off appears from this as 190,000 horse power, and there is considerable more on the tributaries. An exhaustive investigation of the reservoir possibilities on this river in connection with a programme relating to navigation on the Mississippi, was made by the United States Engineer Corps some years ago. Eight reservoir sites were located with an aggregate storage capacity of 20,000,000,000 cubic feet; these reservoirs have a contributory drainage area of 1,410 square miles, would fill (with a run-off of 1.25 cubic second feet) in about four months (March to June) and could furnish a continuous flow of 2,500 cubic second feet during the three low-flow months, December to February; by this the present power capacity of 190,000 horse power would be increased to 315,000 horse power. This increase of 125,000 horse power, with a charge of $10 per horse power, or $1,250,000 total, would pay the interest, at 5 per cent, on an investment for storage reservoirs of $25,000,000. A higher charge could be paid by it, since the increase of cost to realize this additional output would be only that due to the additional generating equipment and perhaps a larger power station. The cost of the dam would be the same as for the smaller flow, while that of works now required to control the flood volume, such as waste ways, gates, etc., would be reduced. The conservation programme would practically eliminate all floods on the river, and the complete development of the enumerated powers would make the Wisconsin a navigable river, which it is not at present.

The market for all the electric power which can be developed, the 315,000 horse power, is in the river valley at Prairie du Chien, Prairie du Sac, Sauk City, Madison, Baraboo, Portage Mauston, New Lisbon, Needa, Grand Rapids, Stevens Point, Mosinee, Wausau, Merrill, Tomahawk and Rhinelander; for the operating of the Wisconsin Central, the Chicago, Milwaukee & St. Paul, and the Chicago & Western Railroads on their lines paralleling the river; and for barge haulage on the river, as the bulk of the manufactured products could be thus transported down the Wisconsin into the Mississippi.

The Wisconsin is the first of the important American power rivers on which proper steps have been taken to bring about the control of the flow by a flood run-off conservation programme. The Federal Government investigated this subject, as has been stated, years ago—not, however, for the purpose of conserving the water-power resources nor for the creating of navigation on the Wisconsin, but as one of the factors in connection with navigation on the Mississippi.

This investigation was extended to several of the important Mississippi tributaries and a number of reservoirs were constructed on the upper Mississippi and have been in operation for a number of years. The State of Wisconsin is prevented constitutionally from entering upon any such undertaking as the creating of storage reservoirs, but the owners of some of the most important power sites recognized the value of conservation years ago, and pooled their interests in this direction for the purpose of securing legislative authorization to acquire storage sites, construct and operate reservoirs, and collect toll from the beneficiaries of such a programme; and after several fruitless attempts, they finally succeeded last year in securing the passage of a statute incorporating the Wisconsin Valley Improvement Company, with authority to exercise the power of eminent domain for the acquiring of necessary lands, and to collect tolls from water powers. The company is to operate under the supervision of a State Commission, and the State reserves the right to take over the company's works at a stated valuation whenever constitutionally authorized to do so. The capital stock of the company was allotted to the owners of water powers in ratio of the power capacities controlled by them, 790 shares out of the total 1,000 being thus distributed between twenty-five power owners. This is the programme generally outlined in my former articles, with the, to me, recommendable addition of a tax upon all the powers, whether developed or not, thereby securing the prompt development of all, preventing the withdrawal of this valuable public power resource from the market, and thus making the cost to the consumer the lowest practicable; and finally the river is rendered navigable without any serious additional expenditures on the part of the Federal Government. This example of a practically accomplished conservation undertaking will serve as a model applying to a large number of other rivers in the United States where it is equally practicable and would be effective. The people of any State in the Union would readily recognize the immense benefits to be derived by them from such a programme and their legislatures would or should be ready to emulate the statesmen of Wisconsin. Furthermore, this programme possesses the elements of an attractive financial investment and, where justifiable by probable results, none should have to seek long for the needed support. To enumerate the rivers which are capable of a conservation treatment like that planned for the Wisconsin would make a long list; some represent returns not quite as promising, others better.

The second typical case to be presented is of one of the southern rivers of that large class which has been made navigable by the Federal Government by the construction of successive dams and locks, but on which little water power is now developed because the available sites are under Government control, while the flow fluctuations are of such extremes that, even with a liberal policy on the part of the War Department in granting permits and leases for power development, these do not now represent attractive ventures. Navigation itself is uncertain, as in low-flow seasons the proposed channel depth cannot be maintained, while the annual flood damages run into many millions. The floods of last August are still fresh in the memory of the readers.

The Kentucky River's catchment area of 6,900 square miles lies entirely in the State of Kentucky; the river's fall is some 1,089 feet, its length 380 miles. The run-off is well-known from gauge readings at Government dams for a long period of years; it ranges from 0.05 for the minimum to 3 second feet and higher for the flood flow. The monthly mean run-off during the year 1905, as measured by me at the Government dam at Valley View, near the center of the catchment area, was as per Table 2:

January	0.20	cubic feet per second per square mile.
February	0.25	" " " " " " "
March	1.70	" " " " " " "
April	1.30	" " " " " " "
May	1.00	" " " " " " "
June	0.50	" " " " " " "
July	0.25	" " " " " " "
August	0.20	" " " " " " "
September	0.15	" " " " " " "
October	0.15	" " " " " " "
November	0.25	" " " " " " "
December	0.60	" " " " " " "

This was a normal precipitation year.

The Government is carrying out a programme to create slack-water navigation as far up the river as the Three Forks, which is a distance of 260 miles; this requires fifteen locks and dams; twelve are now in commission, and the others will be in a couple of years. The location of each of these dams, the area of the contributing drainage, and the power capacity in electric horse power represented at each of these, based upon a continuously available flow of 0.2 of a second foot, are given in Table 3.

There is some 800 feet more fall on the branches above the head of navigation. The only water power now developed is of some 70 horse power at Frankfort.

Location.	Fall, in feet.	Drainage area. Sq. miles.	Power capacity. Electrical horse power.
1, Carrollton	16	6,840	1,760
2, Lockport	14	6,075	1,360
3, Gest	13	5,960	1,240
4, Frankfort	14	5,350	1,200
5, Tyrone	14	5,230	1,160
6, Warwick	14	5,170	1,150
7, High Bridge	15.5	5,100	1,340
8, Little Hickman	18	4,620	1,320
9, Valley View	18	4,210	1,200
10, Ford	17	4,110	1,180
11, College Hill	18	3,330	960
12, Wagersville	18	2,880	820
13, ...	18	2,620	760
14, ...	18	2,500	720
Totals..................	225.5	.....	16,170

I have made designs for developments at several of the sites and, generally speaking, have found the opportunities good for low development cost; but the annual flood stages, sometimes three per year, go to such extreme heights that then no working head remains, and these periods frequently are of ten days and longer. A considerable portion of this flood run-off could be economically stored; in fact, it appears likely that reservoir sites are available in which the flood flow of the headwaters catchment basin of some 2,000 square miles could thus be stored to the extent of 16,000,000,000 cubic feet and more. These reservoir sites are in the lower valleys of the chief tributaries or forks; the slope of these is quite flat toward their outflow into the main river and the lower ends of the valleys contracted, affording short dam sites on rock ledges. These reservoir sites may aggregate a storage area of some 15 square miles, with a mean storage depth of 40 feet; the storage volume could be accumulated from a run-off of one second foot during a period aggregating three months and, if distributed during the six low-flow months, the natural flow could be enhanced by about 1,000 second feet, and this increase for the fall at the fourteen dams would represent a power, in addition to that quoted, of 18,000 horse, or practically a total power capacity for the river of 35,000 horse power. The flood rises would be so diminshed that a working head would be available at all times. The navigation programme which is now being completed by the Government aims to secure a channel depth of 5.5 feet, but this is not realized during the very low months when the depth is frequently reduced, over certain reaches, to 2.5 feet; its maintenance requirs a constant and considerable expenditure for the dredging of bars and shoals deposited by the floods. The navigation works have cost $3,000,000, and will require to complete them, $1,700,000. Operating and maintenance of works aggregates to date $1,250,000, or practically a total of $6,000,000. The annual cost of dredging is about $30,000.

This important investment has not as yet had any appreciable effect on freight rates, and therefore on the encouragement of water transportation, the annual tonnage being now less than 300,000. The adding from storage of a flow of 1,000 second feet during the low stage months would create all-year navigation for 1,000-ton barges, and then the Kentucky would become one of the busiest inland waterways in the South.

And what of the cost of securing this certainly much to be desired condition, making 35,000 horse power of electric energy available to supply one of the best current markets in the South—to render this river navigable, in fact? The land for the reservoirs, some 10,000 acres, might cost $100,000, the dam need not exceed 100 feet in height, and, while my data are not conclusive, I believe they can be constructed for $4,000,000 or less; maintenance and operation might run to $25,000 anually; 5 per cent. interest on the investment of $4,100,000 would be $205,000; operation and maintenance, $25,000. This makes the annual charges against the reservoir system $230,000. If taxed entirely to the water-power resources of some 35,000 horse power, it would amount to $6.60 per horse power.

Is there any question that this is a good investment for the Government to create this storage system and lease the power privileges? Or for a private corporation to secure the necessary authority from the State and from the United States, similar to that vested in the Wisconsin River Valley Improvement Company? Can the power be sold remuneratively? Frankfort, Lexington, Richmond, Paris, Winchester, Versailles, Shelbyville, Carrollton, Nicholasville, and other smaller towns in the rich "Blue Grass" region; the coal mines, barge haulage, and the fast growing electric-railroad net in that section—these will consume more than the output quoted, and if there is any left, the focus of this power field is only 135 miles from Louisville and 150 miles from Cincinnati, and there is some 30,000 horse power available from another stream not so distant from the Kentucky but that it can be taken into a trunk transmission line for these large centers.

Will it pay the Government to stop the annual dredging expense, to collect a handsome revenue from the power privileges, to operate the locks electrically instead of erecting and operating steam plants for this purpose as is now being done at several of the Government lock sites? Will it pay to diminish, if not eliminate, the constantly recurring floods and the dangers to the Government navigation works, which are constantly threatened by them? Two years ago one of these floods on the Kentucky River washed out the abutments on two of the new dams which had just been accepted by the Government from the contractors, and the required repairs amounted to a considerable sum. But the case, it seems to me, has been sufficiently made out. There are quite a number of rivers in this class; Table 4 gives a partial list of Government Locks and Dams with respective falls:

River.	State.	Number of Government Dams.	Aggregate Fall.
Allegheny	Penn.	3	30 feet
Barren	Ky.	1	15 "
Big Sandy	Ky.	3	46 "
Black Warrior	Ala.	11	112 "
Columbia	Ore.	1	20 "
Coosa	La.	5	46 "
Cumberland	Tenn.	8	90 "
Illinois and Mississippi	Ill.	29	274 "
Kanawha	W. Va.	11	100 "
Muskingum	Ohio	10	115 "
Ohio	Pa., Va. and Ky.	10	80 "
Ouachita	La. and Ark.	2	26 "
Rough	Ky.	1	9 "
Tennessee	Tenn.	12	136 "
Upper White	Ark.	2	28 "
Wabash	Ill.	1	11.5 "
Total		110	1,138 feet

It is not claimed that the programme suggested as feasible in connection with the Kentucky River applies to all of these, nor is it positively known that it would not. Here are 110 dams built and maintained by the nation, representing a large amount of available water power; it is submitted that the possibilities of rendering that power available for industrial purposes should be fully exploited by the National Government, because it is in control and most vitally interested. If these investigations show the feasibility, then capital will not be lacking to improve the opportunities.

In conclusion of this series the author submits the following general outline of a programme which it appears may realize conservation of our now wasting water-power resources:

First. Examinations of storage possibilities; these should be made by the Federal Government or States, as the river is interstate, navigable, or not. Such examinations would be carried on by preliminary methods, reconnaissance, flying levels, and stadia compass surveys; these can be executed economically; level lines at $4.00, topography $5.00, and mapping $1.00 per mile, is the cost record of a recently carried out State survey for the same purpose in Wisconsin. Where the river is entirely in the one State and not navigable these examinations are logically a State project; when the river passes through several States they should act jointly or co-operate with the Federal departments. Navigable rivers are pre-eminently National subjects of this kind. Much of the required information has already been secured in connection with the surveys for the original navigation programme; the available power sites are occupied by the locks and dams and therefore have been surveyed in detail—in fact, this is chiefly a work of compilation, this exploitation of the feasibility of power conservation on rivers occupied by Government locks and dams, probably supplemented by some reconnaissance work to locate the reservoir sites. The Government has all the necessary force and equipment to carry on this work, in several different survey departments, and some of both could no doubt be utilized for this purpose without seriously impeding or interfering with the current duties of these organizations.

Second. Publication of the collected storage and power data by the States and the United States, for the purpose of bringing them to the attention of private enterprise and capital, having the storage works constructed and the powers developed in accordance with the most efficient methods and with plans approved and under the supervision of the State or the United States.

Third. Chartering organizations by State and Federal legislation to create reservoir systems, vesting in them the power of eminent domain for reservoir and flowage areas, and giving them authority to collect toll from all available water powers of a minimum head.

Fourth. Chartering corporations by State legislation to develop the water powers and market the current, vesting in these the power of eminent domain to cover development sites, pondage areas, and transmission-line right of way, and regulating and supervising the development programme and methods and the current prices.

Fifth. Completing the navigability on the river, the National Government appropriating the funds required for the construction of the locks, the dams being erected by the development concerns, regulating the use of the water and the price of the current to be supplied to the Government for the operation of locks, and for electric barge haulage; navigation of the river to be toll free.

Is all or any of this practical? This will only be determined by writing and talking and thinking about it a good deal.

WAYS AND MEANS OF PRODUCING WORK IN THE MACHINE SHOP.

By W. Burns.

Mr. Burns, while voluntarily assuming the position of an outsider looking through the machine shop, yet directs a line of inquiry which might advantageously be followed by a careful owner or manager seeking the improvement of his own plant. The less familiar line of approach—interrogatory rather than didactic—may make this analysis of shop conditions contributing to efficiency more than ordinarily suggestive.—The Editors.

WHEN we go into a strange shop or one engaged on a different class of work from that with which we are familiar, we insensibly make comparison between the shops we have hitherto known, and the one under observation. If it is a large shop and crowded with machines and plant it may take us some little time to itemize the whole equipment, and so get a basis for comparison. But when we have done this and placed the details side by side with the details of the other shops, we are enabled to see clearly the relative economic value of the two plants. If we find that the machinery employed on the different processes is essentially the same as in the other shops, we note this point, and turn our attention to the manner in which it is arranged with reference to the sequence of operations, the tools employed on each machine, and the manner in which power is supplied. Then, leaving the plant we examine the means by which the machines are operated; the personnel of the shop. Taking these points, the machines, tools used, their arrangement, manner of driving, auxiliary plant, and labour, let us go into some details.

The machines; are they of the latest and most approved design for the class of work done on them? Is there enough work of the same class to warrant the use or introduction of special machines for its accomplishment, or is work being done on general machines, when by a small alteration in design it could be more profitably operated on by a special machine? The machines may not be of the latest design, but still too good to be put out of action; have any steps been taken to adapt them, and the work to be done on them, so that it shall be produced as efficiently as possible, or is the work put through the machines without regard for economies? Are there a large number of machines of the same type employed, each finishing complete a piece of work, instead of two or more machines performing a limited number of operations on the same piece of work, and to better advantage? What class of machines is employed; are they of the best obtainable, equipped with time and labour-saving devices, and of the finest and best wearing materials, or are they the cheapest obtainable machines of their class, bought without much regard to their work-producing and upkeep value? What course has been followed in getting the different machines in the shop; when the manager or foreman has advised the purchase of a new machine, has the employer or purchasing agent gone out and bought a machine of the type and size asked for; what reasons influenced his choice; did he buy a machine by this maker because his name was well-known as a builder of first-class machines, or did he purchase it of the other man, as he quoted the lowest price? What did the man who wanted the machine say when he got a machine of the same name and size as he had asked for, but not at all the class of machine he required, or the one best suited to his work; or was he allowed to go and select his machine without regard to initial cost?

What machines have been discarded and placed in the scrap pile in the yard; how long have they been in use; were they displaced because they were worn out, and it would cost more to repair them than to buy a new machine; or, were they thrown out of action because some big improvement in the same type of machine, or some other new type of machine, now made it impracticable to operate the older machine at a profit?

Tools; what practise prevails in this connection? Is the high-speed steel chosen on account of its price per pound, or is the best selected by a comparative trial of the leading brands of steel? How is it used; are the tools issued ready for use from a central tool room, and when worn down returned to be re-dressed and ground? Are tool holders used, so that steel of light section may be employed instead of the common-sized machine tool, and a large amount of tool dressing obviated? Are multiple cutting tools used wherever practicable, and are formed and built up tools and cutters used to finish work?

Boring bars and cutters; do we notice that they are fitted with standard-sized roughing and finishing cutters, hardened and ground, or is a piece of steel of suitable section wedged or held approximately in position by a set screw, and adjusted by taps with a hammer?

Is the work machined to gauges, or does the practise of taking the size from a graduated scale, and machining the corresponding piece to suit, still prevail? Are all mandrels standard sizes hardened and ground, or has a mandrel to be turned up afresh every time it is wanted?

The arrangement and driving of machines; does the work in process of manufacture progress steadily in one direction, entering in the rough state at one end of the department and emerging finished at the other; are the machines arranged so that the work requires a minimum of handling, machines of the same class being grouped together, the heavy tools arranged in proper sequence and the light tools in suitable groups? Is all the power furnished to a central line shaft, and are the machines placed in rows parallel to this shaft, being driven therefrom?

Is the group system of driving adopted, each group having a short line shaft driven by a separate electric motor, and some of the heavier tools being provided with an individual motor drive?

Auxiliary plant; what is provided in this line? Are the machines placed on a good, solid wood or cement floor? Are there facilities for the catching and removal of cuttings? How is the work handled; are there suitable bogies or boxes which can be easily and quickly moved from the one group to the other, holding many light pieces of work? Are there light overhead jib cranes or runways provided with quick lifting tackle, over the heavier machines, and delivering the finished work direct into the erecting department? Are the heavier tools placed so as to be easily accessible to the overhead traveller and at the same time allow a clear floor space for the erection of work?

Labour; what class of men should be employed on the work—will it pay better to employ skilled men and turn out first-class work, or less skilled men and a lower grade of work, or is the work of such a type that we can employ skilled men to make special tools to be used by unskilled men?

Suppose that we direct our attention to a lathe, one of a group driven from a short line shaft, the shaft motor-driven. We have already gone round the shop and have some idea of the relation in which this machine stands to the rest of the equipment. A shaft is being turned; it seems to be the same as this lot of five lying in front of the machine, two of which are finished. The lathe is on single speed and the machine man devotes his attention to keeping his centers from firing up and sizing the shaft; the feed seems to be coarse and he has not much time to stand. On examining the shafts beside the machine we observe that they are left rough-turned, the shoulders and fillets only being finished; this means that they will be ground to size on the grinding machine we observed in another group. This lathe is not a modern machine; it is fitted with a gap piece, is screw-cutting, and is supplied with driver, face plate, and chuck. The shafts are not very heavy, and there being but little material to be taken off, the performance of this machine on this piece of work seems to compare very favourably with some of the modern machines. These shafts could probably be machined in a shorter time on a hollow-spindle turret lathe, but there is not enough work to keep one running constantly.

In a larger shop having a big output of work this lathe would perhaps be kept going with work of which there was only one or two pieces at a time, and these not readily handled on a standard machine; or, if there was not enough work of this class and the machine was somewhat worn and requiring adjustment and repair, it might be put out of action, being replaced by a modern machine which might be either a centre lathe and screw-cutting or a chuck lathe, with hollow spindle and turret rest, depending on which fitted in best with the rest of the equipment.

Here is a heavy chuck-lathe; we note that the spindle is hollow, the chuck heavy with wide range of speed, the bed is short, the carriage and turret heavy and fitted with automatic stops. There is not much duplicate work beside this machine, but it is fairly heavy and within range of the chuck; the automatic stops will not be of much use, but the turret carrying five tool holders will save much changing of tools. Alongside we observe some heavy boring bars and sockets, not in use at present, but which will fit into the turret when there is boring to be done. There are also some jig plates having turned projections to fit the hole in the chuck and recessed on the outside to fit some spigot; these will insure accuracy when doing duplicate work which has to be turned on both sides. A vertical boring mill could probably handle some of this work to better advantage.

There is no overhead or jib crane to serve this lathe, a chain block hung from the beams overhead sufficing; this means when putting in or taking out a job that the turner is steadying the work as it slides over the edge of the lathe while the labourer supplies the motive power. Contrast this with a vertical boring mill placed under an overhead traveller; the chuck set ready for the work, the job is slung and dropped into place, leaving the slinger and crane free for other work.

This planer is a fairly heavy machine, two tool boxes on cross rail and one at side of table moving vertically on upright. It is motor-driven, and placed under the overhead crane. There is a fair sized casting on the table and both tools are cutting; the speed and depth of cut seem to indicate high-speed steel. A box tool holder with two or three tools might make a little better time on the work; there is one lying beside the machine, but it does not seem to be much used. There is no cushioning of the table on this machine and a heavy stress is thrown on belts and motor at each reverse.

This small planer has only one tool holder and to traverse this piece of work will take some time; as this is a small piece one compares the performance with that of a milling machine with face mill taking all the width at one cut, the setting taking practically the same time as on the plane. Where there is a large piece of work to be done the planer will show to better advantage, as the initial cost of a milling machine with its equipment of cutters large enough to handle the range of work is greater; where duplicate work is being done in quantity, the heavy milling machine with vertical spindles and face cutters, or horizontal spindle and ordinary cutters, will machine much more quickly, especially if formed or checked work is being done, when a gang of cutters could be used.

The tendency is to multiply the number of cutting points at work and so to economise time; this is very noticeable in the milling-machine processes where every available surface is being operated on at the same instant, in very many cases special jigs and fixtures being made to hold the work so that every surface in the same plane may be machined at one operation.

On hollow-spindle turret lathes forming pieces from the solid bar, and also on some chuck work, turning and boring operations proceed at the same instant, and with automatic machines the filling of the magazine, or the putting in a length of rod, is all the attention that is necessary. The grinding wheel also by means of its thousands of cutting points, each removing a grain of metal at a very high speed, makes practicable the rapid finishing of work and to very fine limits.

THE USE AND PERFORMANCE OF BELT CONVEYORS.

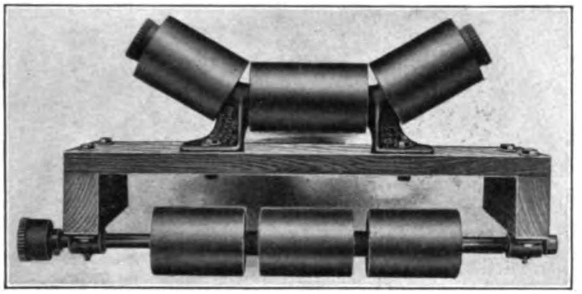
By Werner Boecklin.

Mr. Boecklin's article is noteworthy for the thoroughly practical manner in which he treats the questions of mechanical construction, of care and upkeep, and of economy in operation which are often obscure to users of belt conveyors. It is a useful summary of general working principles and a guide to recognition of the larger problems in which the assistance of the specialist must be obtained.—The Editors.

ECONOMICAL operation is the goal at which the present-day manager must aim. As a result of the necessity and desire to minimize the cost of manufacture, machinery for handling materials economically has received a full share of attention from designers, manufacturers, and users.

As a transporting apparatus the belt conveyor is not new. Before its modern extensive use in all classes of industries it was confined to the transportation of grains in grain elevators. There, as an endless woven cotton band, it was run flat over the simplest of wood pulleys, or idlers. Although the belt conveyor in the evolution from its primal form to the present condition underwent certain modifications, these were more in the nature of changes in detail than in principle.

The original belt conveyor consisted of a very wide belt running on straight idlers and carrying a small amount of material distributed along the middle. As a means of increasing the capacity and preventing spill, by tilting the edges of the belt, the "concentrator," which is a bell-shaped pulley placed at either end of the straight idler, was early applied. This step was a leader to the modern troughed belt, obtained by using a "troughing idler." An important result was accomplished when the troughing idler was invented and placed in service. The capacity of the conveyor was increased without increasing the width of the belt. A troughed belt will carry from two to three times the amount carried by a flat one of the same width. The continuous troughing of the belt, resulting from the use of such idlers, made a higher efficiency possible and one which could not be realized in the old types. Mistakes were made in the early designs of the troughing idlers due to the manufacturer's desire to get more out of the belt than it was capable of giving. A belt having its outer edges

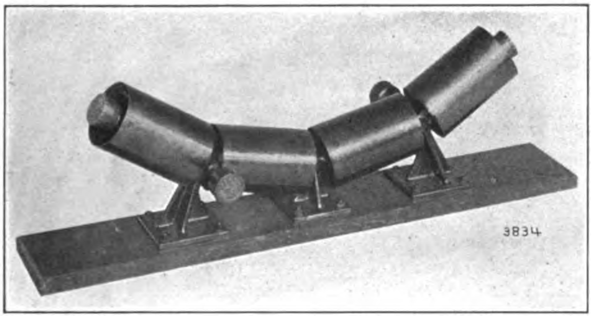


IDLERS FOR BELT CONVEYOR.

All three pulleys are in the same vertical plane, and are centrally lubricated by grease. The shaft is fixed and the pulleys turn. Robins Conveying Belt Co.

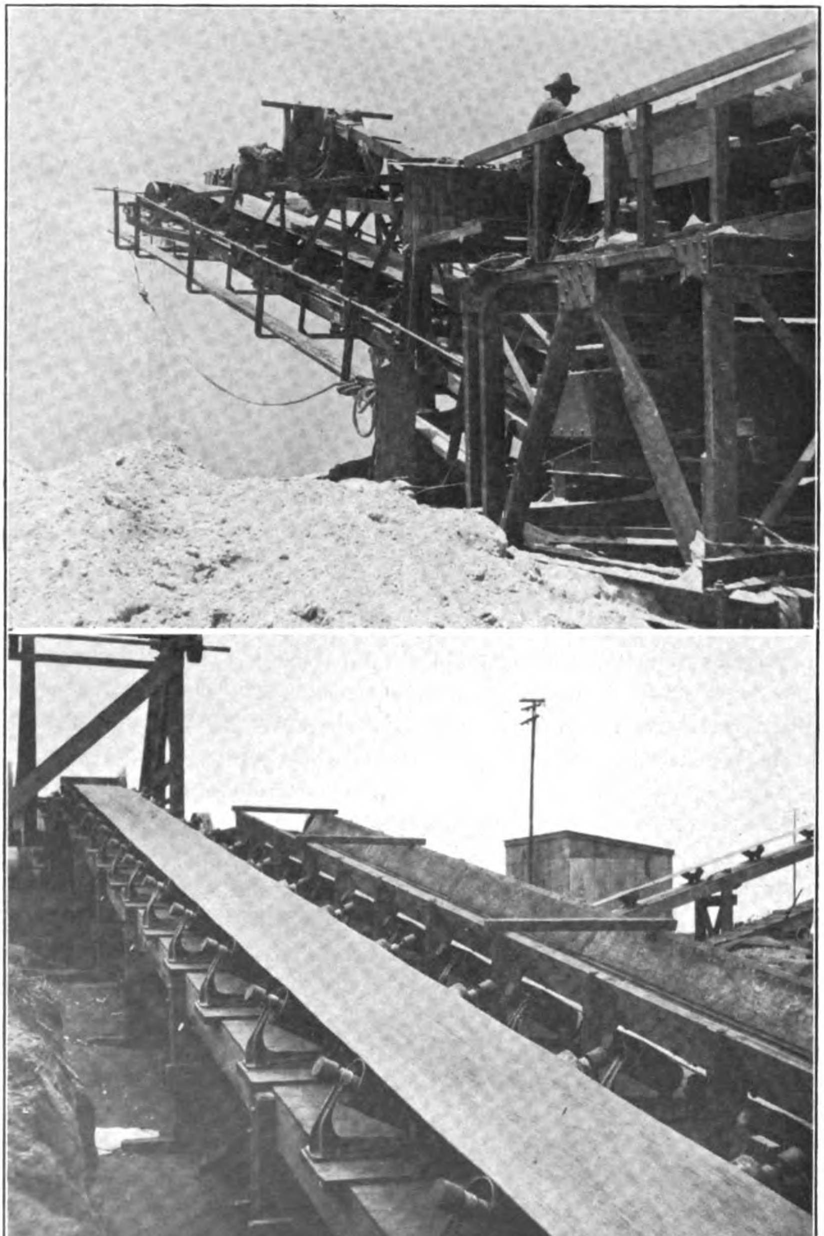
tilted to an angle of 45 degrees, the early designers calculated would give more of a trough and hence a greater capacity than one having inclinations of 30 degrees. The first idlers were built with side pulleys at an inclination of 45 degrees, but experience has demonstrated this to be excessive; 35 degrees was standard for a long time, then 30 and 25 were tried and found to give even better results.

There are two general classes of belts used for conveyor purposes, viz, cotton and rubber (so called). Cotton belt consists of 4, 5, 6, 7 or more plies of duck, stitched together and soaked in various oil preparations to make it waterproof and increase its life. Rubber conveying belts are made up of 4, 5, 6, 7 or more plies of cotton duck bound together by a suitable mixture known in the trade as "friction," and having on one side an extra thickness of rubber forming a wearing surface. Care must be exercised in the manufacture of such belting to prevent over-vulcanization of the covering, which should be soft, tough and pliable. The usual thickness of such wearing coat is 1/8 inch, but 3/16 inch and 1/4 inch are called for in some specifications, depending upon the nature of the material to be handled. Patent belts include certain rubber belts in which changes are made in arrangement of plies and rubber as compared with the ordi-



FOUR-ROLL TYPE LINK BELT COMPANY BELT CONVEYOR FOR LARGE CAPACITY.

Designed to secure relatively deep troughing without sharp bends.

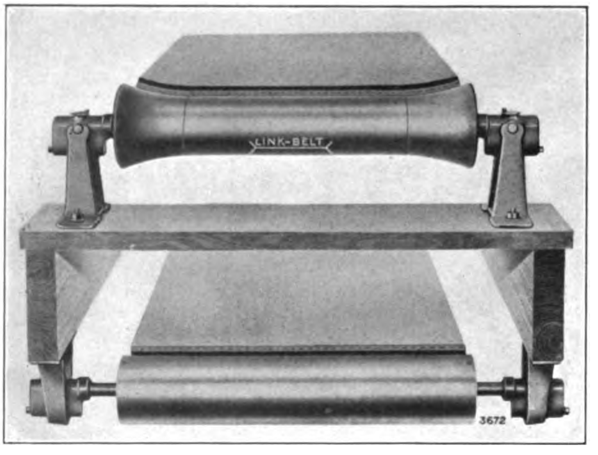


CONVEYORS FOR MILL TAILINGS AND REFUSE FROM CYANIDE TANKS.

Part of the Knights' Deep and Simmer & Jack East plant. The upper view shows the movable tailings stacker at top of the dump. Jeffrey Manufacturing Co.

nary rubber belt. In one well-known make the middle portions of some of the plies are omitted and the section thus left is filled with the rubber covering, giving an extra reinforcement to this part of the belt. In another patent belt some plies are left out along the bending lines imposed by the troughing idlers, giving the belt greater flexibility at these points.

Different theories are responsible for the two designs. In the case of the first, it is argued that as most of the material is delivered to and carried by the middle portion of the belt, hence this part should have additional reinforcement to withstand the greater wear put upon it. In case of the second, the inventor claims that belts deteriorate more from the effect of bending, with a resulting separation of the plies, and his remedy is therefore to give more flexibility to the belt at the points where it is most needed. Many belts, however, may be found which wear out neither at the center nor along the bend lines, proving that the theories are by no means universally applicable. The rubber covering is often worn down to the cotton along the outer thirds of the belt, the balance remaining in good condition, showing either wrong method of loading or the use of guide idlers or both. It may be stated however that the transverse flexibility secured in the patent belts cause them to hug the central pulley more closely, thus reducing the tendency to run off sideways and doing away with the guide and steering idlers.

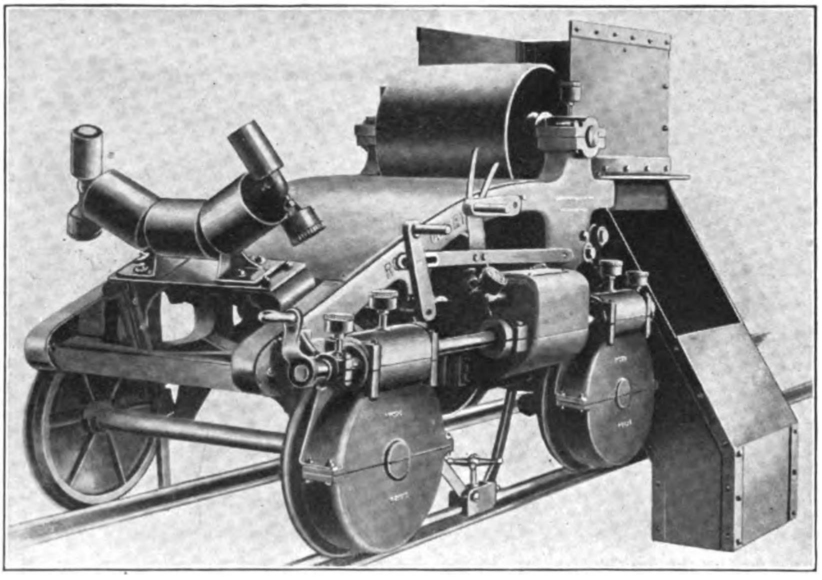


PRESSED-STEEL TROUGHING AND RETURN ROLLS FOR CONVEYOR BELT.

The bell-shaped end sections are flanged on their inner edges so as to overlap the center part snugly. The ends are closed to prevent entry of material. The straight center is designed to act as a one-piece carrying roll, eliminating troughing strain. The Link Belt Co.

Of troughing idlers there are two general types, the straight-line and the offset, and the details for each are various. In the former all pulleys forming the idler have their axes in the same vertical plane;

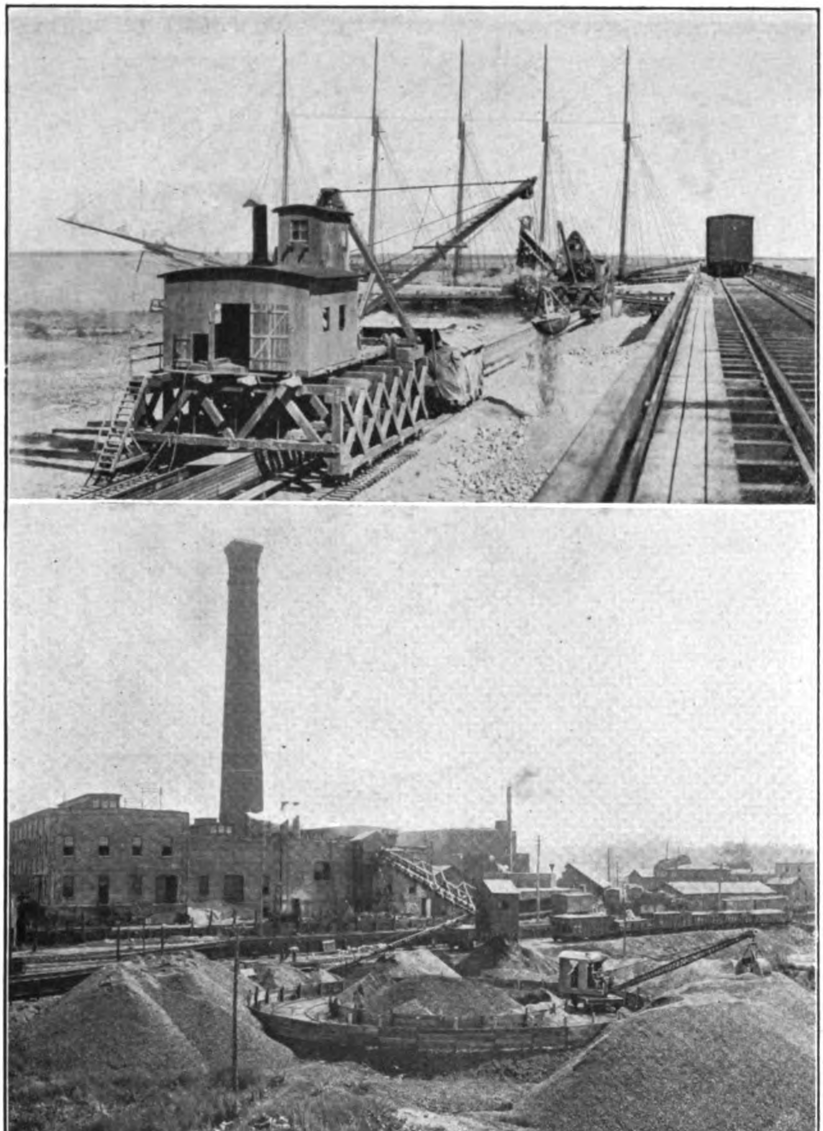
in the latter the horizontal pulleys are not in the same vertical plane with the inclined or troughing pulleys. Hollow shafts are largely used on which the pulleys run loose, the shafts or tubes being filled with grease which is forced through holes drilled in the shafts by means of compression grease cups. With a solid shaft, self-oiling bearings or ordinary bushed bearings with suitable oiling devices are extensively used. A good design of graphite bearing would be found satisfactory in many localities, and friction may be still further reduced by the use of ball bearings as manufactured by one company for belt-conveyor purposes.



TRIPPER FOR BELT CONVEYOR.
Automatically reversing, or may be clamped to the track. Robins Conveying Belt Co.

Troughing idlers are spaced about 3½ feet centers in case of large conveyors to 6 feet centers for the smaller ones. The return idlers may be spaced 10, 12, or even 15 feet apart, depending upon local conditions. Guide idlers are small pulleys with their stands placed at intervals along the conveyor to prevent the skidding of the belt sideways.

Trippers, which are designed to discharge the load at any convenient point along the length of the conveyor, are of two types, stationary and movable; the latter may be either hand-propelled or self-propelling. The essential parts consist of two pulleys placed approximately one above the other with their shafts running in suitable

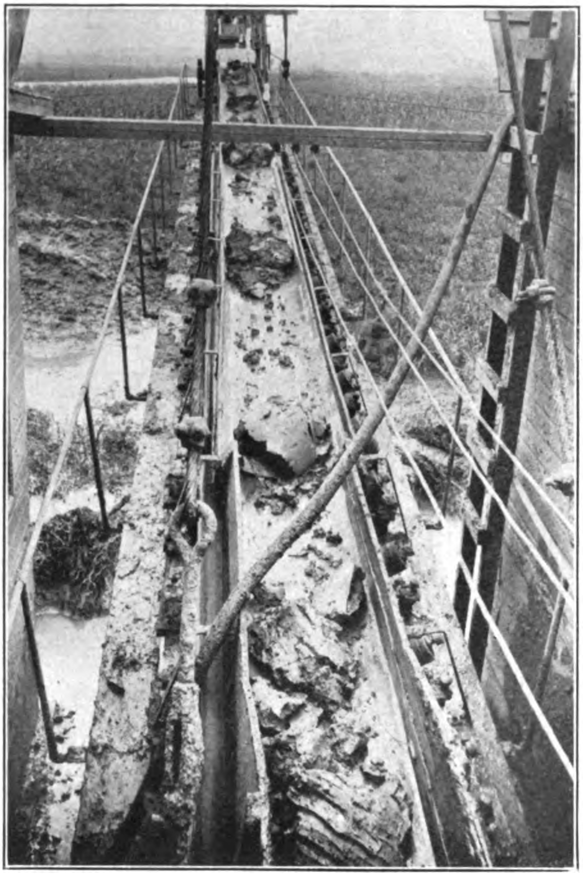


HANDLING MATERIALS WITH HAYWARD BUCKET AND ROBINS CONVEYING BELT.

The picture above illustrates loading of sulphur; the Hayward traveling excavators with orange-peel buckets deliver to conveyors centrally located under the machines, and thence to the vessel. The lower view shows the coal-handling system of the Syracuse Lighting Co., installed by the Robins Conveying Belt Co. and using the Hayward Co. 1½ cu. yd. bucket, with many novel features.

A BELT-CONVEYOR ORE-HANDLING PLANT FOR A LARGE MINE.

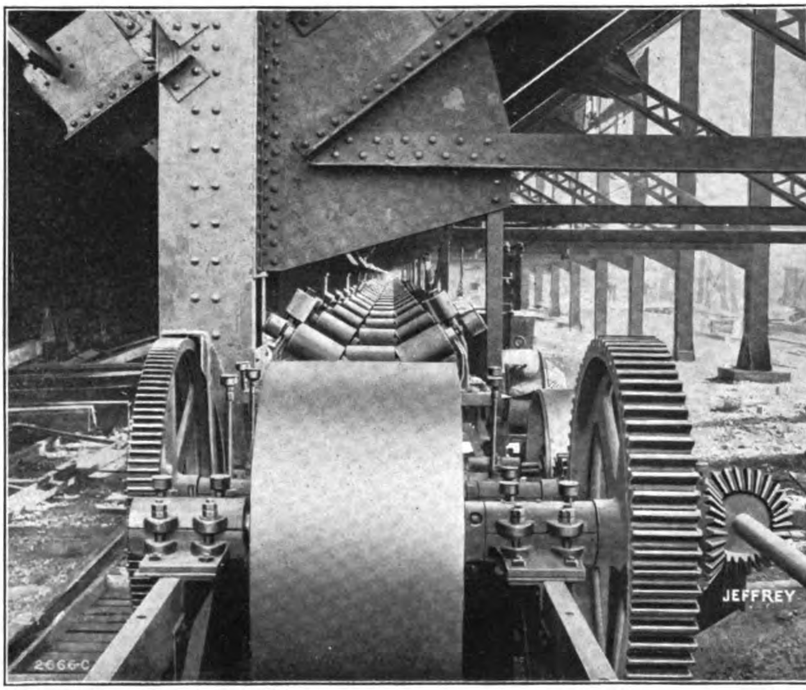
The 30-inch cross conveyor, loaded through a steel-apron feeder by a 3-ton skip, delivers to either of the long 30-inch conveyors. These are each 330 ft. in length. Automatic self-reversing trippers distribute the ore uniformly to the cars; steel deflecting plates prevent ore from falling between the cars. Stephens-Adamson Mfg. Co.



A 36-INCH CONVEYOR CARRYING MATERIAL FROM A DREDGE.
The huge "chunks" are handled as they come from the dredge bucket. Stephens-Adamson Mfg. Co., Aurora, Ill.

bearings, all supported on a frame. The upper belt is led around the pulleys in the form of a letter S, resulting in throwing the material free from the belt, whence it is conducted to one or both sides by chutes. The hand-propelled tripper is moved from point to point along a tripper track by means of a hand crank. In the self-propelled machine power is transmitted by gearing or sprocket chain from the conveyor belt to the truck wheels. By utilizing the opposite directions of rotation of the two principal pulleys, the tripper is driven in either direction. Attachments on the tripper make it self-reversing.

In designing a belt conveyor the first question presenting itself is, what is the required capacity? Capacity depends upon two factors, speed and width of belt. Moderate speeds when practicable are advisable, as (other conditions remaining the same) belts wear longer than when run at high speeds; 300 or 400 feet per minute are considered moderate belt speeds and 700 or 800 feet per minute are high. Narrow belts can not be run at speeds possible with wide belts. Thus certain limiting speeds have come to be recognized and adopted as a working basis. These are given in the table on the next page.



COKE-HANDLING CONVEYOR FOR THE TENNESSEE COAL, IRON & RAILWAY CO., ENSLEY, ALA.

Jeffrey rubber belt, 1032 ft. long between terminal pulleys. Photographed during construction, showing idlers and drivers.

As the result of long experience with belt-conveyor drivers, certain diameters for driving pulley have been adopted as minimum. As a guide in the design of drives the following sizes, used by one of the leading manufacturers, are also given in the table.

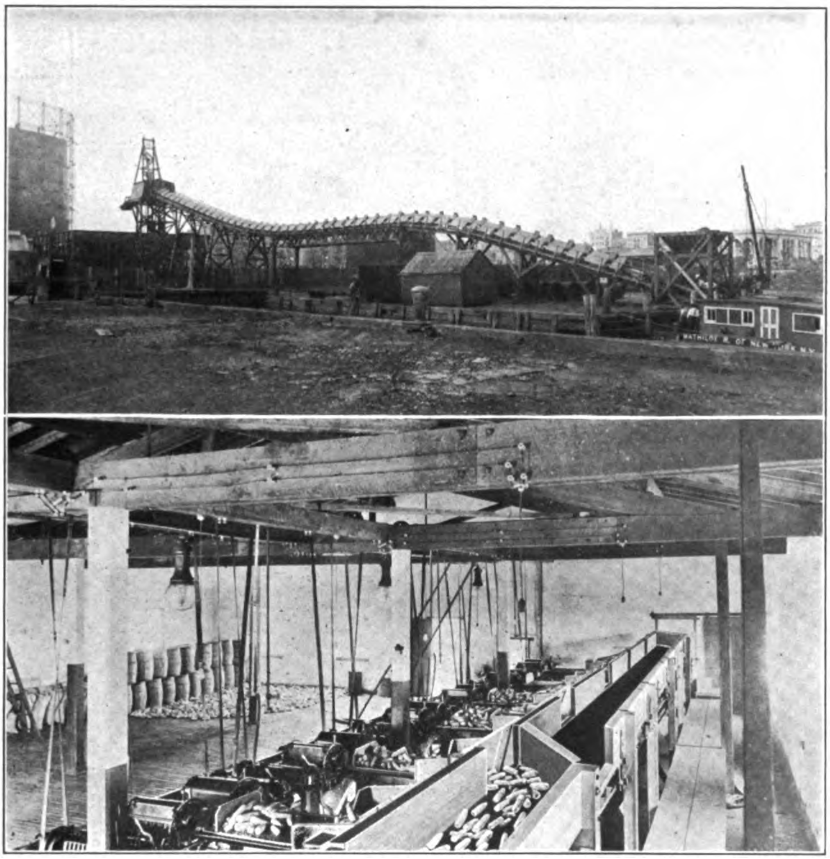
LIMITING SPEEDS OF BELT CONVEYORS.

Width of Belt.	Speed, Feet per Min.
12 inches	350
16 "	400
20 "	450
24 "	500
30 "	600
36 "	700
42 "	725
48 "	750
60 "	800

For 12 and 14 inch belts, minimum diameter driving pulley 16 inches.
" 16 to 24 " " " " " " 20 "
" 26 to 36 " " " " " " 30 "

As the lengths increase and the power required to drive becomes greater, a tandem arrangement of pulleys is often resorted to. By running the belt over two pulleys connected by a pair of gears, the increased friction adds materially to the efficiency of the drive. In order to keep down the diameter of the driving pulley, lagging is frequently resorted to thereby increasing the coefficient of friction between the belt and the face of the pulley.

The horse power required to operate a belt conveyor depends upon the length, width, and weight of belt, whether run horizontal or inclined, weight of material carried, type of idler used, and general condition of machinery. The size and weight of belt and the weight of material are all factors producing the friction resistance of the idlers carrying the belt, and therefore have a direct effect upon the pull. The frictional resistance is modified to a certain degree by the kind of bear-

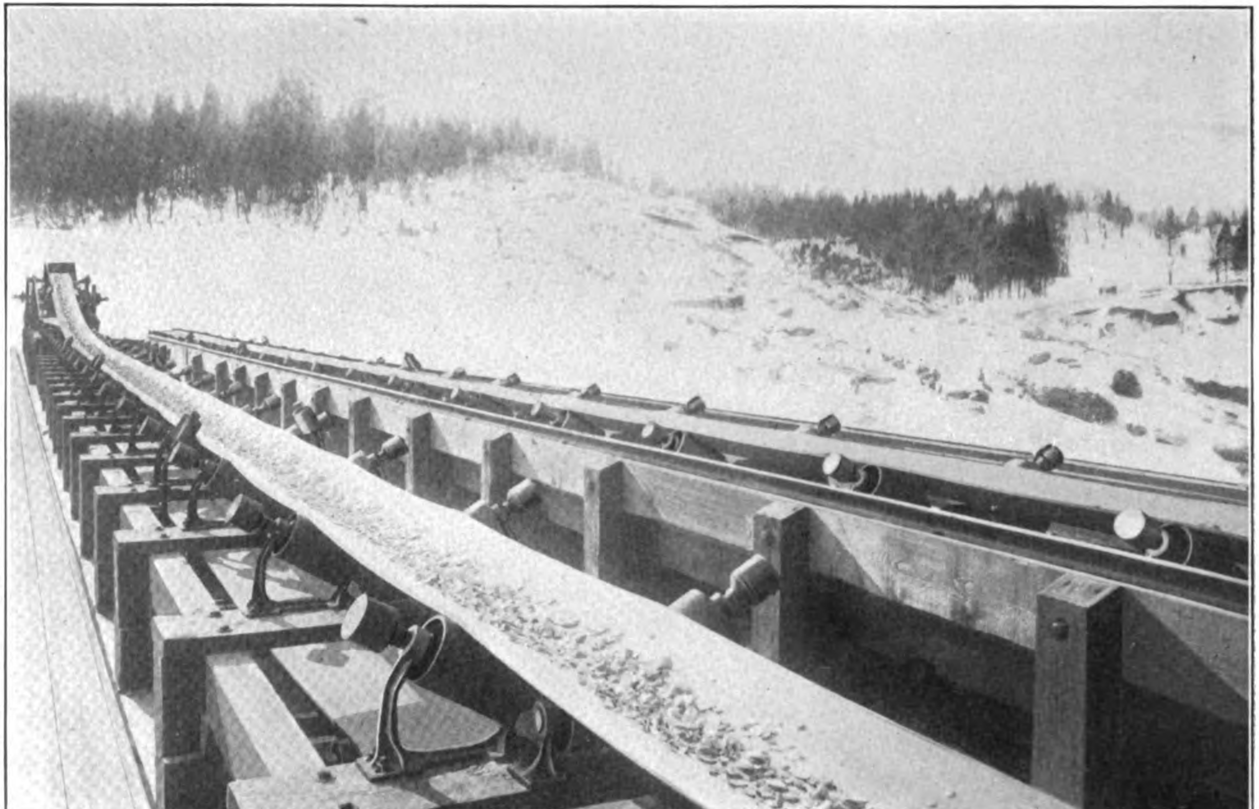


BELT CONVEYORS IN INDOOR AND OUTDOOR INSTALLATIONS.

The view above shows a 325-ft. 30-inch housed belt conveyor with pressed steel rolls, coke-receiving station of Astoria Heat & Power Co., N. Y.; capacity 60 tons an hour. The lower is of a 22-inch flat belt conveyor for handling corn; hinged sections of the trough side deflect the ears to the cutting-machine bins. The Link Belt Company, Nicetown, Pa.

A 36-INCH CONVEYOR TAKING COAL FROM TWO FAST UNLOADING PLANTS.

The two unloaders deliver simultaneously to the conveyor at the rate of about 700 tons per hour. The conveyor dips under six railroad tracks and connects with conveyors and stocking bridge aggregating more than ½ mile in length. The space to the right is reserved for an additional installation bringing the plant up to 1500 tons per hour. Installed for the By-Products Coke Corporation, South Chicago, Ill., by the Robins Conveying Belt Co.

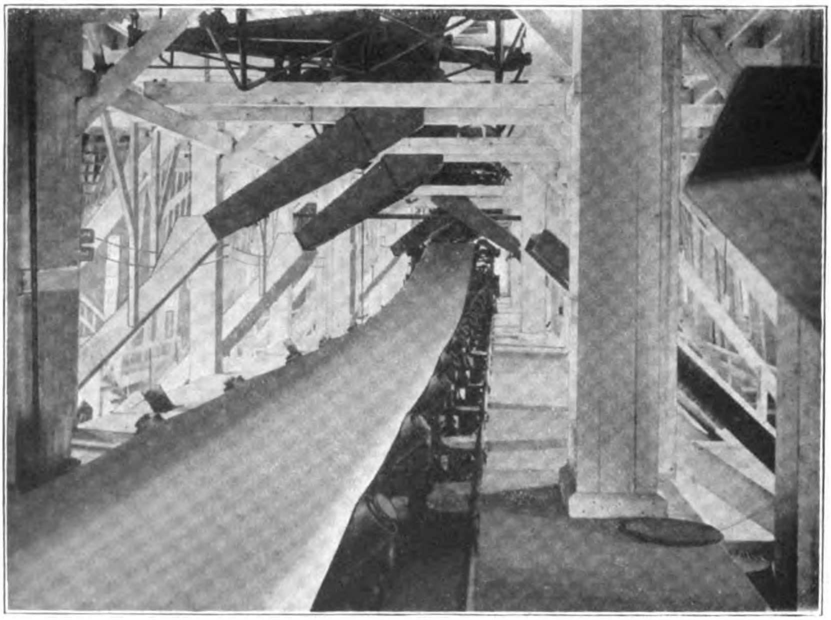


JEFFREY BELT CONVEYOR DISTRIBUTING STONE INTO STORAGE BINS.

ings used on the idlers thus affecting the pull upon the belt. An inclined conveyor imposes an additional factor, that of lifting the material, which presents the ordinary problem of pounds lifted in feet per minute.

The amount of power needed to operate a belt conveyor is always so small, when measured by the capacity, that ultra-refinements in equipment in order to cut down power seem wasted. Manufacturers often emphasize the heavy strains induced in belts by the inferior type of idlers used. A specific case will throw some light on this subject. A 24-inch belt 300 feet long carrying coal and running horizontally at a speed of 400 feet, requires about 15 horse-power to operate. The effective pull from belt formula:

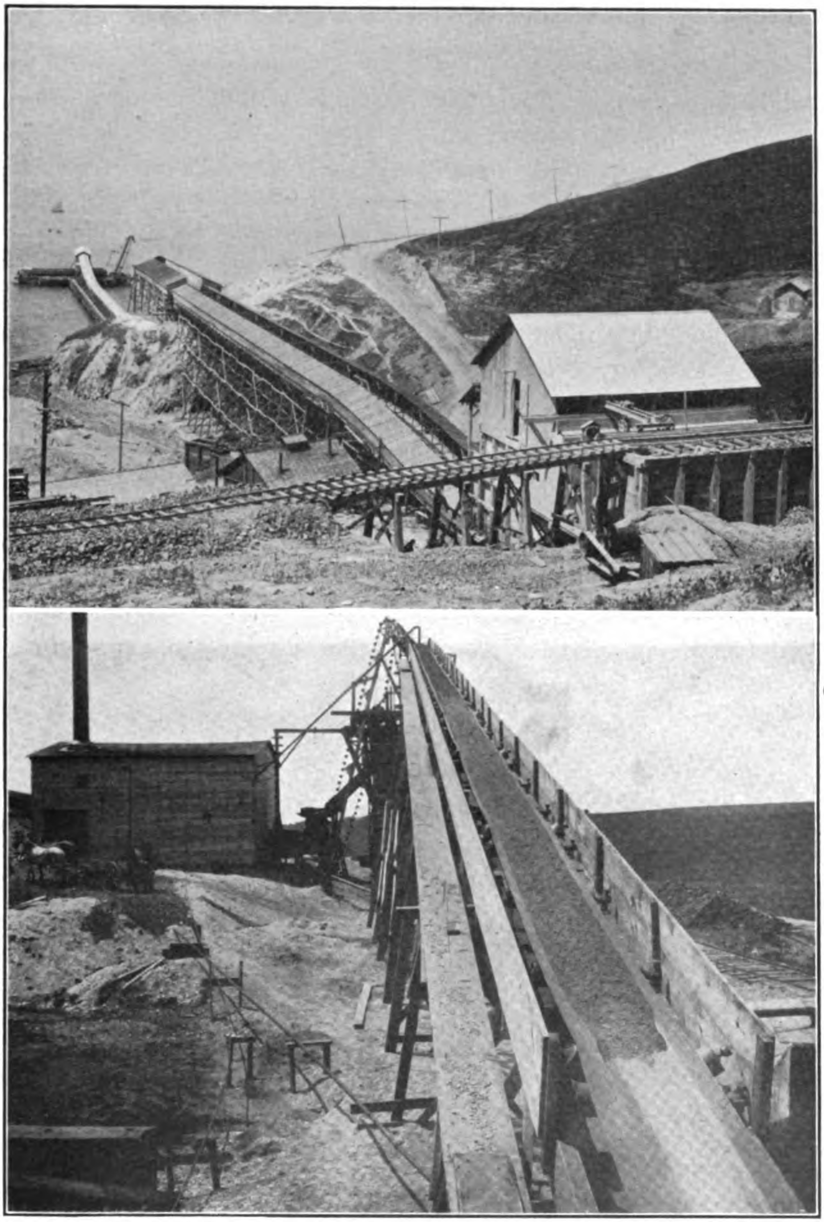
Pull × Speed = H. P. × 33,000, equals 1,237 pounds.



WEBSTER 40-INCH REVERSIBLE BELT CONVEYOR, 310-FEET CENTERS FOR GRAIN ELEVATOR.

Assuming the maximum pull on the working side of belt at 25 per cent higher than effective pull, the greatest strain on the belt is 1,546 pounds. Figuring on the basis of a four-ply belt, the ultimate strength of which is about 1,000 pounds per inch of width, the breaking load of the belt in question is 24,000 pounds and the factor of safety amounts to 16, which is a large enough margin for the poorest sort of idler.

Belt conveyors are designed to run in three ways; horizontal,



BELT CONVEYORS FOR HANDLING CRUSHED STONE AND SAND.

Above is the plant of the San Pablo Quarry Co., California. Two **16-inch conveyors** 600 ft. **long carry the stone** from the crusher house to storage bunkers blasted out of the rock. **Thence two 20-inch** conveyors 750 ft. long, **with a capacity of** 150 tons an hour **each, carry the stone** to the barge. These conveyors receive the stone through **special feed hoppers.** Below is a 20-inch conveyor carrying sand.
Stephens-Adamson Co.

straight incline, and in a vertical curve. Experience has demonstrated that materials such as coal, grain, stone, and sand can be conveyed on inclinations from 20 degrees to 25 degrees. Lump material tends to roll back, but this tendency is stopped when there is an admixture of fine and lump. The nature of the material will determine, therefore, the amount of inclination possible. The vertical-curve lay-out is frequently employed to advantage. The minimum radius which can be adopted depends upon the weight of belt, weight of material, and amount of slack in the belt. No satisfactory mathematical treatment can be accorded this problem. I have adopted a radius of 100 feet with satisfactory working results. Of course a conveyor will operate with vertical curves of smaller radii, the belt running as much as two feet above the idlers when light and falling to position as the load comes along.

The unit cost of handling materials by means of belt conveyors varies according to conditions, but remarkably low costs are obtained in many instances. The examination of data taken from several hundred installations shows figures as low as $0.0025 and $0.0020 per ton conveyed 100 feet. This includes power, maintenance, depreciation, and interest on investment.

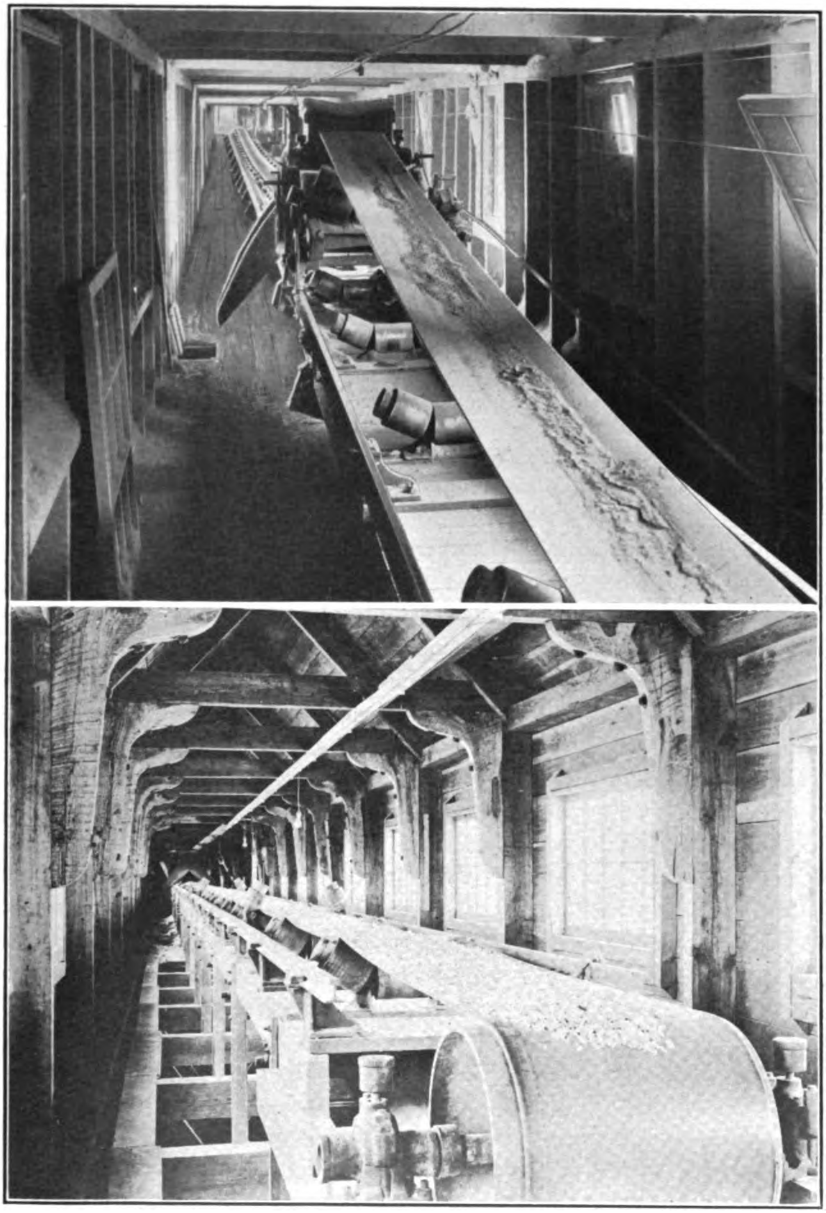
The following points relating to operation suggest themselves as of particular interest to owners:

First. A high-grade belt although costing more in the beginning lasts longer and gives better satisfaction than a cheap belt.

Second. It is best to put conveyors under cover if the installation is to be a permanent one. Rain, snow and ice are not conducive to long life for any sort of machinery. Water may get between the plies, and freezing, force them apart; frost getting into the idlers prevents them from turning, and when the power is applied, the belt (if it can be moved at all) has an excessive strain thrown upon it, with bad results. By covering the conveyor, better attention will be paid to oiling than if in the open exposed to all sorts of weather. In high exposed positions, winds must be taken into consideration, for not only is the material being transported blown off an exposed belt, but the belt itself is often lifted off the troughing idlers and forced over to one side.

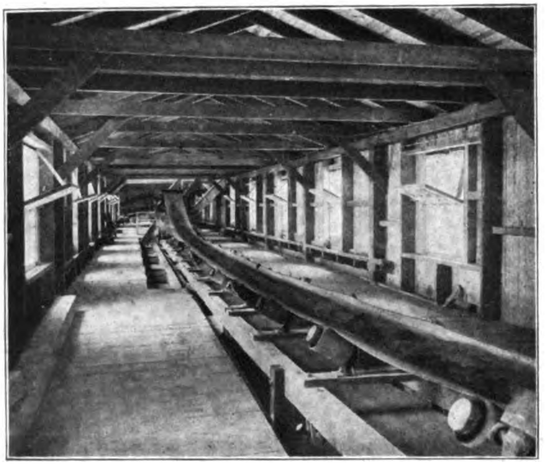
Third. The inclination of troughing idlers should not be excessive; 25 degrees is about the correct slant to which the edge of a belt may be subjected without undue bending and stretching of the plies. As a result of excessive bending, the plies buckle and separate, thus quickly destroying the belt.

Fourth. If possible, all guide idlers should be dispensed with.



HANDLING MATERIALS BY ROBINS BELT CONVEYORS.

The upper installation handles cement at the plant of the Marquette Portland Cement Co.; the lower carries wood chips at the paper mill of the West Virginia Pulp and Paper Co. Both by the Robins Conveying Belt Co.



WEBSTER BELT CONVEYOR OPERATING IN CEMENT PLANT.

Where belts refuse to run straight and guides are put in to keep them in line, the edges rubbing against the guides are quickly injured. the cotton duck being exposed and the plies torn apart. To prevent skidding of belt, a simple device is employed consisting of what is known as a "steering idler." This consists essentially of a standard troughing idler centrally pivoted and having two arms extending to each side of the belt, which carry small steering pulleys. As the belt starts to skew and comes against a steering pulley this turns the troughing idler about its center sufficiently to induce an opposite sideways movement of the belt, which is thus made to line itself automatically and by means of friction at the middle rather than by pressure against the edges as in the old type of guides.

Fifth. Delivery chutes are often a source of undue belt wear. Pieces of iron, or rock, becoming lodged between the edge of the chute and the belt, often do considerable damage before power can be cut off. The design of delivery chutes deserves more attention than is usually accorded the subject. They are almost invariably made too wide and the skirt boards instead of diverging slightly are made parallel. Chutes should deliver the material to the belt in the direction in which the conveyor is traveling, thus giving the material a certain amount of initial velocity which preferably is equal to that of the belt. There is also less tendency to spill when the conveyor is loaded in this manner.

Sixth. Belt conveyors will not carry hot or wet materials, or material giving chemical reactions, without frequent renewals. Where such materials are to be handled by belts the higher-grade ones give better results.

Seventh. Proper supervision is important in the economical operation of any kind of machinery, and continual attention in the case of belt conveyors will reward the owner in the form of fewer shut downs and renewals of parts.

SYSTEMATIC FOUNDRY OPERATION AND FOUNDRY COSTING.

By C. E. Knoeppel.

III. THE ELEMENTS ENTERING INTO PRODUCTION COSTS.

Mr. Knoeppel's series began in the October issue of The Engineering Magazine with an outline of the simple elements of the problem of foundry costing. Last month he dealt with the importance of correct burden apportionment. In the present instalment he enumerates and classifies the elements entering into production costs. His discussion next month will show how the various items are grouped and how and why they are apportioned to product.—The Editors.

WHEN times are prosperous and money "easy," a manufacturer is usually too busy with details to which attention *must* be given, to give the matter of increased efficiency the consideration it is entitled to and should receive. Production is at a high point, the percentage of profit gratifying, with the result that the management cannot quite see the necessity for introducing methods that have for their ultimate purpose the bettering of results that are, or seem to be, satisfactory. Possible leaks seem insignificant, so satisfied is the management with what is an apparent accomplishment.

Just as soon, however, as a period of depression makes itself felt in the way of a falling off in sales, perhaps at decreased prices, this feeling of satisfaction becomes one of uneasiness—the management realizing that costs increase and profits decrease as the volume of sales decreases, and that prices cannot be increased on account of the fact that any increase in price at such a time would likely result in a still further falling off in sales which, under the conditions, would be most disastrous. At such a time, a full and complete knowledge of the pertinent details would be of inestimable value to the management, as it would assist materially in keeping costs down to as low a figure as possible, besides showing what might be done toward increasing the productivity of the plant; consequently there is regret that more efficient methods were not introduced at a time when business was more prosperous. Concentration of endeavor is one of the roads to success —if it is known *where* to concentrate.

The maintenance of price does not imply a maintenance of profit. Careful buying may result in a lower cost for direct materials, and proper supervision may reduce the cost per 100 pounds for direct labor, but the best of management cannot expect to reduce the overhead expenses or "burden" in proportion to the reduction in the volume of production. As a result we find that burden costs increase as the output decreases, any increase in cost affecting profit as the following will show:—

	A	B	C	D
Monthly tonnage	250	200	150	100
Monthly burden	$5,000	$5,000	$4,000	$4,000
Direct material per 100 lb.	$1.00	$1.00	$1.00	$1.00
Direct labor per 100 lb.	.75	.75	.75	.75
Prime cost	$1.75	$1.75	$1.75	$1.75
Burden per 100 lb.	1.00	1.25	1.40	2.00
Total cost per 100 lb.	$2.75	$3.00	$3.15	$3.75
Selling price per 100 lb.	3.00	3.00	3.00	3.00
Profit per 100 lb.	.25	....	....	....
Loss per 100 lb.	....	....	.15	.75
Per cent of burden to direct labor	133⅓	166⅔	186⅔	266⅔

It can be seen from this table that the item of "burden" has considerable to do with the amount of profit, that there is a certain point in the amount produced where *income balances cost,* and that profits as well as losses begin from this point. *Do you know where it is in your business?*

A shrewd manager recently stated that his designer once handed him the design covering a proposed addition to one of the main factory buildings, with the petition that he approve it at once so that the work could be started, stating that the plan as set forth by the design had been looked over by several and approved by them. The manager looked at it for a moment and laid it on his desk with the remark that he would decide later in the day as to its merits. This rather incensed the designer, who stated that he felt the manager qualified to reach a decision from the facts as set forth by the design, and that the desire to postpone the decision was really a reflection on his ability as a designer. The manager replied by saying that as far as he could see, the design covered the ground in a satisfactory manner; but that he was less concerned with what *was* shown on the design than he was with what had *not* been shown at all, which would have to be considered before an intelligent decision could be reached. The manager told me that in going over the design later in the day, he found that it failed to consider several important points—that it did not take into consideration the future growth and expansion of the business; consequently the design had to be revised, the revision eventually saving the company in question considerable money, due to nothing but a search for points that had not been covered.

What you are doing is apparent and evident; but it is what you are *not* doing that should receive your careful attention. *Appoint yourself a court of investigation, issue to yourself an order to show cause why your methods should not be discarded on account of their inability to secure you, through their use, maximum results at a minimum outlay.* In the preparation of your defense, you will undoubtedly be surprised at the large amount of information you will gather as you investigate the merits of your methods. You may start out with the feeling that they meet all requirements, but in actually defending them you will begin to see that here, there, and elsewhere there are weak places—strings which lead to nowhere in particular, points not covered at all, inaccuracies, and many other faults which render efficient costing out of the question. Even though you find but few serious faults, you will discover enough to warrant the investigation.

Be dissatisfied. Records are made only to be broken. Rejoicing over the accomplishment of some particular ambition is right and proper if it is not at a sacrifice of your determination to make each success a stepping stone to a still greater success. If your foreman tells you that you are getting 500 pounds per day per man of a certain class of product, strive for 600 pounds, and even if you are not able to secure this amount you might get 550 pounds—at any rate, an effort will be made, and it is effort that counts in these days.

Success in any branch of endeavor does not just "happen," but is rather the result of intelligent oversight and supervision. If the owner of a foundry business could be the moulder, core maker, melter, business getter, book keeper, and executive combined, all would be well; but as this is impossible, the foundry executive must depend upon as intelligent an assistance as is possible to secure—succeeding or failing, according to the efficiency or inefficiency of this assistance. Methods, men, clerks, etc., are simply "tools" which can be used to decided advantage or to no real purpose at the will of the executive, and it should be his duty to see to it, first, that these tools are what they should be, and second, that they are used to advantage. This duty the executive owes to himself, to his business in particular, to his industry in general.

Looking at the matter from a standpoint purely financial, the investment is the item which influences success or failure; and made up (as it is) of every conceivable kind of expenditure, it needs the most careful watching in order that the returns shall include a fair margin of profit on this investment. If you purchase a knife at a hardware store for 75 cents and induce some one to purchase it from you for $1.00, you have made 25 cents on your investment, or 33 1-3 per cent. If you purchase pig and scrap irons, coke, the services of moulders, core makers, cleaners, laborers, supervision, clerical help, materials, and supplies, and sell the resulting product of this investment to several people, you must see to it that you charge each one enough to cover your investment and at the same time allow yourself a margin for your efforts. If after taking care of this investment you find that you have been able to deposit a reasonable amount to your credit, you have a right to feel that you have successfully conducted operations. This success is an effect; something contributed to it, and what this something was and why it assisted you is entitled to more than passing attention, for if you can ascertain the reasons and properly classify, tag and file them away for future reference, you have at your disposal a means of forestalling disaster. If, on the other hand, you had found, after meeting your obligations, that you were on the wrong side of the books, you would without any question want to know what the causes were; but unless you had at your command some means for assisting you in your search, you would be forced to spend considerable time in an endeavor to pick past performances to pieces before locating your trouble, and the chances are that at best you would get only a general idea of what you desired to ascertain.

Any manufacturing enterprise is one of countless details, even though results can be expressed in very few figures; and considering everything expended as "expenses," the end in view of the manufacturer being to keep them within a reasonable margin of the "receipts," it stands to reason that each and every one of these details—having as it has, a direct influence on the ultimate results—is entitled to most careful consideration, either separately or collectively. The well known maxim—"everything occurring and coming up in a business is important" should be of highest significance to every manufacturer.

A man in the act of putting his hand in his pocket for his knife was asked why he did so. He replied by saying that he did not know, but believed that his head told his hand to do so. When asked why his head suggested such a procedure, his reply was, "my head knew that the knife would not come to my hand, so it sent my hand after the knife." Putting this same bit of logic in another way, we have—"details will not come to the executive, so the executive must send something after the details."

Expenses (details in the aggregate) are either conservative or beyond all reason—legitimate or illegitimate; the executive must therefore provide himself with some method which from time to time will acquaint him with these details properly classified, so as to enable him to keep his fingers on the pulse of the business and ascertain its condition. Chemistry of bodies undertakes their resolving into component parts while "Chemistry of Costs" undertakes the resolving of facts and information into the elements necessary for arriving at result-producing conclusions. It is evident to all, however, that we cannot separate that which has not been grouped, hence the necessity for logically joining together the pertinent details of a business. This joining or grouping we will term "synthesis," which may be defined as:

> The process of automatically grouping together the various details of like nature, which when properly arranged and classified, will show, at stated periods, what has been expended or accomplished.

The resolving of results, which we will term "analysis," may be defined as:

> The process of separating and placing by themselves the various details of like nature, which when contrasted or compared with the details of the same nature for previous periods, will enable the executive, through the instrumentality of thought and deduction, to determine whether results are as they should be or not, or to reach a definite conclusion regarding a policy.

It has been well said, "complexity breeds perplexity." This is especially so in the case of a foundryman who has been the recipient of repeated reminders, in one form or another, that things are not as they should be. How low can I consistently bid? Where is my money going? What can I do at different productions? These are some of the questions that the foundryman will ask himself, realizing that to turn a loss into a profit, or to increase his profits, he must either increase his prices or decrease his cost of producing castings; but as competition is such as admits of no increase in prices, his cost information is the something upon which he must concentrate his attention. He finds, however, that in the absence of a well organized means for furnishing pertinent details this information can be given to him only in a general way, and that it will be rather a difficult task to answer the self-imposed questions to his entire satisfaction. He therefore determines to find out what he wants to know, but is confronted with what seems to him to be a problem more or less complex. As a starting point, however, he decides to arrange for a careful monthly accounting of his expenditures, giving the various details proper consideration and bearing in mind that there are three principal elements in production cost—A—Materials, B—Labor, C—Expenses—he sets out, in a receptive mood, for impressions to assist him in his work, making proper notations as he decides on methods of procedure.

In the first place, he notices in going through the foundry at casting time that he has certain materials going through a melting process before castings are produced, these materials being the pig irons, purchased iron and steel scraps, his own or home scrap (comprising bad castings made in the shop, gates, sprues, shot, and over-iron), and the coke necessary to melt the iron. He knows that in the core room they are using a coke inferior to that charged into the cupola, and that to operate his plant he is forced to buy coal for power. Earlier in the day, when the moulders and core makers were putting up their work, the fact that sand was used by them suggested the two kinds used—moulding and core sands; also that a miscellaneous lot of materials were being used by the men throughout the plant, such as chaplets, hammers, brooms, brushes, facing, oils, iron and wire, bolts and nuts, etc., all of which he decides to call "stores," before they are delivered to the men and "supplies" when delivered to them. To control his item of materials properly, he decided that it can best be handled by giving each kind of material a separate number, opening an account with it on his books, charging it with what is received and crediting it with whatever is consumed, arranging at the same time to take care of adjustments that may be necessary, the following being an exhibit of his material accounts:

Account Number.	Name of Account.
100 to 114	Various pig irons purchased.
115	Scrap iron—purchased.
116	Scrap steel—purchased.
117	Home scrap—bad castings and remelt.
118	Core sand.
119	Moulding sand.
120	Foundry coke.
121	Stock coke.
122	Coal.
123	Stores.
130	Material adjustments.

In studying the conditions more closely, he observes that there are many things being done by his men which if classified and tagged would provide a means for acquainting him with the channels through which his money passes. He notices laborers digging pits, ramming up, and in other ways assisting the moulders; that some of them have regular helpers; that there are apprentices at work; that certain men are operating moulding machines, and that a part of this work which he calls "moulding" is given up to cutting sand, pouring off, and shaking out. The moulding process naturally suggests core making as a separate operation, while the cleaning of the castings suggests another, and as he notices that considerable chipping is necessary before castings are in a condition for inspection and shipment, he decides that it would be well for information purposes, to keep this item separate from the cleaning of castings.

He carefully watches the laboring men working around the cupola, in the yard, around the shops, at night getting out the work, etc., making notes as he does so; he sees that considerable is expended to replace castings that have not been accepted by the inspector, which according to his way of looking at it is information he should have in deciding as to the efficiency of his men; and while he knows that he expends quite a little for supervision and clerical work, he decides in favor of keeping this item separate so as to tell, periodically, just what this amounts to without having it looked up for him. As before stated, he has notice that quite an amount of miscellaneous materials is being used by the men around the plant, and as it is his desire to place each department upon its own footing, he concludes to charge them with the supplies they use in a given period of time, which information he can use for purposes of comparison and analysis, in this way perhaps reducing the consumption of the indirect or expense materials.

He finds it necessary to repair one of the factory buildings; this suggests a logical division of the expenditures for maintaining his plant, instead of depending upon one total at the end of the year, which really tells him nothing regarding where the money went and what required the most or repeated repairing or replacing. As he has several departments such as his stable, power plant, pattern, machine, carpenter and blacksmith shops, pattern storage and shipping rooms, he decides in favor of keeping separate the expenses of operating them, so as to enable him to keep in closer touch with the details of his business.

In watching his shop operations, he notices that some lifting plates are being made in order to facilitate the making of a particular order; this suggests to him an account that would tell him what it costs to rig up for special or new work. He decides to charge this expense for rigging against the work necessitating the expenditures—as a direct charge—at the same time providing a place in his expense account for this item, apportioning to his product the difference between the total expenses and the rigging expense, the advantages of which are that while each order is charged with its proper rigging cost, the rigging expense is *in total* in a place by itself—in this way facilitating study and analysis; and as it appears in the burden statement as a memorandum charge only, he is in a position to take this expenditure into consideration when estimating on new or special work.

The item of salaries he divides into officers' and office salaries; traveling expense into sales traveling and general traveling; donations and dues perhaps amount to enough to warrant him in keeping this item separate, and in this way he goes through each class of expenditure like taxes, insurance, depreciation, legal expense, office expense, commissions, allowances, etc., but before finishing his preliminary work he happens to see some credits to customers for defective castings returned, and while heretofore he has credited his customers and charged his sales—thereby reducing his sales or revenue account—he decides to open an account which he calls "defective castings," crediting his customers the same as before, but charging his scrap account with the scrap value of the castings returned and his defective castings account with the difference between the scrap value and the invoice amount. He decides this way because first of all he wants some means that will bring to his attention, automatically, the amount of defectives returned, so that he may concentrate his endeavors along the lines necessary to keep the item down to as low a figure as possible, and because it is hardly fair to reduce the sales of one month by work that was credited to the sales account several months before. If the sales this month are $50,000, the business is entitled to this credit despite the fact that castings to the invoice value of $2,000, invoiced three months ago when the sales were $40,000, are returned this month. We cannot reduce the sales of three months ago; the defectives returned have nothing whatever to do with this month's business, and as the $2,000 in credits to the customers is a *loss,* less the scrap value, the logical plan is to place this item where it will *plainly show as a loss.* In effect both methods are the same as regards "net income"; for by charging sales with returns, we reduce income but allow costs to remain as they are, while by charging cost with the returns, we increase cost but allow income to remain as it stands, so that the net income would be alike in either case. It seems, however, that there is more justice in the latter method with the decided advantage of providing the executive with the best kind of danger signal.

After deciding on the various items that he wants to keep track of, the foundryman opens an account with each one, giving each an account number to which can be posted the various expenditures. His first consideration after taking care of his materials, as was explained heretofore, is to separate his labor into "direct labor" and "expense labor"—under the first classification placing:—

MOULDING.—*Account No.* 150—which is to include all time of:
- Moulders.
- Moulders' helpers.
- Apprentices.
- Moulding machine operators.
- Laborers digging pits.
- Laborers ramming up.
- Cutting sand.
- Pouring off and shaking out.

CORE MAKING.—*Account No.* 151—which is to include all time of:
- Core makers.
- Core makers' helpers.
- Oven tenders.
- Mixers and pasters.

Under the second classification—expense account—he will include:

CUPOLA LABOR.—*Account No.* 152—to include all labor:
- Getting materials from yard to charging platform.
- Weighing and placing charges.
- Taking bad castings and remelt to charging platform.
- Charging and tending cupolas.
- Breaking stock.
- Cleaning and daubing ladles.
- Cleaning and preparing cupolas for each day's heat.

CLEANING.—*Account No.* 153—to include all labor:
- Cleaning and grinding castings.
- Tending rattlers.
- Pickling castings.
- Using sand blast.

CHIPPING.—*Account No.* 154—to include all labor chipping and getting castings in condition for inspection and shipment.

HANDLING MATERIALS.—*Account No.* 155—to include labor unloading, stacking and piling of:
- Pig and scrap irons.
- Coal and coke.
- Sea coal.
- Fire clay and brick.
- Limestone.
- Core flour.
- Lumber and slab wood.
- Moulding and core sands.
- Other materials not specified above.

YARD.—*Account No.* 156—to include labor loading dirt cars, cleaning up yard, etc.

SHOP SUPERVISION AND CLERICAL.—*Account No.* 157—to include salaries and wages of:
- Superintendent.
- Foremen.
- Shop clerks.

REPLACE LABOR.—*Account No.* 158—to include labor in foundry or core room replacing work lost or extra work done on account of causes other than faulty design or construction of patterns.

FOUNDRY GENERAL—*Account No.* 159—to include time of all laborers (when not acting as moulders' helpers) working around foundry or core room:
- Cleaning up floors.
- Carrying out scrap and castings.
- Carrying iron.
- Shifting weights.
- Going after supplies.
- Carrying flasks, patterns and cores.
- Time of—
  - Watchman.
  - Crane men.
- Any incidental work not specified above.

NIGHT GANG.—*Account No.* 160—to include all time of laborers:
- Taking out castings.
- Placing flasks.
- Removing gaggers and clamps from sand.
- Fixing sand and getting floors in condition for use by moulders when they arrive in the morning.

The third element—expense—is divided into Supplies, Maintenance, Departmental, Miscellaneous Shop and the Commercial expenses, as follows:

SUPPLIES.

FOUNDRY SUPPLIES.—*Account No.* 165—to include all supplies used by the foundry which cannot be charged directly to any one order such as:
- Moulding sands, charcoal, stock coke, brushes and brooms, pails, bellows, files, nails and spikes, hammers and hammer handles, torch oils, chaplets, riddles, shovels, iron and wire, facings, parting, bolts, nuts, screws, buckets, torches, wicking, cement, mallets, sledges, wheel barrows, waste and any other incidental materials used as supplies in the foundry.

CORE ROOM SUPPLIES.—*Account No.* 166—to include all supplies used by the core room which cannot be charged directly to any one order such as:
- Stock coke, moulding sand, core sand, core oils, molasses, paper, bolts and nuts, files, slab wood, wire and rods, core wash and core compounds, flour, gravel, brushes and brooms, nails, bellows, wheel barrows, wax tapers and other miscellaneous supplies used by the core room.

CUPOLA SUPPLIES.—*Account No.* 167—to include all supplies not otherwise chargeable such as:
- Sand, slab wood, alloys, gravel, clay, limestone, wheel barrows, shovels, coke forks, coke baskets, brooms, tapping bars and any other materials used as supplies around the cupola.

CLEANING ROOM SUPPLIES.—*Account No.* 168—to include supplies such as:
- Brushes, shovels, wheel barrows, brooms, chisels, hammers and hammer handles, carbo blocks, etc.

MAINTENANCE.

BUILDINGS AND REAL ESTATE—*Account No.* 170—to include all labor spent and materials used in repairing:

Buildings, roofs, fences, sidewalks, tracks, etc.

PLANT EQUIPMENT.—*Account No.* 171—to include all labor spent and materials used in repairing:

Cupolas, blowers, moulding machines, cranes, grinding, rattling and sand blast machinery, elevators, air equipment, pattern, machine, carpenter and blacksmith shop equipments, the stable equipment, etc.

POWER AND TRANSMISSION.—*Account No.* 172—to include all labor spent and materials used in repairing:

Boilers, engines, compressors, dynamos, lights, line and counter shafting, boxes, hangers, belts, pulleys, brackets, etc.

CAST EQUIPMENT.—*Account No.* 173—to include all labor spent and materials used in making:

Stars, clamps, gaggers, braces, bench and flask weights, etc.

PATTERNS.—*Account No.* 174—to include all labor spent and materials used in repairing patterns, also replacing patterns broken. This account is to cover work that is not chargeable to customers.

FLASKS.—*Account No.* 175—to include all labor and material used in repairing burned, broken or worn out wood flasks, wood flask bars, also broken iron flask parts.

DEPARTMENTAL.

STABLE.—*Account No.* 180—to include time of teamsters and those employed about stable, also feed, bedding, horseshoeing and supplies used.

PATTERN SHOP.—*Account No.* 181—to include labor and materials that cannot be charged direct to some other account, also pattern-shop supplies.

MACHINE SHOP.—*Account No.* 182—to include labor and materials that cannot be charged direct to some other account, also machine-shop supplies.

CARPENTER SHOP.—*Account No.* 183—to include labor and materials that cannot be charged direct to some other account, also carpenter-shop supplies.

BLACKSMITH SHOP.—*Account No.* 184—to include labor and materials that cannot be charged direct to some other account, also supplies used by the blacksmith shop.

POWER PLANT.—*Account No.* 185—to include time of engineer and fireman and any other labor used in the boiler and engine rooms, also coal, oils, compound, waste, tools, etc.

PATTERN STORAGE.—*Account No.* 186—to include time of those in charge of the pattern storage as well as any supplies used in same.

SHIPPING ROOM.—*Account No.* 187—to include labor in shipping room, boxes or barrels (made or purchased) with which to ship castings as well as any supplies used in same.

MISCELLANEOUS SHOP.

RIGGING.—*Account No.* 190—to comprise the rigging or special equipment made for some particular customer or work and to include time of moulders, core makers, pattern maker or carpenter or any other labor applied to this particular class of work and to also include cost of metal used, and any supplies like bolts, nuts, screws, rods, rings, etc.

TAXES.—*Account No.* 191—(*).

INSURANCE.—*Account No.* 192—(*).

DEPRECIATION.—*Account No.* 193—(*).

ANALYSIS EXPENSE.—*Account No.* 194—to include expense of operating chemical laboratory, such as salary of chemist, supplies used, etc., or the amounts paid to outside chemists for metal analysis.

* Self-explanatory.

COMMERCIAL—ADMINISTRATIVE.

OFFICERS' SALARIES.—*Account No.* 200—salaries of the executive officers of the company.

OFFICE SALARIES.—*Account No.* 201—salaries and wages paid to heads of departments, clerks and stenographers.

LEGAL EXPENSE.—*Account No.* 202—(*).

INTEREST AND DISCOUNT.—*Account No.* 203—(*).

GENERAL TRAVELING EXPENSE.—*Account No.* 204—all expense of traveling, having nothing to do with the selling of product.

TELEPHONE, TELEGRAMS AND POSTAGE.—*Account No.* 205—(*).

OFFICE EXPENSE.—*Account No.* 206—to include such items as:
Pencils, pens, stationery, forms, rubber bands, pins, ice, inks, brooms and dusters, folders and other miscellaneous office supplies.

DONATIONS AND DUES.—*Account No.* 207—to include such items as:
Subscriptions to magazines, association dues, gifts for charitable and other purposes.

COMMERCIAL—SELLING.

SALARIES OF SALESMEN.—*Account No.* 215—(*).

SALES TRAVELING EXPENSE.—*Account No.* 216—to include expenses for traveling when expended for the purpose of selling the product of the plant.

COMMISSION.—*Account No.* 217—(*).

SALES FREIGHT.—*Account No.* 218—to include prepaid freight or express charges on shipments to customers.

ALLOWANCES.—*Account No.* 219—to include credits given to customers when they do not come under the head of credits for defective material or invoice corrections.

DEFECTIVE CASTINGS—*Account No.* 220:
A—to be charged with castings returned from customers at invoice prices, less scrap value.
B—to be charged with difference between scrap and invoice values when castings are kept by customers.
C—to be charged with castings scrapped after being weighed and reported as good, at cost value less scrap value.

These various items are in reality a number of "magnets" which are ready to draw the various details to them *automatically* in such a manner as to show periodically the totals of the various accounts. It would hardly do, however, to list the various totals on an adding machine in order to arrive at the total cost for two reasons:—

1.—Because analysis is facilitated only when the item of *total cost* is divided into the groups necessary to enable the executive fully to grasp the real significance of the grand total.

2.—Because the various items vary widely in their nature. It is therefore necessary to separate the items, as shown above, into their logical controlling elements; but as the length of this article renders further elaboration out of the question, the discussion of the elements entering into production costs will be concluded in the paper to follow, which will show how the various items are grouped, how and why they are apportioned to product, etc.

* Self-explanatory.

THE LUBRICATION OF BEARINGS.

By A. L. Campbell

LUBRICANTS may roughly be classed under three heads—solids, greases, and oils. Graphite, or plumbago, is probably the most used solid lubricant. It is an amorphous form of carbon and is used in the form of a fine, flaky powder obtained by grinding. It is used extensively alone, but more commonly mixed with oil. It finds its most extensive use with very heavy pressures and slow speeds, although sometimes used alone on light machinery, such as silk looms, where oil would injure the silk.

Soapstone is occasionally used mixed with oil for heavy duty. Graphite and soapstone are sometimes employed, mixed with soap, for lubricating wood. Soapstone should, however, be used with care, since it is apt to contain more or less grit. Flowers of sulphur may be used with oil on bearings which are apt to run hot, instead of graphite. The sulphur is apt to collect in and to clog the oil channels. It is now almost entirely replaced by heavy mineral oils.

Grease is any compound of oils or oil-producing substances which is solid or semi-solid at ordinary temperatures. Grease should never be used in a bearing except where the temperature of the surrounding air is higher than the melting point of the grease. If the air is not so hot as this then work must be converted into heat in order to keep the bearing hot enough to make the grease run to it. This is a fact often overlooked in power-plant economy, and may amount to a considerable sum per year.

For example, a standard cast-iron babbited pillow block for a 3 7/16 inch shaft will have about 2 square feet of external surface. If it is lubricated by a grease which melts at 120 degrees F., and the temperature of the air is 60 degrees, find the power consumed in melting the grease.

The temperature of the bearing must be not less than 120 degrees F. in order that the grease may run and the bearing be lubricated. Then the difference in temperature of the bearing and the air surrounding it will be 60 degrees F. Text books on heating and ventilation give the radiation from cast iron to air to be about 1.5 B.t.u.

per square foot per hour per degree difference of temperature, where the source of heat is 60 degrees hotter than the air. Then the total number of B.t.u. radiated by the bearing per hour will be about 180. Since one B.t.u. is equivalent to 778 foot pounds of work, we have 140,000 foot pounds of energy per hour, equivalent to 0.071 horse power, consumed in melting this grease alone. This amount does not take into account the friction in the bearing due to the viscosity of the grease after it is melted, or other sources of friction. If a horse power is worth $75 per year, 0.071 horse power will cost $5.32, and this is the amount which may be wasted per year by using grease in a single bearing of this size. In a small plant where the engine is overloaded a horse power on the line shaft is worth much more than the above sum to the owner, and by using a good grade of lubricating oil in the bearings instead of grease, many plants would be able to install the extra machinery they need so badly, with no further load on the source of power.

Lubricating oils may be divided into two classes, viz., animal and vegetable oils on the one hand, and mineral oils on the other.

The former are all fixed oils, since the volatile and essential oils are not used for lubricating. Any attempt to volatilize them results in causing them to decompose. They contain a small amount of oxygen, and being complicated chemical compounds they are attacked by the oxygen of the air. Mineral oils being more stable are not attacked by it. The fixed oils that are most easily attacked by oxygen are the drying oils, which are of use to the painter; while it is the non-drying oils that furnish the lubricants.

Mineral oils are much more satisfactory than either animal or vegetable oils, and though they usually cost more their superior qualities outweigh the higher price. One reason for this is that oils of animal or vegetable origin contain more or less fatty matter which is apt to decompose, and form acids. These acids attack the bearing surfaces with which they come in contact, causing them to corrode and become pitted. This acid may, however, be neutralized by placing lead or zinc shavings in the oil and agitating it. The acid then combines with the metal, forming lead or zinc soap, which is easily separated from the oil. To prevent further acidity suspend a piece of either of the above metals in the oil tank. Such oils should never be used in a hot place, as in a steam cylinder. Even if the oil contains no acid when used, the heat will at once decompose it and acids will be formed.

In these days of large and high-speed engines the quality of the lubricant is of vital importance. However, it is by no means an uncommon thing for a firm to pay a large bonus for an engine of extra high duty, and then furnish the engineer with an inferior oil for the sake of saving a few cents per gallon. The falseness of this economy is apparent when it is known that there may be a difference of as much as 5 per cent in the efficiency of the engine by using an inferior lubricant instead of a good one. Also with inferior oils the wear and tear on brasses, journals, etc., may be serious, whereas with a proper supply of good lubricant there should be no appreciable depreciation. As a general proposition it is safe to say that the best oil is by far the cheapest in the end.

Competition is now so keen that the adulteration of lubricating oils has become very common. Whenever possible the safest way to avoid trouble and loss is to have samples examined by a competent chemist, who also has the means of testing their lubricating properties.

A good lubricant should have sufficient viscosity, or body, to keep the rubbing surfaces separated (the amount of body required varying with the duty to be performed), a low coefficient of friction, and a large capacity for absorbing and dissipating heat. It must vaporize at a high temperature and solidify at a low one. It must be free from grit, or acids, or anything that would injure the bearing surfaces. It must not gum up or decompose while in use, and it should not evaporate or catch fire under the conditions of service for which it is used.

In general, that lubricant should be used whose viscosity is the least required for the duty which it has to perform. This is due to the fact that, other things being equal, the friction in a bearing is proportional to the viscosity of the lubricant. Thus power is lost by using an oil of too great viscosity for the work done.

The manner in which the lubricant is supplied to the bearings is of vital importance. One gallon of good oil properly distributed to the bearings will do more good than a barrel of the same oil not properly applied.

The following rule can be easily learned, and applied to nearly all classes of bearings:—Introduce the oil at the points of least pressure and do not provide a means of escape for it at the points of greater pressure. It is quite easy to find those points of a bearing that are least subject to pressure, and with a little scheming the oil can usually be brought there. The means of escape most often found are oil holes and channels placed just at the crown of the bearing, where the pressure (for a vertical engine) is greatest.

When the pressure on such a bearing is intermittent the oil goes in when the pressure is taken off, and escapes again when the pressure is applied, and the bearing is able to support only a portion of the load which it could support if lubricated according to the above rule. It is almost impossible to lubricate such a bearing well if subject to a continuous load. Not a drop of oil will run down the hole at the crown of the bearing, and if oil is put in elsewhere it runs out of the hole at the crown.

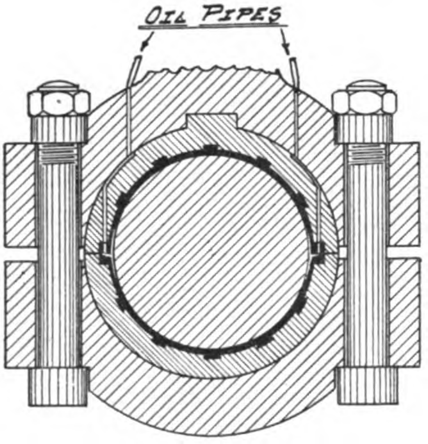


FIG. I. LUBRICATION OF CRANK END OF CONNECTING ROD ON A VERTICAL ENGINE.

The accompanying diagrams represent the principal bearings of a vertical engine to which this rule has been applied.

Figure 1 is the crank end of the connecting rod. In this case the two sides of the bearing are the points of least pressure, and oil is led to chambers at the sides. From these chambers suitable inclined planes are provided, and the oil will arrive at the surfaces which have to bear the load at a pressure equal to the load. It will be noticed from the illustrations that the means of lubrication are in duplicate. This provides for emergencies, and in the case of large bearings is strongly recommended, as otherwise one-half of the bearing must be lubricated by the oil which has passed through the other half; and in very large bearings this is not always sufficient, especially when they are new.

Another excellent way to oil the crank pin is illustrated by Figure 2. The crank disk is grooved and a ring is fastened to it. An oil hole leads from the bottom of the groove to the surface of the crank pin, and oil that is put into the groove will be carried by centrifugal force to the crank-pin bearing

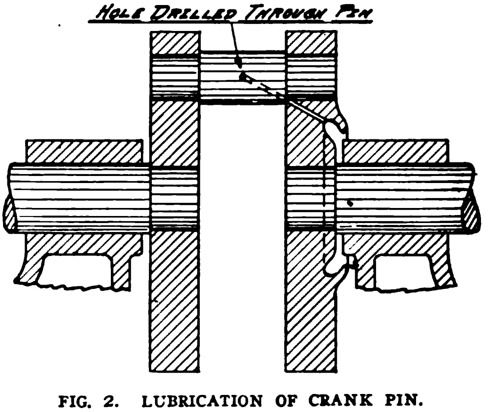


FIG. 2. LUBRICATION OF CRANK PIN.

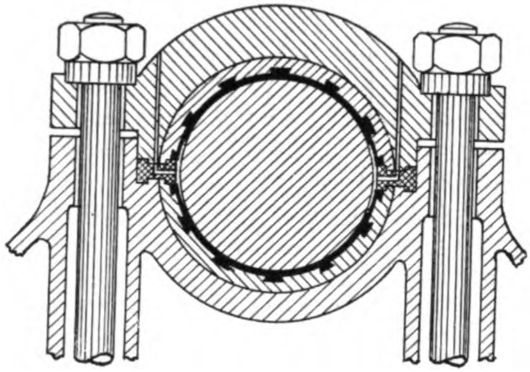


FIG. 3. LUBRICATION OF MAIN OR CRANK-SHAFT BEARINGS.

when the parts are rotating. The drip from the inner end of the crank-shaft bearing may be thus used for the crank pin or oil can be fed directly into the groove by means of a pipe leading to the under side of the crank shaft.

Figure 3 represents the main or crank-shaft bearings. The duty of these bearings is almost identical with that of the big end of the connecting rod. As will be seen, the method of lubrication is also the same.

It seems to be an established custom to make the under brasses of these bearings hexagonal or square, and carefully fitted to their seats. At one time it was customary to provide them with projecting faces, called chipping strips, to avoid the necessity of chipping and filing the entire outer surface. As steam pressures increased and engines grew larger this was found to be highly objectionable, since the brass was not supported at all points and deflected under the heavy percussive forces coming upon it; and the practice has become unpopular among engine builders. With improved machine tools this practice is now unnecessary because the whole surface can be machined almost as cheaply as a part of it only.

The square or hexagonal brass is open to objection for two reasons, one being that it is impossible to remove it from most engines without first lifting out the crank shaft. The other reason is that when it becomes hot it invariably changes its shape due to the varying thickness of metal, and eventually it breaks lengthwise through the crown.

The first of these evils is overcome by making the bottom brass cylindrical and of equal thickness throughout. It can then be removed by easing off the shaft from its seat and working the brass around on top. This style of brass is also easier and cheaper to machine than the others. The change of shape is also partly overcome by making the brasses circular, but even this form of brass is often found cracked through the crown. Both styles of brasses when hot expand along the inner or bearing surface. This tends to open the brass and make the bore of larger diameter, if not prevented by the cooler outside portion, and by the bearing seat. If the bearing becomes hot suddenly the resistance to expansion causes permanent set in the metal near the shaft, so that when cool again the brass contracts and grips the shaft. Sufficient friction will then be created to heat and expand the brass again, and at that temperature the shaft will run freely in the bearing. This is why some bearings always run warm. Repeated expansion and contraction of the metal causes it to crack, just as a piece of sheet metal may be broken by bending back and forth at a given point.

This action of the brass may be prevented by securing its two edges to the bearing seat by means of an H-shaped strip, as shown in Figure 3. If the strip be accurately fitted there will be no further trouble of this kind. This device is now used on marine engines of all sizes, and on many for land use.

Figure 4 shows the cross-head pin at the little end of the connecting rod. Here again the oil must be delivered to the sides the same as at the big end. The diagram shows the oil passages drilled in the cross-head pin. At the end a swivel joint (not shown) is screwed in and connected to a telescope oiling device. Oil is also conducted from this point to the big end by means of the two pipes shown in Figure 1.

A hot bearing is usually due to improper or insufficient lubrication, or to incorrect proportions. If the oil is supplied as shown by the diagrams, heating may be due to the fact that the shaft is not round, or is not running true with the bearing, or is not smooth enough. Still another reason may be that the bearings are not properly fitted. It is no small task to surface up a bearing so that the shaft bears evenly throughout.

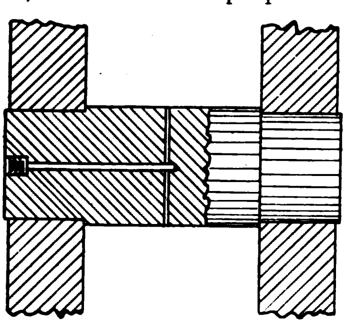


FIG. 4.

Never use emery, emery cloth, or sand paper for finishing or truing up a journal or bearing. If used the particles of emery or glass, being so hard, become imbedded in the surface of the metal and the bearing will always run hot. The best material to use is rottenstone, or powdered grindstone, mixed with a liberal amount of oil or water to "slush" out the particles of grit.

In general it may be stated that the smoother the surfaces of a bearing are the more satisfactory will be the service they will give.

It has been found that by burnishing the surface of a journal with a roller burnisher, pressed hard against it while rotating in a lathe, the friction of the bearing was lessened and more satisfactory results were secured. It is the practice of at least one of the railroads of the middle west thus to roll the journals of their car axles while turning the wheels in a lathe. However, a bearing which heats continually may sometimes be cured by draw filing the journal. In this case the longitudinal scratches on the shaft act as little pockets, or reservoirs, which carry the oil in between the surfaces and distribute it over them. The improvement in the bearing is no doubt due to more efficient lubrication alone.

To prevent injury to an oil-lubricated bearing if it runs dry through neglect or failure of the oiling device, sufficient grease to lubricate it for a reasonable period may be placed in a suitable recess formed in the bearing. As long as the lubrication is sufficient to keep the bearing cool the grease remains; but as soon as the temperature rises the grease melts, and flows to the journal.

In most cases where a bearing must perform heavy service the diameter should be made only large enough for the necessary strength and stiffness and the length is then made such that the unit bearing pressure will be sufficiently low.

The effect of the proportions of a journal may be illustrated as follows: Suppose a bearing of a given size is overloaded, and heats excessively, and must be redesigned. First, let the diameter of the journal be doubled, the length remaining as before. The total frictional resistance to rotation will be the same in both cases. The rubbing velocity is, however, twice as great as before, so the power lost in the bearing is doubled. This means that twice the amount of heat is generated in the larger bearing. The area of the surface which conducts this heat away is also doubled, so the amount of heat to be taken care of by each unit of surface is the same in both cases. Therefore, this bearing will heat as badly as the first one, and in addition twice as much power is absorbed by the second bearing.

Now let the length of the bearing be doubled and the diameter remain unchanged. The frictional resistance to rotation and the velocity of rubbing are the same as in the original bearing, so the power lost in friction, and the heat generated, is no more. But the surface carrying away the heat is twice as great, so the amount carried per unit of surface is diminished by one-half; and with these proportions the bearing ought to run cool.

So long as enough lubricant is fed to a bearing to keep the journal and box from touching almost any of the common metals could be used. The weakness of some of these metals or the injury which is apt to occur to them if lubrication ceases bars them from use in bearings except for slow speeds and light loads. Other metals, while efficient in all other respects, have a very high coefficient of friction, and should not be used.

A bearing that is used for heavy service continuously should be made of materials which will continue to run together even though lubrication is scanty, or fails entirely for a time.

Marine engineers seem to be very generally agreed that bearings should be lined with one of the alloys known as the white metals. These alloys have a low coefficient of friction, fuse at a low temperature, and pour readily like babbitt. They do not injure the surface of the journal when lubrication fails and in case of excessive heating they melt and flow out of the box. This is a valuable property for some classes of high-speed machinery where sudden stoppage by the bearing freezing would be disastrous.

The white metals may be divided into three classes. The first contains up to 80 per cent of tin, the second up to 80 per cent of zinc, and the third up to 80 per cent of lead. If we could be sure of always using an oil containing no acids, there would be little choice between these three classes. But those who are responsible for the lining of a bearing are not always responsible for the quality of oil used in it. Lead and zinc are readily attacked by the acids of lubricating oils, while tin is affected very little by them; so the safest way is to use an alloy composed principally of tin, and containing only enough lead and zinc to impart to it other necessary qualities.

Many of the bearing metals now used are too soft for heavy duty, and yield under a load of as little as 1,000 pounds per square inch. Such a metal is liable to squeeze out of place when in use. An all-around bearing alloy should stand five times this load without any yield.

It is a very common custom to hammer or peen the alloy after a bearing has been lined. If the alloy is as hard as is usually needed it will not be very ductile, and hammering cracks it in all directions. If, on the other hand, the alloy is ductile enough to stand hammering, it is certainly too soft for lining any bearing except those whose duty is light.

NEWER ORE-TREATMENT AND METALLURGICAL PROCESSES AND THEIR MACHINERY.

By Chas. C. Christensen

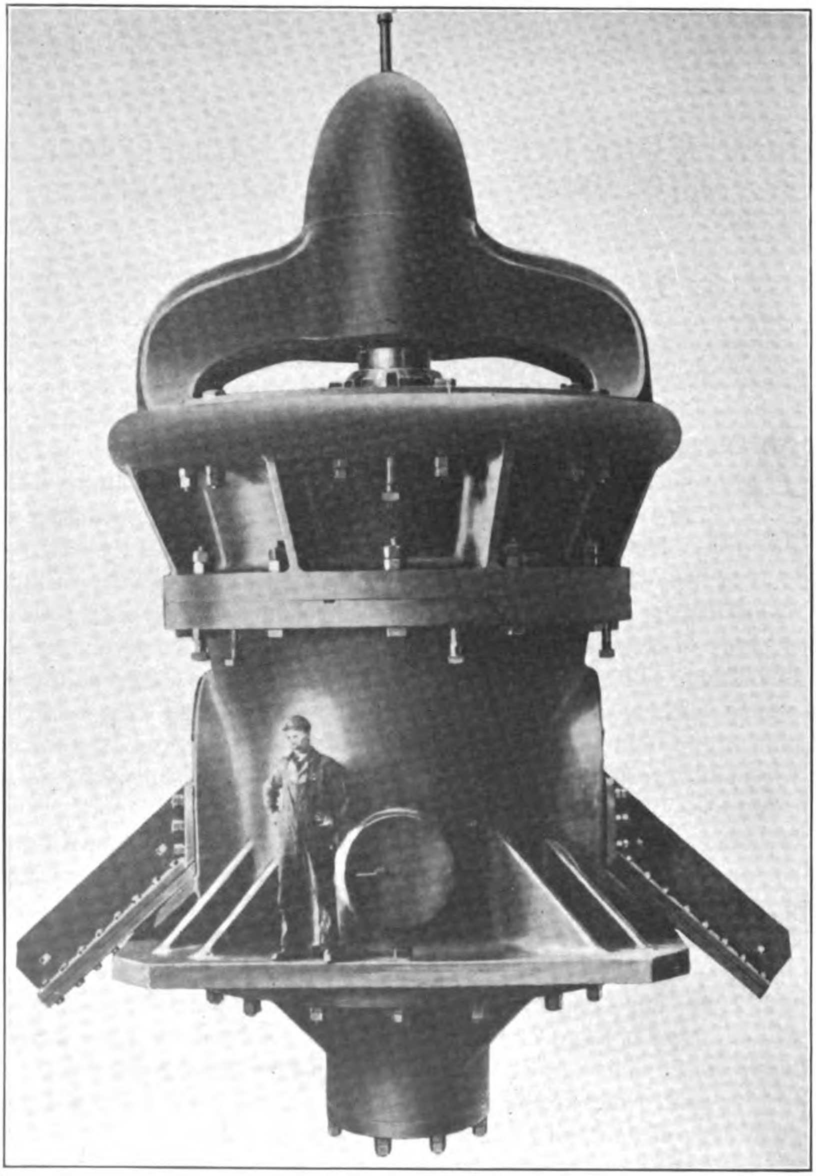
An Efficiency and Economy Number of THE ENGINEERING MAGAZINE would not be complete without some reference to the rapid progress in ore-treatment and metallurgical processes and machinery. Mr. Christensen's review deals with the latest practice in a few of the more recently developed processes, namely, the modern cyanide process, the lixiviation of oxides and carbonates of copper, the electrolytic treatment of copper sulphide ores, the Elmore vacuum process for the concentration of mixed sulphides, and, among new appliances, the electrically operated copper converter.—THE EDITORS.

ALTHOUGH the mining machinery of to-day is as perfect and prominent in design as are the new fast Cunard liners in their own element, new ideas make their appearance all the time. New processes are introduced and consequently new machinery must be designed to meet them. Mining engineers as well as mechanical engineers are kept busy—even in so-called panic times—to solve these new problems, to design and build the new plants, and to redesign and rebuild existing mills. A number of modern mining plants, each a masterpiece of engineering in itself, have been designed and built in the United States since the beginning of the century, and several more, at the time this article is written, are in course of construction in America and elsewhere.

A consideration of the changes in processes and in the machinery required may well begin with the examination of a modern cyanide plant as it should be designed today. I will assume that the predominating value of the ore is silver and that the pulp will require about 24 hours to be brought into solution. I will further assume that I can buy commercially an electric current, transform it down to the proper voltage, and distribute the power from the main switchboard to the motors in the mill, and I will distribute the motors so as to give unit drives to the several sections of the plant. I will figure on a separate crushing plant of double the capacity required, so as to run it in the daytime only, and I will assume the cyanide plant to treat about 200 tons of ore per day of 24 hours.

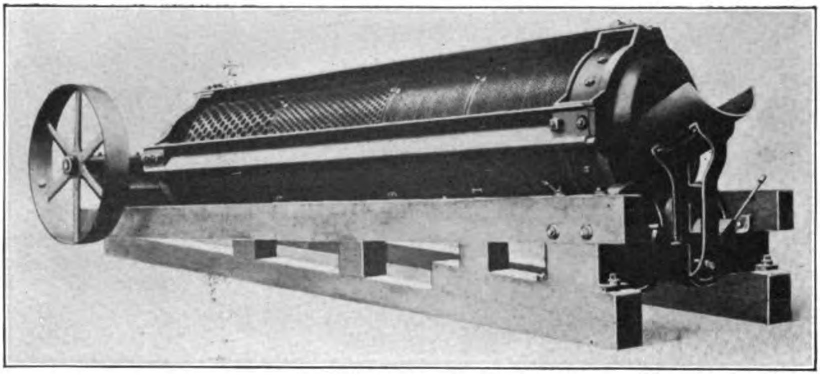
Following up these data the process and its machinery would be as follows:

The ore is taken from the mine in cars and discharged into a large steel ore bin, located in the crusher building, and the ore is



A LARGE GATES CRUSHER.

drawn therefrom through an ore-bin gate of the counterbalanced type, into a large Gates ore breaker. This gyrating type of crusher stands to-day as the leader among ore breakers. The crusher is set to crush all the ore to pass a 2-inch ring and the product is delivered to a continuous-bucket elevator, which elevates and discharges the ore into an iron-frame revolving screen 40 inches in diameter and 12 feet long, having 1-inch perforations. This revolving screen has no shaft, spider, or other obstructions to wear out or impede the free passage of the material to the discharge openings. It runs on rollers and is driven by a pulley placed on a countershaft, having a bevel wheel fastened to the periphery of the discharge end.

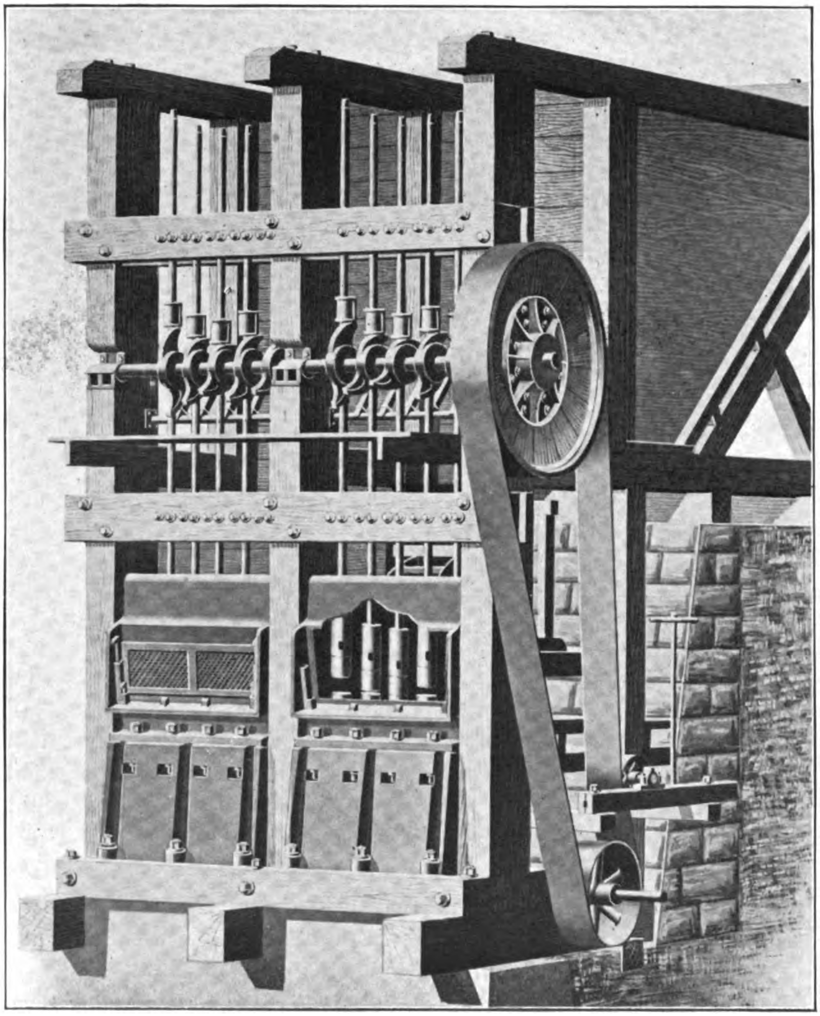


GATES IRON-FRAME REVOLVING SCREEN, LEFT-HAND DRIVE.
The Allis-Chalmers Co.

The product passing through the 1-inch holes is delivered directly to a belt conveyor and conveyed to the mill building. The rejections from the screen, or material which will not pass 1-inch perforations, is spouted into two smaller Gates crushers. These breakers, of the special short-head type for fine crushing, reduce these rejections to ¾-inch size and finer, and discharge the product direct on the same conveyor which receives the less than 1-inch material from the screen. This conveyor has a carrying belt 14 inches wide, and, if necessary, could be designed to travel up an incline of about 20 feet per 100 feet of length.

At the entrance to the mill building this belt conveyor discharges the ore on another conveyor of the same type and size, but operating in a horizontal plane. This conveyor is provided with an automatic tripper or distributor which travels along the whole length of the ore bins located behind the stamp batteries, delivering the ore automatically into the bins throughout their entire length.

At the point where the ore is discharged from the first conveyor on the second, a Cole automatic sampling device is placed to take samples of the crushed ore. This sampler is very ingenious. The arrangement is such that a sample scoop is made to pass through the ore stream and take a sample across the full width of the belt during

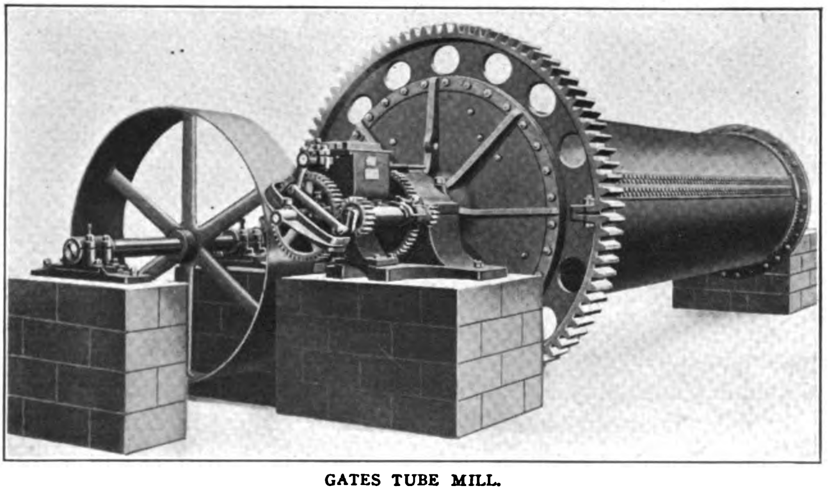


A TEN-STAMP BATTERY, CAST-IRON ANVIL BLOCK AND CONCRETE FOUNDATIONS.
The Allis-Chalmers Co.

its passage. By adjusting the driving mechanism the frequency of sampling can be arranged.

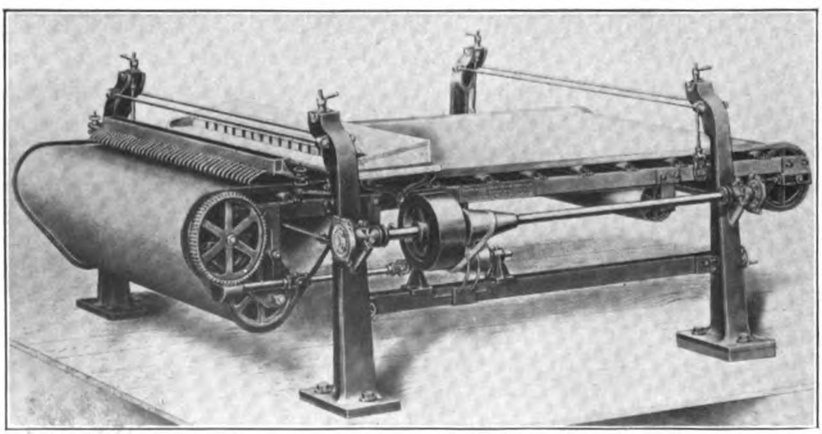
The crushed ore is drawn from the battery bins into the automatic feeders which are of the suspended or hanging type, arranged to be moved back from the mortars when necessary, giving a large working space for making repairs. There is one ore-bin gate for each five-stamp battery. Forty stamps are required, each weighing 1,050 pounds, and they are arranged in eight batteries of five stamps each, driven by belt with tightener from the line shaft. The batteries are made right- and left-hand, set in three post frames. The mortars, one for each five stamps, are of the narrow, rapid-crushing, quick-discharge type, provided with 12-mesh screens, and the principal battery parts are made of steel to insure maximum wearing life. The pulp from each five-stamp battery is delivered to a 24-inch sizer or cone classifier, which makes two products. The spigot or coarse product of each is spouted to a Wilfley concentrating table and the overflow from each cone is delivered to two Dorr classifiers. The tailings from the eight Wilfley concentrators—one for each five stamps—are also forwarded to the Dorr classifiers by belt and bucket elevators. In the Dorr classifiers the sand and the slimes are mechanically separated.

All the pulp is crushed to 150-mesh and finer in the tube mills. The Dorr classifiers separate that part of the pulp which is already crushed to this size and it is delivered to the thickening cones for concentration on vanners as will be described hereafter. The coarse sand product from the Dorr classifiers is discharged into two trunnion-style wet-grinding spur-gear-driven tube mills. These mills are arranged with silex flint-brick linings 4 inches thick, and the initial charge of pebble stones for each mill is 10 tons. The sands are all ground to 150-mesh or finer in these mills, each discharging its product into a classifying cone 4 feet in diameter. These cones are arranged for the purpose of separating from the product any sands which might have passed through the mills without being reground fine enough, and these sands are elevated back to the Dorr



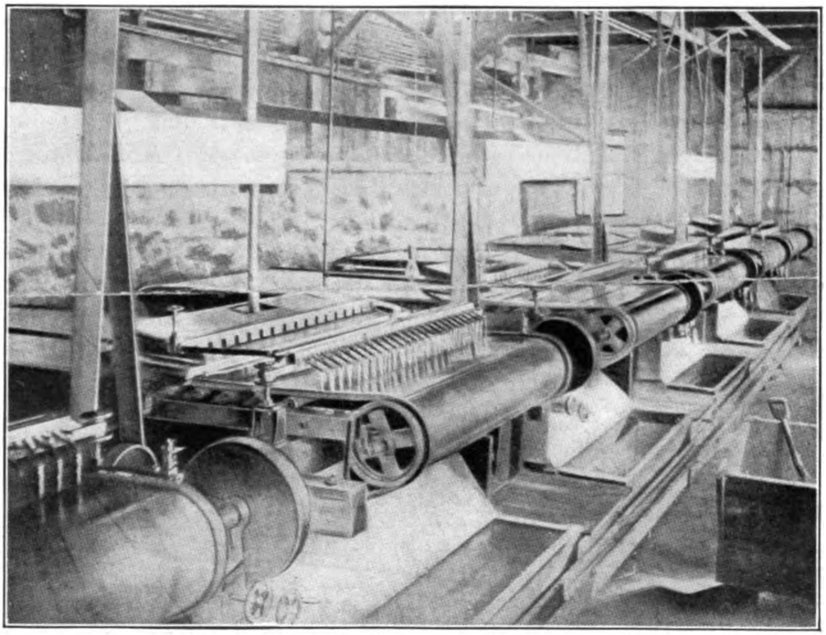
GATES TUBE MILL.
The Allis-Chalmers Co., Milwaukee.

classifiers to be fed again to the tube mills. The finished product is delivered to spiral sand pumps by which it is elevated to two large pulp-thickening or settling cones, where any excess of water is removed and forwarded to the cyanide plant. The thickening pulp from the bottom discharge is conveyed to Frue vanning machines or concentrators. This type of concentrator has an endless rubber belt supported by rollers so as to form a plane inclined rubber surface, bounded on the sides by rubber flanges. The belt travels up the incline and round a lower drum, which dips into a water tank in which the mineral is collected. In addition to the travel of the belt the latter receives a steady shaking or setting motion from a crank shaft along one side, the shake being at right angles to the inclination and travel of the belt. The pulp is fed on the belt about three feet from the head, and flows slowly down the incline subjected to the steady shaking motion, which deposits the mineral on the belt. At the head of the belt is placed a row of water jets which wash back the lighter sand, allowing only the heavy mineral to pass and become deposited in the water tank below, as already mentioned. The Frue vanners remove and collect any mineral particles in addition to what is saved by the Wilfley tables. This concentrated product is collected and dried, after which it is shipped to the smelter.



SUSPENDED IRON FRAME FRUE VANNER.
The Allis-Chalmers Co.

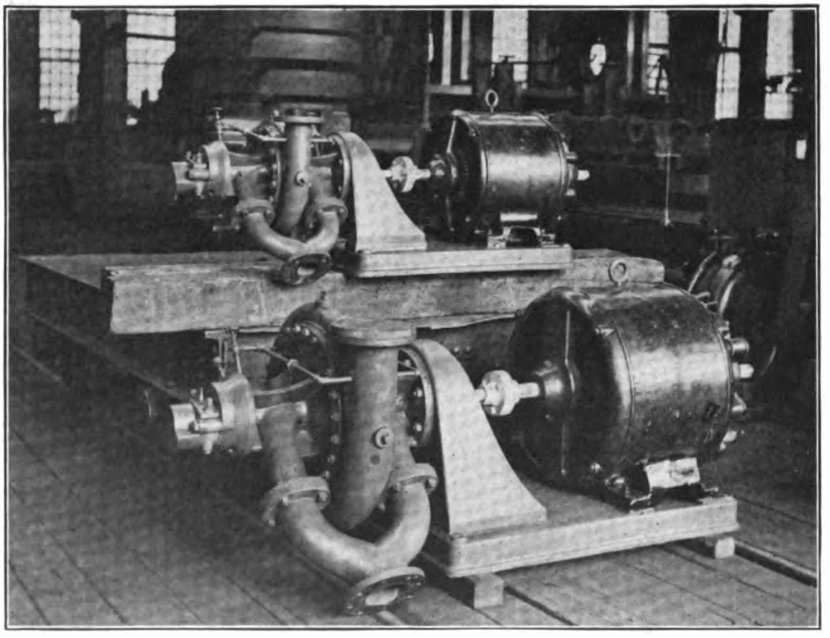
The tailings from the vanners and the overflow from the settling cones are delivered to any one of three de-watering tanks in the cyanide plant. These tanks are provided with filters through which the water is drawn off and flows to a final settling box, to collect any slimes carried in suspension, after which it is delivered to a water sump tank to be pumped back to the mill and used over again.



ROW OF FRUE VANNERS IN CONCENTRATOR ROOM OF A MODERN MILL.

The thickened and de-watered pulp from the settling tanks is drawn off from the bottom discharge through a pipe line connected to the suction of a centrifugal pump. This pipe line is arranged so that the contents of any tank can be drawn off, and a cyanide-solution pipe is connected to each tank to introduce solution if desired. The pulp is discharged by the pump into the agitator tanks, which are of the Hendryx type designed for rapid extraction of gold and silver by means of agitation in weak chemical solutions containing a small percentage of cyanide. The mechanical feature of this agitator is a cylindrical steel tank with a deep conical bottom. In the center of the tank is a large pipe which extends nearly to the top and the bottom, being supported by braces from the tank sides and having a circular wide flange at the top which slopes gradually toward the wall of the tank and permits the ore-pulp solution, in flowing over it, to be spread out into a thin umbrella-shaped sheet and to absorb an abundance of free oxygen. In this center pipe is a hollow shaft to which is keyed a driving pulley, near the top, and a number of pulp-solution-lifting screw propellers. A coil of pipe raises the temperature of the charge by means of hot water or steam. The revolutions of the propellers in the large pipe produce a strong upward current, resulting in a rapid and complete circulation of the pulp upward to the umbrella flange, where it spreads out, looses its velocity, and falls gently from the edge of the flange into the mass of ore-pulp solution, where its velocity is further reduced, and then it drops gently down to the bottom of the agitator tank.

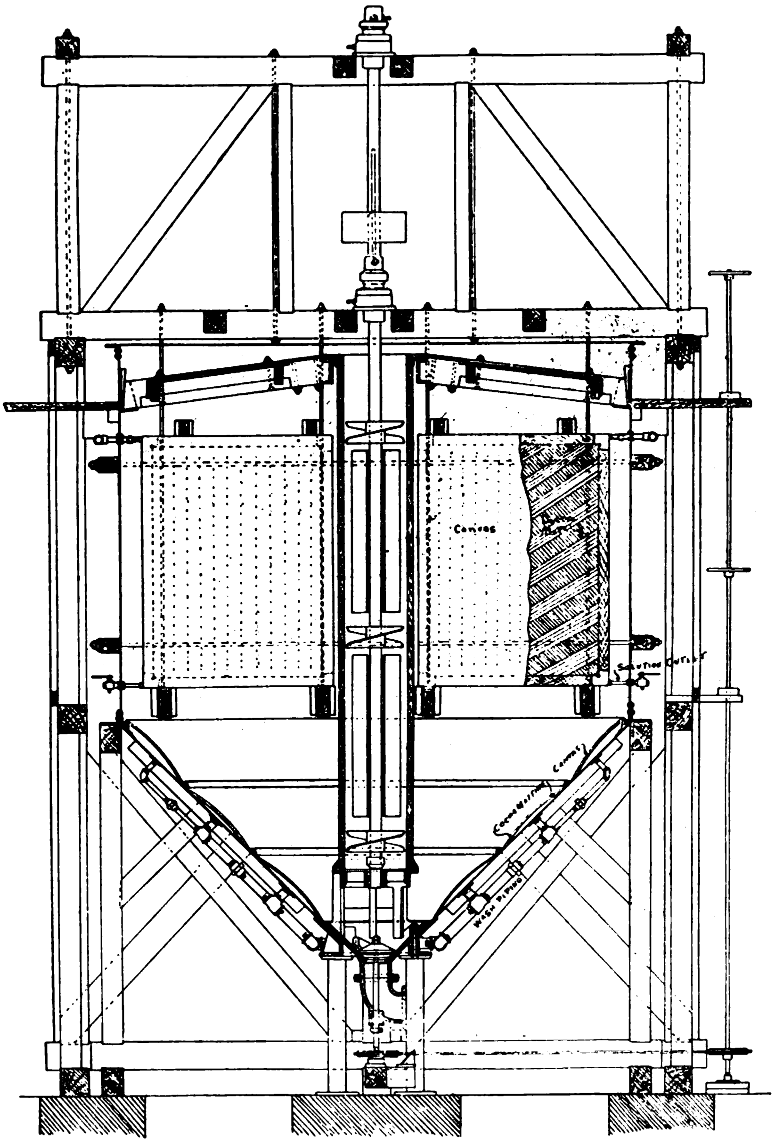
As already mentioned I have assumed the predominating value of the ore to be silver, requiring about 24 hours to be brought into solution; therefore I will figure on six 17-feet diameter agitators. After the required period of agitation, the pulp is drawn from these tanks by a centrifugal pump and delivered into the pulp-storage tank. In this tank the pulp is kept in gentle agitation and prevented from settling by a stirring gear, and from this tank the charges are drawn into the filter tanks as required.



SINGLE-STAGE ELECTRICALLY DRIVEN CENTRIFUGAL MINE PUMP.

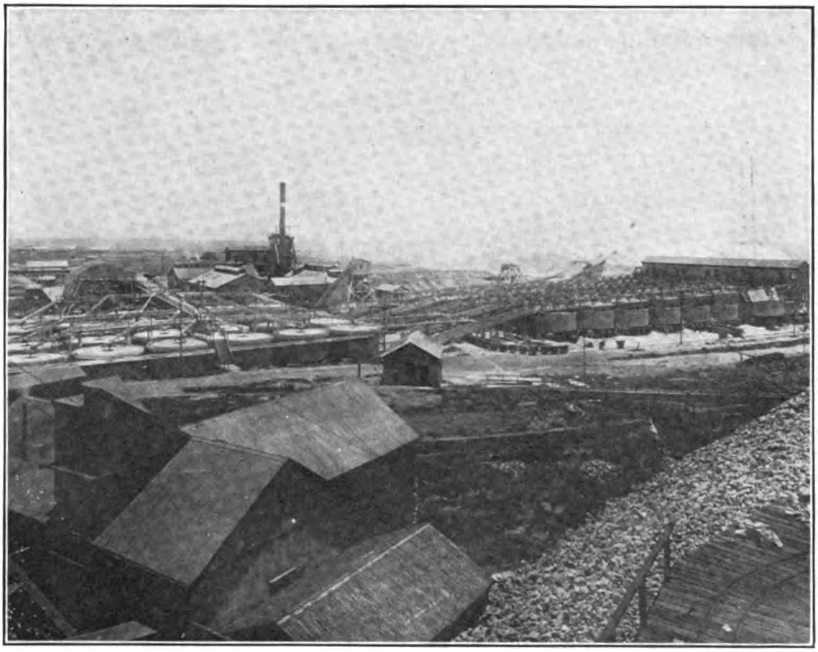
Capacity of 3-inch size, 250 gallons per minute; of 5-inch size, 800 gallons per minute. Allis-Chalmers Co.

For removing the solution from the pulp the Butters vacuum filter system is used. It consists of two filter boxes each containing 72 filter leaves. A charge of pulp is delivered to the filter box, and after removing the solution by a vacuum applied to the filter leaves, and following up with the necessary washes, the pulp is finally discharged through the bottom from the filter leaves and is sluiced out to waste. The solution is collected in a small storage tank and from there is pumped through a clarifying filter press into any one of three precipitating tanks.



HENDRYX COMBINATION AGITATOR AND FILTER.

By means of zinc dust introduced in the form of an emulsion, and with agitation by compressed air, precipitation is effected. The contents of the precipitating tanks are pumped up to the refining plant and



A LARGE OPEN-AIR CYANIDE PLANT IN SOUTH AFRICA.
The Simmer and Jack cyanide plant.

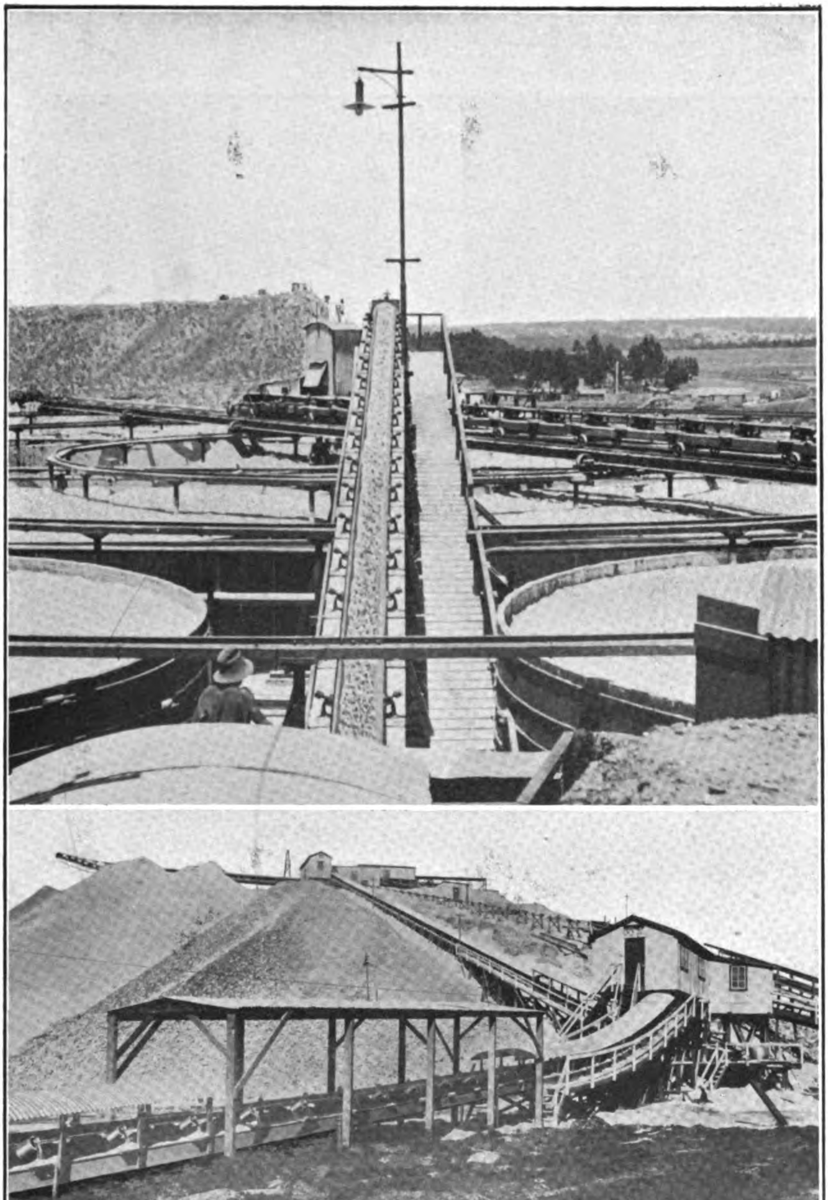
the precipitates are collected in the filter presses, through which the material passes. The solution is delivered to the storage tanks for restandardizing and used over again. The precipitates are dried and shipped to the refineries for reduction to bullion. The loss of cyanide of potassium is about 4½ pounds per ton of ore treated.

All elevators and pumps for handling water solution and slimes, for such a mill as described above, should be installed in duplicate to insure against stopping of the entire plant in case of repairs.

For a cyanide plant treating ores where gold is the predominating value the number of tanks and agitators will be reduced according to the time used for bringing the pulp into solution, and loss of cyanide of potassium in pounds per ton of ore treated will be proportionally lower.

Treatment of Oxides and Carbonates of Copper by the Leaching Process.

Ore of this character, is first ground to about 20-mesh, and run into the Hendryx agitator in the proportion of two tons of water to one ton of ore, the percentage of copper present having been previously determined. Sulphuric acid is then added in pro-

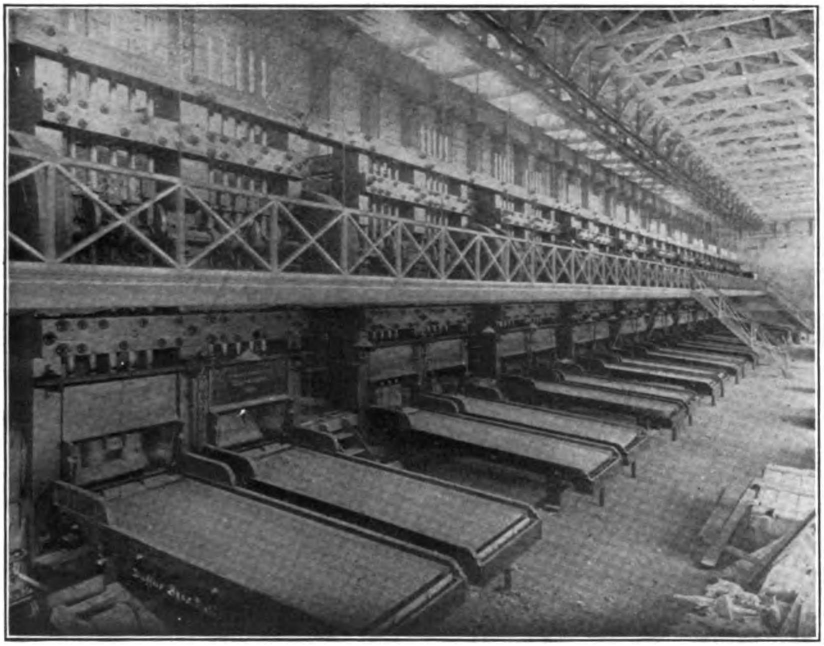


CONVEYING MACHINERY, JOINT CYANIDE PLANT OF KNIGHT'S DEEP, LTD., AND SIMMER AND JACK EAST, LTD.

Four 20-inch distributing conveyors over treatment tanks and four 20-inch refuse conveyors under, each 426 ft. long. Refuse is delivered to 30-inch conveyor 810 ft. long rising 20 ft. to foot of dumps as shown in the lower view, foreground. Thence a 30-inch conveyor 480 ft. long with a rise of 100 ft. more delivers the refuse to a 36-inch distributing conveyor. Ultimately a plateau ⅛ mile in diameter will be there built. Jeffrey Manufacturing Co., Columbus, Ohio.

VIEWS OF THE DREIFONTAIN AND ANGELO MINES, EAST RAND PROPRIETARY MINES COMPANY, EAST RAND, SOUTH AFRICA.
The upper view shows the slimes settling pond and the store house; the lower, the 220-stamp mill.

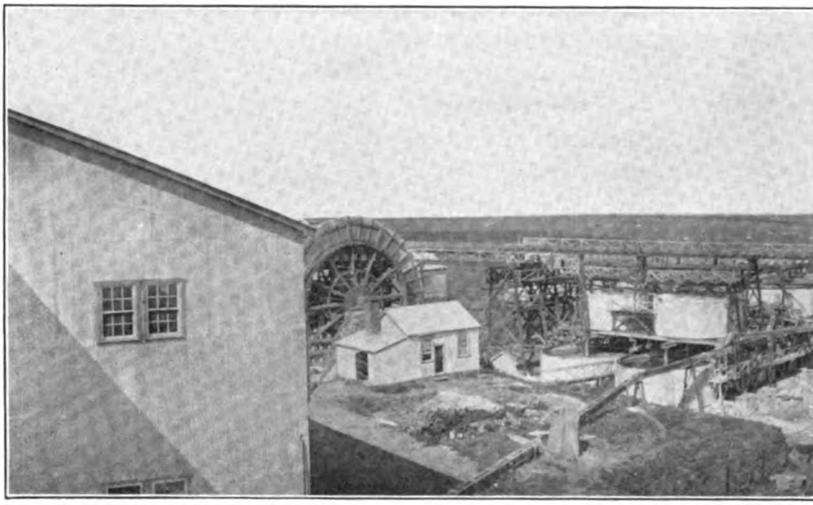
portion to the amount of copper present. The contents of the agitator are then heated by either steam or hot water, run through a coil of pipe, to hasten the dissolving of the copper. The charge is agitated continuously for a period of one and one-half to two hours, which is usually enough to dissolve all the soluble copper. Then the charge is allowed to settle, when 50 per cent or more of the copper sulphate solution is decanted off and run to the Hendryx copper precipitator.



INTERIOR OF DREIFONTAIN AND ANGELO 220-STAMP BATTERY.
East Rand Proprietary Mines.

Sulphite solution, barren of copper, is then discharged into the agitator to replace the decanted solution, and the contents, by agitation, are thoroughly mixed in a few minutes. The charge is then allowed to settle again when the clear solution is decanted in the same manner as above. The operations are repeated until the solution is recovered to a very high percentage. On the average ore, 96 to 98 per cent of the copper solution is recovered by means of three additions of wash water.

The copper sulphate solutions and wash waters are run to the copper precipitator, where the copper is precipitated by means of scrap iron and recovered as cement copper.

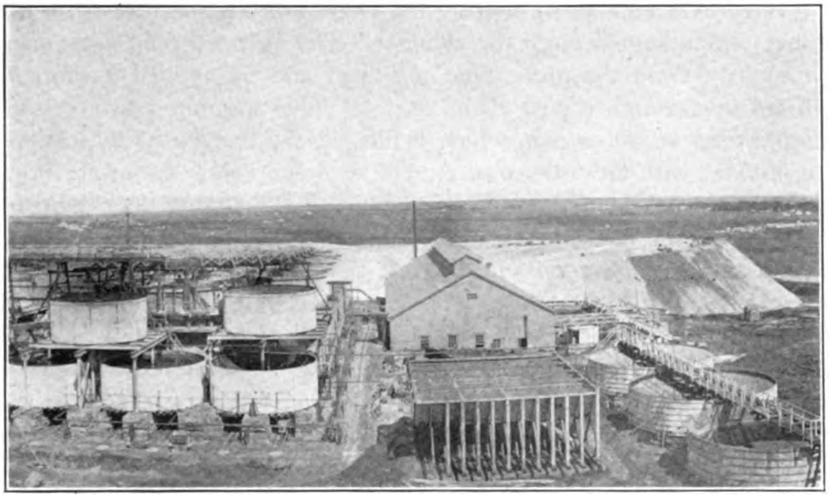


EAST RAND PROPRIETARY MINES, SOUTH AFRICA. PARTIAL VIEW, COMPLETED OPPOSITE.
Cyanide plant, Dreifontain and Angelo battery.

The precipitator consists of a cylinder with perforated heads at both ends and partly filled with scrap iron. The solutions enter at one end and leave at the other end. The cylinder is placed on rollers so that it can be rotated at a slow speed while the solutions pass through it. As soon as the copper solutions enter the cylinder, the copper is precipitated on the scrap iron and the revolving motion of the cylinder causes the scrap iron to roll and tumble, which liberates the copper from the iron. As soon as the copper is liberated from the iron it passes off with the solution to a settling tank and is there recovered as cement copper. The solution, barren of its copper, is returned to a storage tank to be re-used for washing purposes. The solutions are kept in contact with the scrap iron for such a short period of time that the consumption of iron only amounts to about one pound for every pound of copper recovered.

Treatment of Copper Sulphide Ores by Electrolysis.

The ore after it is ground to the desired fineness, is delivered to the copper agitator, which, for this class of ore, is equipped with electrolytic plates of an insoluble material. Agitation and heat are applied, sulphuric acid is added, and an electric current turned on. The iron in the ore is converted into a ferric salt which dissolves the copper. The copper is caught on the cathodes; the iron is oxidized and regenerated as a ferric salt. As soon as the copper in the ore is dissolved, the agitator is emptied, the solution filtered, the tails washed, and the wash water run with solutions previously filtered.



COMPLETION OF PANORAMIC VIEW, EAST RAND PROPRIETARY MINES.
Tailings dump, extractor house, and Comet mill in background.

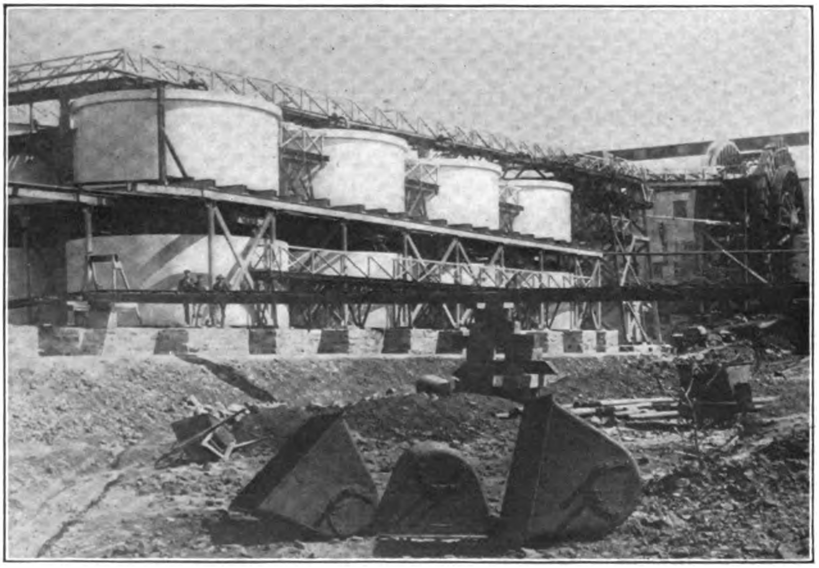
Thereafter the solutions are passed through electrolytic depositing boxes and returned to the supply tank to be used for the next charge of ore. The copper is stripped from the plates in the agitator from time to time, as well as from the plates in the precipitating boxes. The copper recovered is usually above 99 per cent fine.

THE ELMORE OIL PROCESS OR VACUUM-FLOTATION PROCESS FOR CONCENTRATION.

This new process is coming into prominence abroad. It is called after its inventor, F. E. Elmore, and is based upon the fact that, in a flowing pulp of water and pulverized ore, oil has a selective action for the mineral particles as distinct from the gangue or rocky substances. This selective power is much increased by the presence of an acid, and depends also upon the fact that the gases dissolved in water are liberated upon subjecting them to a pressure less than that of the atmosphere. These liberated gases may be increased by introduction from an external source or by generation of gases in the pulp. They attach themselves to the oiled mineral particles, and being largely increased in volume as a result of vacuum applied, cause the oiled mineral particles with bubbles of gas to float to the surface of the solution.

The machinery needed for this process is as follows:

The pulp from the crushing plant is discharged into a mixer—a horizontally placed cylindrical tank—into which is also introduced a small quantity of oil and of acid if needed. The agitation is performed by a number of stirring bars keyed on and rotating with the shaft extending through the cylinder. The agitated pulp flows continuously from the mixer into a funnel and by applied vacuum is lifted up through a pipe about 30 feet above the mixer to a conical separating vessel or pan, which it fills. Near the top of the cone is a launder with an outlet pipe extending down below the mixer flow. The rate of flow of the pulp down this pipe is slightly less than the in-flow up the feed pipe; a small amount of the liquid overflows the edge of the launder carrying with it the concentrates down through the outlet pipe into a water-locked settling tank. At the bottom of the cone is a double-armed rake slowly rotated by means of a worm gear, and the blades of this rake are placed at an angle sufficient to cause the solid matter in the pulp to travel from the center to the periphery of the cone, whence the tailings continuously escape through a pipe in the cone bottom.



PART OF THE DREIFONTAIN AND ANGELO CYANIDE PLANT.

The feed pipe is about 30 feet long, the concentrates and tailings pipes a few feet longer, making the feed pipe and the tailings pipe form the short and the long leg of a syphon; whereby the power required to elevate the pulp into the cone is supplied by the falling column of pulp in the tailings pipe. So long as a steady flow of pulp is supplied to the mixing cylinder, a steady and perfect automatic discharge of tailings and concentrates is secured. In the top part of the cone are several thick glass windows, through which the discharge of the concentrates over the lip of the launder may be observed.

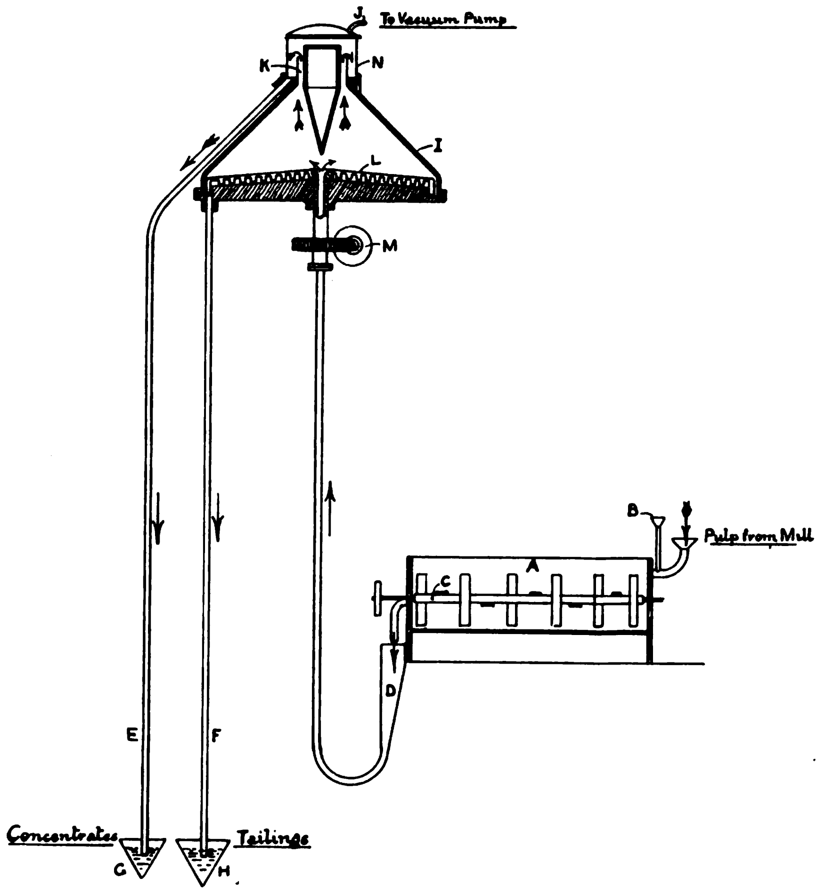
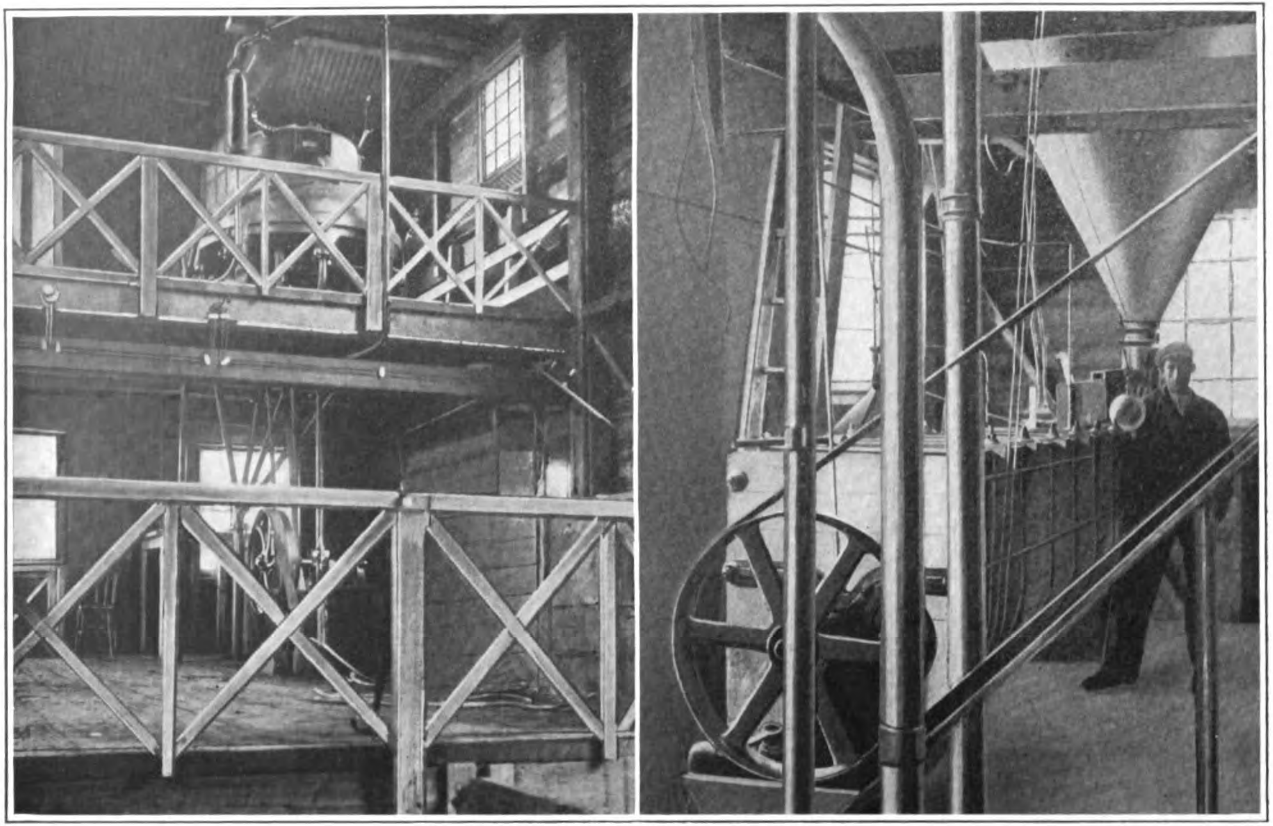


DIAGRAM OF ELMORE VACUUM CONCENTRATOR.

Ore Concentration Co., Ltd., London.

The mixing cylinder is about 2 feet in diameter, and the cone 5 feet in diameter at the bottom. The power required to run the mixer, separator, and vacuum pump, does not exceed 2½ horse power. The capacity varies with character of the ore to be treated, and the fineness to which it has been ground, running from 35 to 45 tons of crude ore per 24 hours.

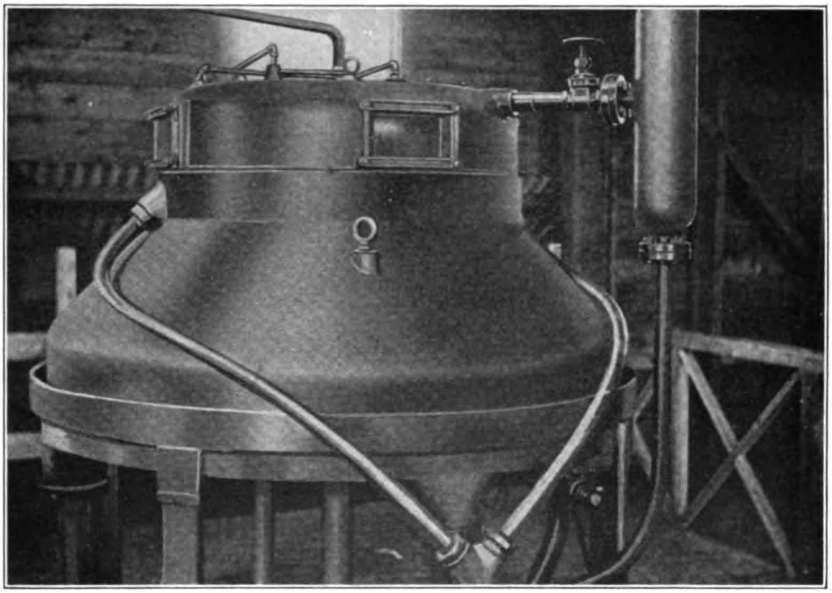
The quantity of oil and acid runs 3 to 10 pounds per ton of ore treated. Almost all kinds of oil are suitable—California and Texas crude oil, Texas residuum, Russian crude oil, fuel oil, Sumatra and



THE ELMORE VACUUM PROCESS AT DOLCOATH.

On the left, vacuum apparatus, with air pump below. On the right, mixer and settling tank.

Borneo cheap oils, blast furnace oils, olive-oil residues, oleic acid, fish oil, kerosene, etc.

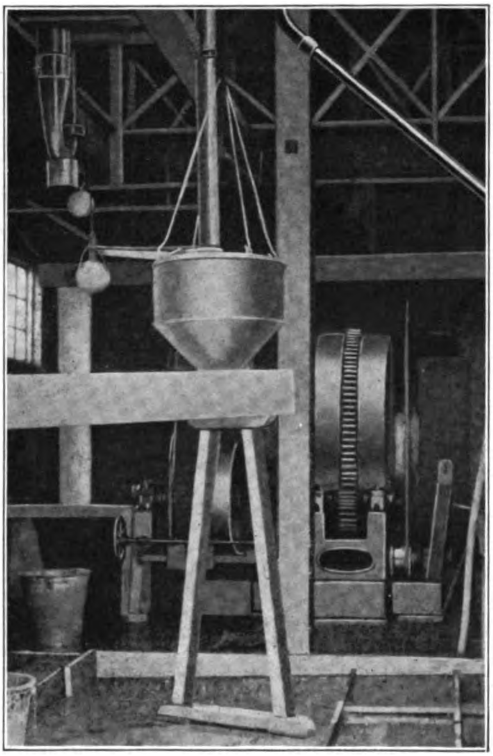


THE ELMORE VACUUM CONCENTRATOR.
Capacity 35 to 45 tons per 24 hours.

The process has been applied successfully to the concentration of ores which could not be concentrated by the usual methods. For example, galena and zinc blende are readily separated from a gangue of baryta, chalcopyrite from magnetite and spathic iron gangues, and copper sulphides from oxide of tin, leaving the tin in the tailings to be separated by the usual processes. Copper, zinc, and lead minerals are separated from garnets and other heavy gangues. Cinnabar and iron pyrites, carrying gold, are easily concentrated, yielding a high-grade product with clean tailings.

The Electrically Operated Copper Converter.

The newer converter plants have adopted the electrically operated copper converter. The evolution of machinery for converting copper matte into blister copper has consisted of a progressive series of improvements, due mostly to the many practical experiments made by the operators at the many plants throughout the mining world. By combining the latest ideas that have given the best results, and eliminating defects, it has been possible to create a converter which has many advantages over those used heretofore. In this new converter the bottom half is 84 inches in diameter, and from the center up to the



TAILINGS VALVE AND BALL MILL, THE ELMORE VACUUM PROCESS.

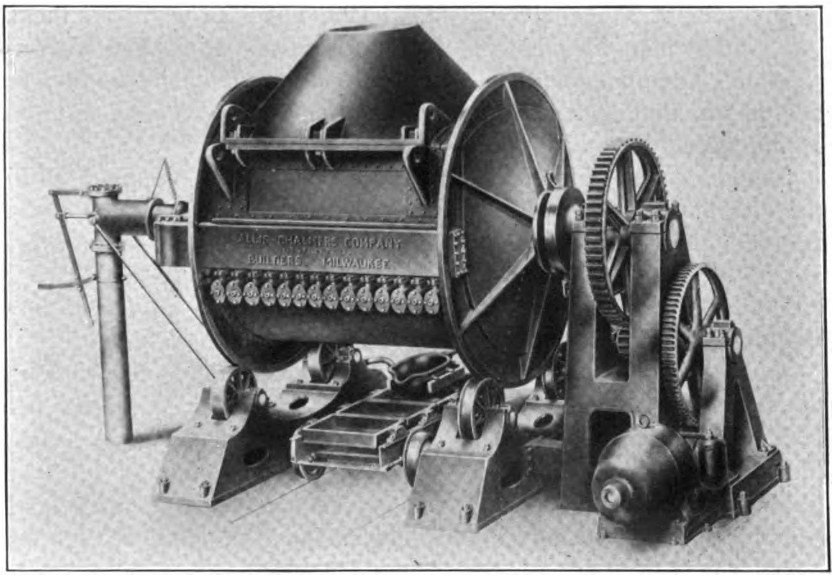
joint both sides of the shell are formed in a tangent to a width at the top of about 80 inches. The object of this is to do away with the unnecessary curvature above the center line to permit of a more secure lining being formed in the converter.

The parting joint between the bottom half and the top half of the shell is considerably higher than in former designs, the idea being to keep it as high as possible and away from the extreme action of the molten copper. The bottom section of the shell is made of flange steel 126 inches long, rigidly attached at both ends to solid cast-steel heads with riding rings cast on. The heads are spherical in shape and reinforced with heavy ribs to reduce expansion and contraction resulting from the intense heat. At the joints on the lower half of the shell are riveted on cast steel reinforcing plates provided with four lugs for lifting the shell. These reinforcing plates are also arranged for bolting on the top half by extra heavy bolts on each side.

The wind box is rectangular in shape, and consists of a plain casting which is placed close to the shell and underneath the riding rings, thereby permitting the shell to make a complete revolution, doing away with the stop placed on the riding rings to protect the wind box and prevent the shell from turning too far. This changed location of the wind box is a great improvement, because with the old stop arrangement it was necessary to be very careful in turning; otherwise the operator would throw the shell off the stand, thus causing a serious accident.

The individual tuyeres are another noteworthy improvement.

There are fourteen Repath individual tuyeres, each provided with a Dyblie ball valve. Each tuyere is secured to the wind box by swing bolts and the discharge end, which is at right angles to the inlet, projects several inches inside the shell, and is secured to the shell through a cast-steel stuffing box. This stuffing box is bored out to suit the projection on each tuyere, and is arranged for holding asbestos packing. Each tuyere is arranged so that the ball valve and its seat are self-contained and the valve can be taken out and rapidly replaced. On the air end of the shell the cast-steel head is arranged to receive the end of the wind box, which is provided with a ball-joint concave flange, and receives the stationary air nipple at the patented blast connection.



ELECTRICALLY DRIVEN COPPER CONVERTER, MODERN TYPE.

The converter is 84 by 126 inches. The Allis-Chalmers Co.

For turning the shell the stand is provided with a 30 horse power direct-current, variable-speed, multipolar, enclosed-type, series-wound motor for 110 volts and 600 revolutions per minute, which is geared up to the main drive shaft so that the maximum speed of the shell is reduced to 1½ revolutions per minute. In plants where alternating current is available, induction motors are of course used.

A sheet-steel housing covers all the driving gears and the motor complete. The capacity of the new converter is about 780,000 pounds of copper per month. Its size is 84 by 126 inches.

SYSTEMS OF WAGES AND THEIR INFLUENCE ON EFFICIENCY.

By Carl Bender.

In the following article, both the graphic method of presentation and the clean-cut definition afforded by comparison combine to show the nature, effect, and limits of the best-known wage systems. The article will be valuable as a standard of reference to all students of shop efficiency as affected by the mode of payment for work.—The Editors.

THERE are two parties primarily concerned in wages—(1), The man who receives them; (2), The man who pays them. The man who receives wages desires that they be as high as possible. The man who pays wages desires, not so much that they be low, as that they afford the largest margin of profit between cost and selling price.

Reconciliation of the two interests, if at all possible, must lie in the direction of relatively high wages and relatively low unit costs. By relatively high wages is meant an earning power above the average of the class or trade in the locality. By relatively low costs is meant costs below the average of competitors. In so far as any system of wages does not attain both ends, it is defective.

Furthermore, that condition is best which secures to the workers the largest aggregate amount of wages; one hundred dollars per month as a total to two men is better than sixty dollars to one man, the other one being idle.

Workers concede that rates for different kinds of work may vary, but would prefer that all men working in the same grade receive the same rate irrespective of efficiency. The wage payer is generally willing to pay a higher rate for a higher efficiency. The rate of wages however is constantly fluctuating, sometimes rising, sometimes falling, even for the same work in the same trade, and rates of wages as well as earning power fluctuate as to the same man. Sometimes he is employed, sometimes not; sometimes he is in one part of the country, sometimes in another; he may for a time be promoted to a foremanship and then drop back again. The extreme variation for unskilled day laborers within the territory of the United States runs from $0.50 per day in parts of the South, to $15.00 per day, at certain gold camps in Alaska.

An improved system of wages is one which will fulfill the following conditions:

1.—A guaranteed rate per hour for each grade for a contract period.

2.—An average earning power continuously higher than usual.

3.—A progressively lower cost to the wage payer, as wages automatically increase.

4.—A supplemental earning power to the worker above day rate, the supplement being based on the efficiency of the worker.

Whether such a system is attainable or not, various systems of paying wages will be enumerated and discussed with reference to these requirements.

All facts as to wages can be put into very simple diagrams. Such diagrams can be made to show:

1.—The rate per hour to the worker.

2.—The total cost per hour to the wage payer.

3.—The rate per piece to the worker.

4.—The cost per piece to the wage payer.

In this study, only diagrams as to rate per hour will be used.

Costs may be divided into wage costs and all other factory costs. Other factory costs can be subdivided into (a), machine rates, and (b), all other overhead charges, generally assessed at so much per productive hour or at so much per dollar of productive wages; it makes little difference which.

Both machine rates and overhead charges increase as hours are shortened, whether owing to shorter days or fewer men. Even if a plant is wholly shut down, such heavy items of expense as insurance, taxes, depreciation and interest on investment remain. Except incidentally, overhead charges will not be drawn into this analysis of systems of paying wages.

In the day-wage diagram shown on the next page, it is assumed that a job should be done in seven hours and that it should therefore cost $1.75 for wages.

Wages and wage cost are in exact proportion to the time the worker is present. If the worker can be driven harder, he earns no more per hour, but his work costs less. If he takes it easy he earns no less per hour, but his work costs more. Day wages were merely a step in advance of slave labor—existed side-by-side with slave labor—and both were based on the supposition that an overseer should stimulate activity much as a driver by various encouragements, abuse included, stimulates a horse. The great objections of the wage payer to this system are; first, that it requires an overseer, one man to do the

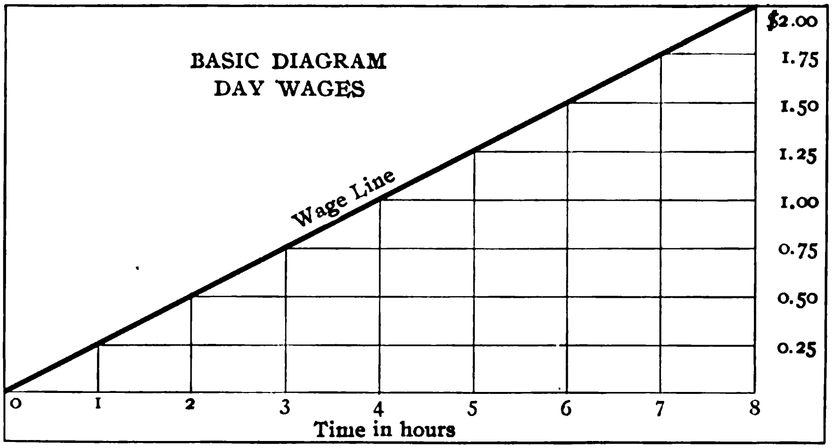


FIG. I. DIAGRAM OF WAGES UNDER DAY-PAY SYSTEM.

work and another to force him to do it; and second, that he (the wage payer) never knows what the work will cost him for wages.

The usual objection to it, from the wage-earner's point of view, is that it puts the best man on the same level as the worst. A worker does not earn in proportion to his efficiency. The results are:

1.—That the more enterprising men are out of sympathy with their surroundings and are lost to the class that most needs them, become strike breakers, etc.

2.—That many men resort to trickery and treachery for advancement rather than to efficiency. They increase their pay by accepting bribes or stipends to spy upon their fellows.

PIECE RATES.

Piece rates were hailed as a great discovery. The wage payer sees in them the means to accomplish for himself several desirable results.

1.—He unloads on the worker the responsibility for everything that goes wrong. This is both unjust to the worker and deleterious to the payer, as it is the payer's, not the wage earner's, business to ameliorate general conditions.

2.—He establishes a fixed cost per piece, which is at least convenient. Moreover, he is temporarily spared any worry over the fact that the cost is not as low as it should be.

3.—The worker who does not deliver the tally is punished by being paid less.

4.—Efficient workers are rewarded by higher earnings, (until their piece rates can be "trimmed").

Piece rate has not proved satisfactory because it rests on a fundamental fallacy—namely, that permanently just rates can be predetermined. Conditions are constantly changing. These changes must be met by a change in rate, either up or down. If a rate proves too low, the worker at once clamors for an increase, and if he can make out a case, obtains it. If it is too high, he makes no complaint, but nurses the soft snap. To correct the rates that seem to him too high, the payer waits for a favorable opportunity and reduces horizontally all the piece rates. Every action of this kind arrays worker against payer. Reason and justice are shoved to one side; brutal ability to further his own advantage, whether by worker or payer, is substituted.

It stands to reason that when the invention of high-speed steel and the building of new wheel lathes reduce the time of turning tires from eighteen hours to one hour, the same piece rate per pair of tires cannot stand, especially as the worker contributed nothing towards the reduction; but, on the other hand, managers have so little understood the delicacy of the piece-rate problem that they have ordered piece rates to be installed on three-days notice, trying to adopt, wholesale, rates not only from other shops in a different part of the country, but initially inaccurate. To establish piece rates in this manner is to sow the wind and reap the whirlwind.

Moreover, the only way a man in the office judges of the correctness of a piece rate is by the earnings of the worker, and fair rates to extremely efficient men are trimmed impartially with too easy rates to inefficient men. A worker, made wise by experience, attempts to protect his rates by limiting his output; so that usually the moral state of a piece-rate shop is decidedly more unfavorable than that of a day-rate shop, both as to employer and employee.

The diagram shows that if the worker fails to do the job in six hours, he earns less than $0.25 per hour; if on the other hand he does the job in three hours, he earns $0.50 an hour. Piece rates share with day rates the advantage of permitting the worker easily to calculate and keep tab on his own earnings.

Systems that are more complicated leave often in the mind of the worker the impression that his wages are being juggled and that he is probably being tricked out of what is justly due him.

Halsey Premium Plan.

To mitigate to some extent the evil workings of piece rates Mr. F. Halsey invented the premium plan shown in diagram on the next page.

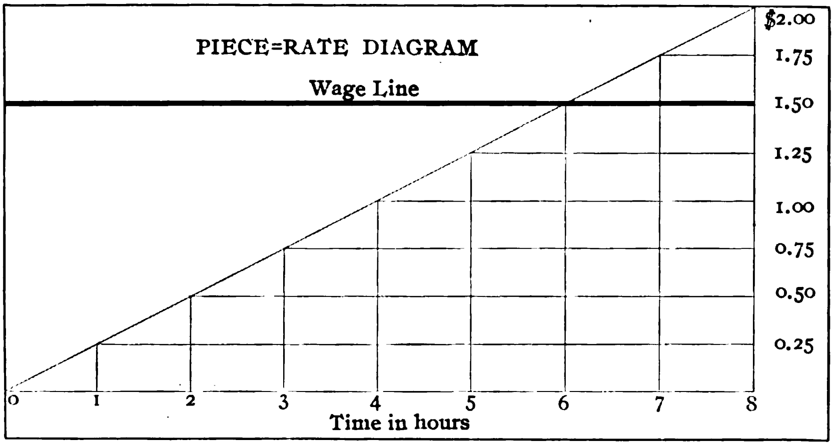


FIG. 2. DIAGRAM SHOWING EFFECT OF PIECE RATES ON WAGES.

The slant of the wage line may be at any angle from horizontal, straight piece rate, to coalescence with day-rate line. This system possesses at least four valuable points:

1.—It pays day rates if a longer time is taken than standard.

2.—It is a very flexible system and can be adapted to different conditions.

3.—It lessens but does not obviate the necessity of changing rates.

4.—It lessens but does not wholly remove the inclination to limit output.

It is in one respect a step backward, since it substitutes uncertainty for definiteness as to wage costs. Nevertheless the Halsey system

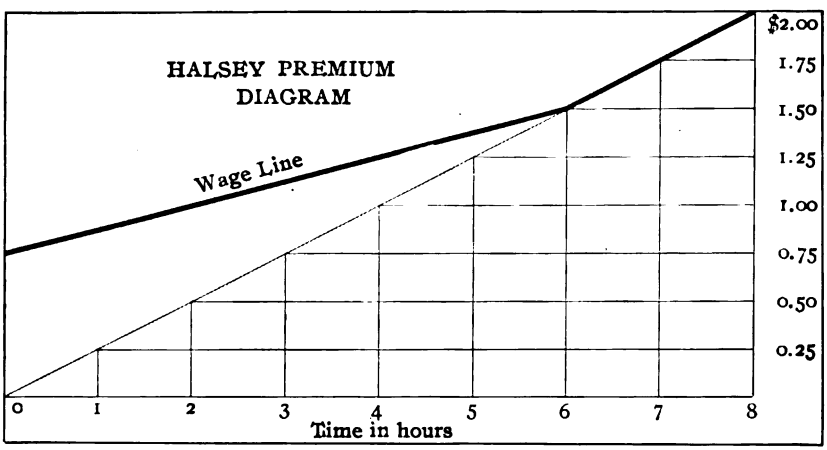


FIG. 3. DIAGRAM SHOWING OPERATION OF HALSEY PREMIUM PLAN.

was an admirable step in advance. Usually the worker is given either one-half or one-third the time he saves. Psychologically it is much better than piece rate, since most workers are more inclined to lessen their time than to increase the number of pieces turned out. A man will deliberately decide that he ought not to turn out more than five pieces a day, but he will not feel the same desire to avoid breaking his own record of two hours per piece.

Under the Halsey system, no limit is placed on a man's earning power per hour, and also a minimum piece rate of one-half or one-third the initial rate per piece is allowed, so that if a man worked on his own time he would at least receive per piece one-half or one-third standard pay.

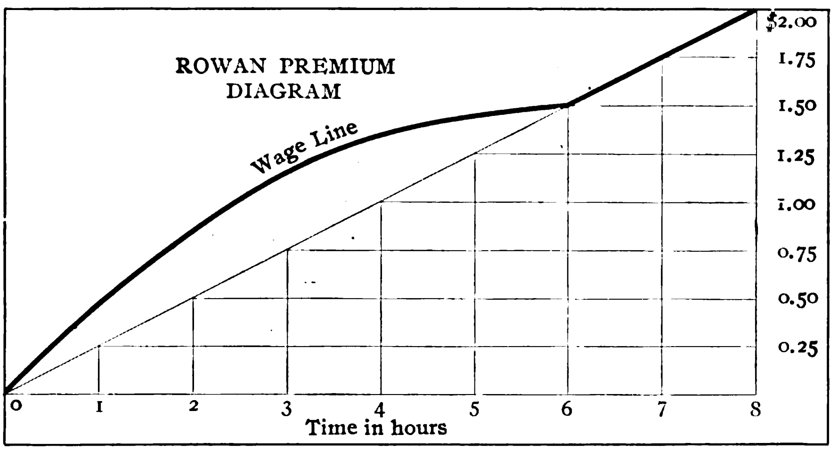


FIG. 4. DIAGRAM OF ROWAN PREMIUM SYSTEM.

The Rowan System.

This is a peculiar modification of the Halsey system and rests on assumptions both fallacious and inhuman.

The theory is that however great a man's efficiency, he must not be allowed under any circumstances to earn more than double pay. Therefore if a time is set at six hours, and the worker saves 10 per cent, or 36 minutes, he is allowed an increase of 10 per cent in wages. If he saves 20 per cent, or 72 minutes, he is allowed 20 per cent increase in wages. If he saves 90 per cent of the time, or 324 minutes, he is given 90 per cent increase in wages. *If he saved all the time he would get nothing, either in wages or premium.* Also, he obtains no more bonus per piece for reducing the time 90 per cent than he does for reducing it only 10 per cent. If two men, therefore, had the same premium job of 6 hours, and one did it in 36 minutes and worked the balance of the day at day rates, while the other did it in 5 hours and 24 minutes and worked the balance at day rate, both men would receive the same total wages and the same premium, although one had done ten times as much work as the other.

The excuse for the plan is as fallacious as its theory. It is assumed that bad mistakes may be made in setting the initial time, and because the worker is prevented from earning a high premium therefore the wage payer avoids risk of loss from excessive pay. This is however an entire mistake. If initial times are set 25 per cent too high, the workers will be regularly paid 20 per cent more than they legitimately deserve, so that for moderate mistakes, the Rowan plan pays more than the Halsey plan. The Rowan plan is in reality nothing but a day-rate plan, with a slight premium to those day workers who come down to a certain limit. It might properly be called a differential day-rate plan. A slight modification of the Halsey plan is one in which the premium does not begin immediately.

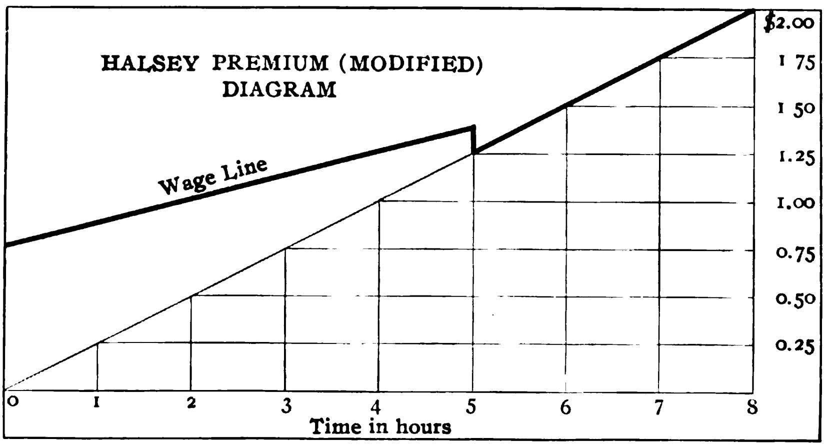


FIG. 5. DIAGRAM OF HALSEY PREMIUM PLAN, MODIFIED.

Taylor Differential Piece Rate.

A fundamental departure was made by Mr. Fred W. Taylor, in his differential piece-rate system. Mr. Taylor does not establish an initial time by guess or by assuming a more rapid gait than on day work, nor does he appropriate other unscientifically determined times. His method is to standardize all conditions in the shop, to make them as perfect and smoothly acting as circumstances will permit, and then to determine a reasonable minimum time in which the job can be done. As a result, Taylor's standard times are very much lower and also very much more carefully and accurately determined than under

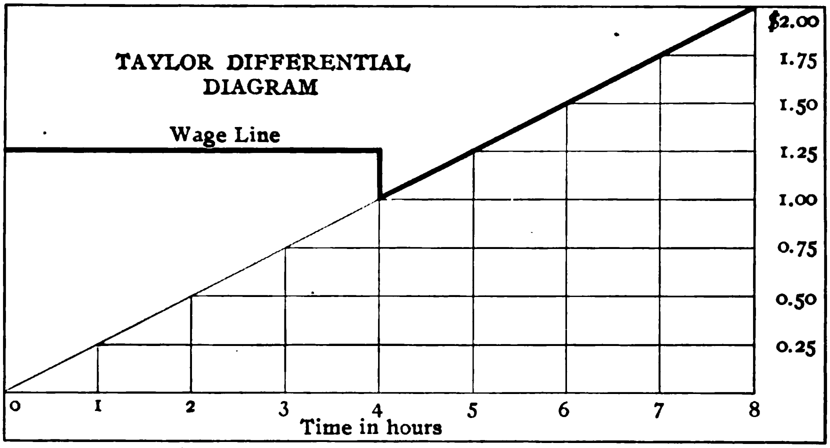


FIG. 6. DIAGRAM OF TAYLOR DIFFERENTIAL PIECE RATE PLAN.

any system hitherto considered. Mr. Taylor scorns the suggestion that by any chance the worker could earn excessive wages. Any wages that an unusually efficient worker can earn are legitimately his own. Assuming that under the Taylor system a worker should do four pieces in 4 hours, his wages for the time would be $1.00, but Mr. Taylor allows an increase of 20 per cent, 25 per cent, 30 per cent, or even more, according to the class of work, for attaining standard time. Let us assume 20 per cent increase. The worker then receives for four pieces in 4 hours, $1.20, a rate of $0.30 each. For less than four pieces the maximum hourly rate is $0.25, therefore $0.25 each. If the worker only delivers three pieces in 4 hours, his earnings are only $0.75, or $0.1875 per hour. Mr. Taylor's system awards therefore a heavy and increasing premium for high efficiency, a heavy penalty for low efficiency.

The method of standard-time determination is so rigorous that the worker cannot figure on curtailing his output. He has to hustle to make wages even at the low piece rate, and if he succeeds in this a very little extra effort will give him a higher piece rate.

The excellence of the system lies in the accuracy with which proper rates are predetermined. It is, however, somewhat inflexible and not so well adapted to work in which unforeseeable variations in time occur.

THE GANTT BONUS SYSTEM.

Mr. Gantt, a disciple of Mr. Taylor, introduced at the Bethlehem Steel Company a bonus plan.

As in Mr. Taylor's system, the proper time is most carefully and

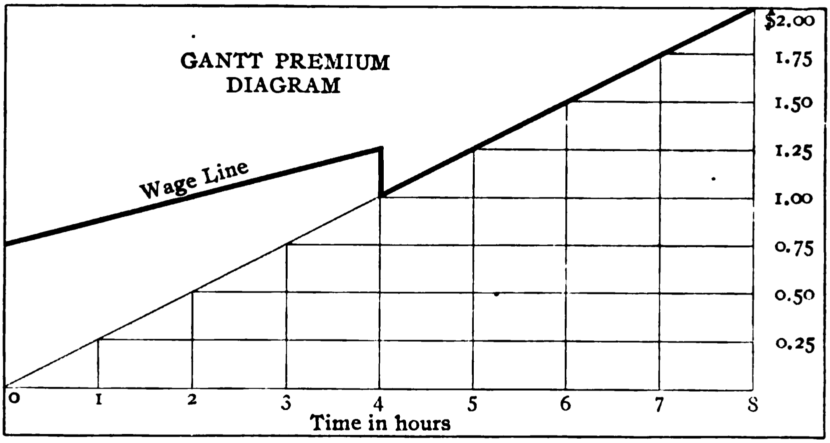


FIG. 7. DIAGRAM OF THE GANTT PREMIUM PLAN.

accurately predetermined. If the worker reached the proper time he is given a bonus of 25 per cent above normal wages for the time. If he does still better he is given half of what he makes, as in the Halsey plan. If he does not reach standard time he is paid only 75 per cent of normal wages for the excess time, provided bonus earned permits the imposition of this fine. If he had bonus to his credit he would not be fined, however much he fell below standard.

This system has shown certain psychological disadvantages in practice:

1.—The men have made it a point of semi-honor, among themselves, not to do better than standard times.

2.—Although the actual fines for failing to reach standard times were insignificant, the men claimed that they were being robbed of thousands of dollars in this manner. Neither fall-downs nor ability to lessen standard time are always up to the man. It is therefore unfortunate, when a favorable chance occurs to lessen time, that the worker deliberately holds back. It is also often unjust that he should be fined for what may not be his fault.

Actual experience with these different wage systems brings out the fact that psychology accounts for quite as much as any other condition, and that a good wage system must not only be fair but must also hit the men right.

Emerson Efficiency System.

The most recent wage system is the "Efficiency System," evolved and perfected in theory by Mr. H. Emerson and his assistants and practically applied by the officials in the shops of the Santa Fé Railway.

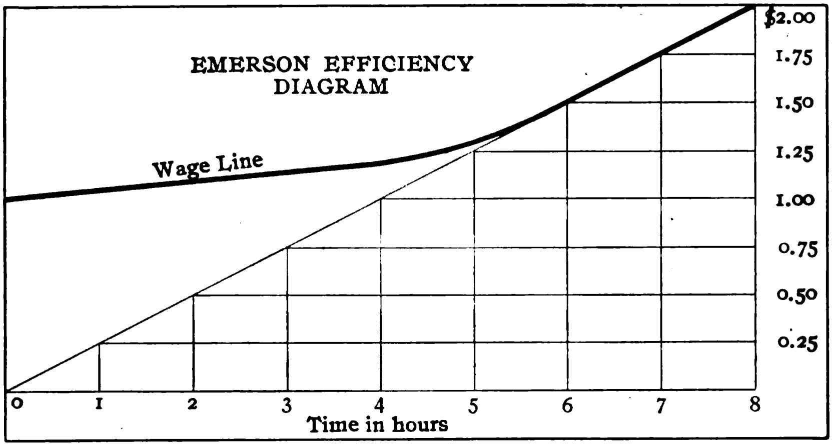


FIG. 8. DIAGRAM OF THE EMERSON EFFICIENCY PLAN.

This wage system superficially resembles the Halsey line, but in theory and in fact differs radically from all previous wage systems, although it embodies much that was best in all of them. It retains the principle of day pay irrespective of performance. It retains in modified form the principle of a flat piece rate. Like the Halsey system, it pays more per piece for less competent work. Above all, it retains Mr. Taylor's and Mr. Gantt's principle of accurate and scientific shop organization, including standard times for every job and operation.

It pays a high premium above wage or piece rate for co-operation or assistant foremanship on the part of the worker, and finally, as part of regular and daily shop practice, it revises erroneous schedules whether they be too low or too high, and it makes this revision without lessening the earning power of the worker. In addition it substitutes for the costly, annoying, inaccurate time recording of each job, a general monthly efficiency record which covers the shop as a whole, each department, gang, foreman, worker and job and, based on accurate study and efficiency, it predetermines, before work is begun, the absolute cost of every operation.

These results are facilitated by recognizing that the attainment of standard conditions as to all operations depends on four totally different elements:

1.—The shop itself must be highly organized and efficiently operated. This is a duty that devolves solely on the management, and for poor organization and operation the worker is not responsible.

2.—The character of the work itself, the quality of materials, etc., may vary greatly on the same job at different times. Neither manager or worker is wholly responsible for this variation.

3.—Assuming standard shop and work conditions, the worker himself can do much to co-operate with the management in making the other conditions as well as himself effective.

4.—Costs should be standardized for the shop on a basis of normal conditions and be adjusted in the counting room on the basis of the monthly efficiency factor.

a. As an incident to high shop organization and efficient operation, the standard time required for every job should be scientifically ascertained.

b. To eliminate accidental and unavoidable variations in material, etc., the worker is allowed to sum the standard times of all his jobs, gaining on some, losing on others, averaging closely even.

c. For co-operating with the management in eliminating wastes, the worker is paid a 20 per cent bonus for an efficiency of 100 per cent, which means, that the time taken for all his jobs must be equal to the standard times allowed for all his jobs. If he takes 10 hours on a 1-hour job and 1 hour on a 10-hour job, his average remains 100 per cent.

d. The same work is assumed to be done always in the same standard manner. Variations from standard are a general charge or credit to shop efficiency, not a specific variation in cost. A train passenger is not charged more because his train has been delayed by a snow storm, or less because a fair wind and a clear track made the particular train run less costly than usual.

Under the efficiency system the worker is entitled to standard day rates, even if he is doing nothing. If, however, by reason of special individual effort or skill, he does his work faster, he is entitled, not to a part (one-third or one-half, as in the Halsey system, or less, as in the Rowan system), but he is entitled to be paid in full for *all* the time he saves. As he has not less co-operated with the management, he is, in addition, entitled to 20 per cent bonus for all the time he works.

Therefore, if a worker whose pay is $0.25 per hour delivers 300 hours of jobs in a month of 250 working hours, he receives:

1.—250 hours at $0.25	$62.50
2.— 50 hours saved, at $0.25	12.50
3.— 20 per cent on 250 hours pay	12.50
Total	$87.50

If however the worker does not so co-operate with the management as to make the shop operate at high efficiency, himself included, he does not receive as much extra pay, but a lessening amount until at 67 per cent and below he is paid day rate and no more.

The diagram shows plainly the efficiency wage line beginning at 6 hours, showing 20 per cent increase at 4 hours, standard time, and paying 4 hours time even if the work took no time at all—a condition that arises practically quite often, as when a worker runs two jobs at the same time, or when he does work on his own time.

While the diagram can be applied to a 4-hour job, the worker is not paid by the separate job, but is paid straight day wages and a bonus for his full pay period efficiency. For each per cent of efficiency there is a corresponding increase in pay.

For 100 per cent efficiency the increase is 20 per cent, and for each 1 per cent increase in efficiency above an efficiency of 100 per cent, the pay also increases 1 per cent; therefore for 120 per cent efficiency the pay is increased 40 per cent. Below 100 per cent the pay table runs as follows:

Efficiency. Per cent.	Additional Pay. Per cent.
67	0.
74	1.
80	3.27
85	6.17
90	9.91
95	14.53
100	20.

The system has other merits:

1.—It standardizes not only the work of each worker, but also of every foreman, every department, and of the shop as a whole.

2.—It therefore standardizes the shop cost of every job whether it is done by a cheap apprentice in two hours, or a high priced mechanic in 10 hours. The average shop or department efficiency factor equalizes accidental variations.

3.—It separates absolutely all questions of wage rate from question of output, shop conditions, or individual excellence.

4.—It fines the management heavily if shop conditions are not maintained so as to realize standard times.

5.—It puts no limit on the ambition or earning power of any man.

6.—Standard times are being constantly corrected. If the standard man cannot average 100 per cent on his schedules, it is evident that some of them are too short and ought to be lengthened. If on the other hand, a new machine tool is introduced, new schedules are drawn up for it, but the worker will not, on that account, make less than he did on the old schedules.

The effect on the worker of these different systems is most plainly revealed by tabulating the results with the assumption:

1.—That he does no work in all his time.

2.—That he does standard work in standard time.

3.—That he does all his work in no time.

System.	No Work in all the Time.	Standard Work in Standard Time.	All Work in No Time.
Day Rate.	Full wages.	Full wages.	No pay.
Piece Rate.	No pay.	Normal pay.	Full piece rate pay.
Halsey Premium.	Full wages.	Full wages.	⅓ to ½ piece rate pay.
Rowan Premium.	Full wages.	Full wages.	No pay.
Taylor, Piece-Rate differential.	No pay.	Bonus above normal pay (higher piece rate).	Full higher piece rate pay.
Gantt Bonus.	¾ to full pay.	Bonus above normal pay.	½ of time saved at bonus rate per hour.
Emerson Efficiency	Full wages.	Bonus above normal pay.	Full piece rate pay.

The efficiency system virtually gives the worker his choice between a day rate and a piece rate, and as the day rate is much more costly to the management, the latter pays a premium above day rate or piece rate for efficiency.

Overhead charges are not considered in this discussion of wage systems. It may be said however that overhead charges are not proportional either to time worked or to total of wages paid, but they follow their own laws. If a plant is wholly shut down there is a large overhead charge due to the general items comprised under the heading rent, as depreciation, insurance, interest on investment. If a plant owing to press of orders suddenly doubles shifts, working 20 hours a day instead of 10 hours, overhead charges are also greatly reduced. Overhead costs should be standardized, so that from month to month they may vary only slowly.

It is too much to expect that any system of paying wages will prevent an outbreak of selfish interests whether of employer or wage earner. There will however be a distinct gain if the nature of the disagreement can be made entirely distinct and plain. Clear thinking must precede clear acting, and this description of different wage systems may contribute towards clearer conceptions and more just practice.

EDITORIAL COMMENT

Prosperity Returning.

THE reassurance resulting from Taft's election seems to be spreading faster and causing a more substantial business revival than a conservative expectation might have conceived; and even if there should be some slackening of the pace later, pending the selection of the cabinet and the definition of a tariff-revision programme, the curve will still extend upward. Most of our depression has been the product of a state of mind rather than a state of facts. Anything, therefore, that betters the public temper relieves at once the brake that has been checking the advance of business. And as far as material conditions are concerned, everything is ripe for a period of extraordinary expansion. Stocks are exhausted, supplies consumed, material and equipment worn down to the point where repair and renewal are imperative. When the first move toward renewal of activity is made, the impulse passes through the whole cycle of our industries and returns, multiplied in energy, to its point of origin. Expansion, like depression, is self-propagating and self-multiplying.

The symptoms generally are encouraging to the expectancy of a sane and sound national growth. The new Administration is pledged to correction of the errors and sins of economics and finance from which the country has been suffering, and the character and temperament of the new President are assurance that the removal of the diseased tissue will be accomplished with a minimum of shock to the sound. We may hope for persistence in all that was good in the Roosevelt policies, without that which was destructive in his methods.

Passing of Piracy.

THE conviction of Morse and Curtis, like the exile of Napoleon or the hanging of Captain Kidd, is one of those startling signs by which, from time to time, the world is advised of progress in evolution to a new stage and is spurred to realizations of new ideals making progress in the new order swifter, and return to the old order impossible.

The parallel is perhaps closer than might be granted at first thought. The enormous development of industry and commerce, and hence of the financial system, during the past few decades has opened fields for enrichment—or for pillage, if you please—more seductive than Gaul ever spread before Caesar, more alluring than the Indies afforded to the adventurers of Spain. Every era in the world's history that spread new vistas of this kind has witnessed also outbreaks of destructive activity on the part of unscrupulous men who were partly quicker than others to see selfish advantages in a new condition of affairs, and partly nearer to the beasts of prey in their lack of conscience in seizing whatever their skill enabled them to grasp and their strength enabled them to hold. But those are not the healthy, but the unhealthy, phenomena of growth and change—the abuses which seem to be always incident to an epoch of change.

They pass and disappear with progress in the general mastery of knowledge and understanding as to what is best for society at large under the new conditions. They are abated not by arresting the whole development, and possibly not so much as is generally thought by legislation and punishment, but rather by a general change in the temper of the world which makes the evil act unthinkable and the position of the evil doer intolerable.

In the days when the greatest prowess the world knew was military, it was the "man on horseback" who waded through blood to power and fortune; but it would be inconceivable that we should have another Napoleon today. The rise of commerce and traffic oversea, with or without that very elastic institution known as "letters of marque," saw the development of piracy to the rank almost of the gentleman's occupation; but piracy has disappeared from the earth, or rather from the ocean. The first great era of railroad building in this country brought with it our now notorious generation of millionaire railroad wreckers; but we must admit that the railroad world has purged itself pretty thoroughly of that disease, or at least that our great lines now are generally administered with honesty and faithful regard for the interests of the security holders.

It is not to be denied that the hanging of pirates and the jailing of dishonest railroad presidents has its effect in stimulating a change of sentiment; but the great cause after all is the altered public opinion which makes the hanging or the jailing possible. To borrow a simile from bacteriology, these poisons that germinate in the body politic, and seem sometimes to be increasing to fatal proportions, appear also to develop their own anti-toxins by which they are finally checked and destroyed. The world no longer lives in fear of an Alexander or a Napoleon, but its confidence is not based upon abolition of the military system which gained Napoleon his opportunity. We still have standing armies far more powerful than those with which Napoleon conducted his campaigns, but in general they inspire in the minds of the Nation feelings of comfort, security and protection. Inevitably, our great industries and financial undertakings must follow the same trend. Trust managers must increasingly appreciate (as some of them do already) that their own best interests are served when they share, to the greatest extent possible, with customers and employees and through them with the public, those advantages in manufacturing which vast organized facilities give. Unquestionably, the conviction of Morse will make other Napoleons and pirates of finance hesitate, but the great significance is that sentiment is changing so that such convictions are possible. It is a step toward the time when men of the stamp of Morse will be as impossible as Napoleon or Kidd would be today.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

THE SCIENTIFIC CONTROL OF FUEL CONSUMPTION.

A PLEA FOR MORE SERIOUS CONSIDERATION OF THE PROBLEMS OF COMBUSTION AND FUEL ECONOMY.

Henry E. Armstrong—Iron and Steel Institute.

A STRIKING plea for the scientific control of fuel consumption is made by Prof. Henry E. Armstrong in a paper presented under the above title at the recent meeting of the Iron and Steel Institute. In introducing his subject, Prof. Armstrong comments upon the gradual exhaustion of coal supplies and emphasizes the necessity for the employment of efficient and economical methods in the use of all classes of fuel. The main point of his argument for a more serious consideration of the problems of combustion and fuel economy are given in the following extracts from his paper.

"But two courses are open: the one involves economy and such improvements as are possible in the practice of present methods of consuming fuel; the other the introduction of methods which are potentially of higher efficiency. In either case success can arise only from more attention being paid to the root conditions of the problem.

"Great advantage is to be derived from the employment of automatic methods of registering continuously the extent to which the oxygen in the air is utilised—because this affords a check on the manner in which fires are attended to, and is therefore a means of securing regular stoking; also because undue loss of heat is avoided if care be taken that the maximum proportion of carbon dioxide is present in the gases escaping into the flues. The use of automatic apparatus of the Callendar type for the continuous registration of temperature is also, for similar reasons, often of importance, and becomes indispensable when the maintenance of a steady heat is a condition of success; it is well known that marked economy in blast-furnace practice has been secured by such means in recent years. The need of paying attention to the maintenance of steady conditions, moreover, at all times has a moral effect on workmen, the value of which cannot well be overrated. But my object on the present occasion is to plead for something more than the mere occasional control of fuel consumption, whether in iron-works or elsewhere: it is to plead for the introduction of a new attitude towards the problems of combustion and of fuel economy; an attitude of understanding based upon sympathetic and serious contemplation of the phenomena—an attitude of real and deep appreciation.

"Ignorance, indeed, has not a little to do with our difficulties, as these arise in no slight degree from our calm contempt of the complexities which surround the whole subject of combustion. Everyone, of course, knows that fire is produced by the oxygen of the air combining with the carbon and hydrogen of the fuel; few realize, however, that the statement is but the barest gloss upon the facts. The chemical student writes C +

$O_2 = CO_2$ and hey-presto! feels that he has said all that the examiner can demand. And while coal is treated as of some consequence because it is paid for in hard cash, little consideration is given to the part which air plays; the fact that it is equally worthy with coal to be treated as fuel is seldom recognised; air being always at hand, it is supposed that it costs nothing; in reality its use is often attended with no inconsiderable expense (apart from that involved in the construction of the smoke-shaft), sometimes because it is used too sparingly, but more often because it is used too lavishly.

"The extraordinary complexity and wondrous beauty of the phenomena of combustion is only beginning to dawn upon us—even the problems to be solved are perceived only dimly; the fire sense has yet to be cultivated." Not very many years ago carbonic oxide, hydrogen and charcoal were considered merely as combustible substances, any one of which would be sure to inflame in the presence of oxygen on the application of sufficient heat. The discoveries of H. B. Dixon in 1883, and of H. Brereton Baker in 1885 and 1902, of the important part played in combustion by moisture, exposed the fallacy of this simple belief and worked a revolution in our knowledge of the phenomena of combustion. The combustion of the hydrocarbons is another point on which the old simplicity of belief has been rudely disturbed. The process is now understood to be one of extreme complexity; the final products, carbon dioxide and water, are but the end products of a whole series of changes which separately escape attention because of the extraordinary rapidity with which they take place.

"It is impossible to understand the changes which attend the combustion of carbonaceous fuels without considerable appreciation of organic chemistry. But we are only at the beginning of our knowledge of such matters. We know almost nothing of the influence of surfaces on the interchanges involved in combustion, except that they exercise a profound influence. And yet all furnace operations are carried out within boundaries—within boundaries which presumably play a determining part beyond that of a mere enclosure. Almont the only practical worker in this field was the late Frederic Siemens, whose name is so well known together with that of his brother, the late Sir William Siemens, in connection with the regenerative furnace; but his labours seem to have passed into oblivion. No subject is of greater importance from a practical point of view. The effective use of gaseous fuel in the future for the purpose of raising steam and in many other ways, especially in substitution for our present wasteful system of domestic heating, must depend on the advance of knowledge in this field. The inefficiency of gas-stoves as now supplied does not bear thinking of. If gas engineers had any understanding of such matters—any scientific conscience—and were not merely engaged in producing gas for sale, with little reference to quality and the results obtained by its use, so long as mere statutory obligations are satisfied, they would hesitate before advocating the employment of the appliances now foisted upon an unwary public. Clear proof that advance is possible is afforded by Auer von Welsbach's discovery of the incandescent mantle; but it is worth while noting that the effective radiant in the mantle is a substance present to the extent of a little more than a fraction of a per cent., and that at most two or three substances are known to be available for the purpose. How long the supply of these materials will hold out we cannot say, but the question is one of no little importance.

"Fuel is like food, quality being of importance as well as quantity. In the first place, the constituents which remain as ashes merit more attention than they receive. The possibility of preventing clinkering by mixing different varieties of coal or by suitable additions is rarely taken into account. The escape of sulphur also receives no proper attention—it probably constitutes a far more serious nuisance than that of smoke production, owing to the effects produced on vegetation and on buildings, especially on iron structures; it is also not improbable that it contributes to no inconsiderable extent to produce fog. Being invisible, the sulphur compounds in smoke do not openly invite resentment; yet the subject is one which must attract public attention at no distant date, if only as a consequence of the unbridled license now allowed to gas engineers.

"To pass to the most important side of the subject, it should be pointed out that fuel is not to be judged only on account of its heating power as determined in the laboratory. Thus hydrogen and carbonic oxide gases have practically the same heats of combustion, measured at ordinary temperatures at which water is liquid; at temperatures at which water is gaseous, however, the heat of combustion of hydrogen is reduced in value to the extent of nearly one-eighth, and falls considerably below that of carbonic oxide. Of the two, carbonic oxide is therefore the more effective fuel; moreover, perhaps owing to its peculiar insensitiveness to oxidation, it seems to be in a measure a milder fuel, and the products of combustion of the two gases—water and carbon dioxide—appear to exercise very different effects; in the re-heating furnace, for example. Refinements such as these, however, have scarcely entered as yet into consideration in manufacturing operations; it has to be recognised that they are of consequence in connection both with the production and with the use of producer gas. In course of time it may also be considered desirable to pay some attention to the composition of the gas supplied for domestic purposes—to deliver a product produced by some more rational process than that involved in coking coal. But so long as the manufacture of gas rests with the engineer alone and not with the chemist, the public must suffer the consequences which always attend imperfect administration.

"In the case of solid fuel, it is well known that no two coals yield quite the same quantity of flame, and that mechanical differences also play an important part in modifying combustion; apparently it is chiefly because changes take place which involve mechanical alterations, not because there is any material loss of calorific power, that steam coal loses its value when stored for any considerable period. The advantage derived from mechanical stoking probably does not arise merely from its being more economical, but also from the fact that combustion takes place in a more nearly uniform manner than when coal is introduced at intervals, the flame retaining its character in consequence of the steady introduction of bituminous matter from which hydro-carbons are distilled off, which burn with a more or less luminous flame. These are all matters which, in the future, must receive much more attention than they have received in the past—the study of radiation phenomena is yet in its earliest infancy.

"But it should be added that, if fuel is to be economised, it will be necessary at the same time to pay attention to the boiler as well as to the fire; the value of water-softening appliances is still far too generally overlooked.

"To pass from the consideration of methods in use to that of methods potentially of far higher efficiency than any of the purely thermal processes now at our disposal, we can at present only look forward to the direct conversion of the energy latent in fuel into electrical energy. To say that this is impossible would be absurd, but it is useless to exaggerate the difficulties. Hydrogen can be burnt electrically in the Grove gas battery, but there is no economical process of preparing hydrogen; it can, however, be obtained by passing steam over red-hot coal, but only in admixture with carbonic oxide. Why not burn such a mixture electrically? it may be asked. Strange to say, not only are we unable to substitute carbonic oxide for hydrogen in a gas battery, but it puts a stop to hydrogen being used in one if mixed with it. Why this difference should obtain between the two gases, both being combustible, we scarcely know, although we may guess at the reason. Why carbonic oxide should hinder the electrolytic oxidation of hydrogen at present entirely passes comprehension. It is problems such as these that we need to solve before any substantial advance can be made. No one has yet succeeded in making a satisfactory voltaic battery with carbon; and before coal is burnt electrically it will certainly be necessary to make it a conductor of electricity. All these are tasks which we should aim at executing, whatever the difficulties, the solution of such problems being of infinite importance to mankind.

"I have thus drawn attention to the complexity of the issues involved in the proper use of fuel, in order that it may be clear that, if we are to advance and effect the economies which we are morally bound to aim at introducing with the least possible delay, a more philosophical treatment must be secured for the subject. We need both to dispel public ignorance and to excite public interest in such matters. This can only be done by schools."

Engineers are now beginning to appreciate the importance of a knowledge of chemistry. "But in the works the engineer must remain an engineer; his mental attitude can never be that of the trained chemist; in all operations involving the occurrence of chemical changes the chemist must be at his side, otherwise the work can only be conducted in an empirical and more or less perfunctory manner. I believe this to be one of the great lessons to be learnt by English manufacturers at the present day. The chemist is rarely employed in our works. The majority of those called chemists in works are not chemists in any proper sense of the term, but merely 'analysts' engaged in controlling the quality of the materials used and of the products; more often than not, they are not allowed access to the works proper, and have little or no opportunity of becoming chemists by familiarising themselves with the actual operations and by reflecting on and inquiring into the nature of the changes which are involved in the processes. Worst of all, they are not called upon to undertake systematic research work. The great success of German manufacturers in recent times is far less a consequence of the training given in the universities and technical schools than it is of the establishment within the works of research laboratories in which the problems the industry affords are systematically studied. Until the German example is followed, we shall do little to place our industries on a scientific basis, as the proper scientific atmosphere and spirit must be lacking in the works, and the opportunities which they afford must necessarily remain unheeded and unexploited."

THE INFLUENCE OF SILICON ON THE PROPERTIES OF IRON.

THE MODIFICATION OF THE MAGNETIC AND CHEMICAL PROPERTIES OF IRON BY THE ADDITION OF SILICON.

A. Jauve—Iron and Steel Institute.

IN our issue for May last, reference was made in these columns to the acid-resisting properties of iron-silicon alloys of high silicon content, in a review of a paper read before the Société des Ingenieurs Civils de France by M. A. Jouve, to whose researches is due the development of the "métillures" industry, which has attained to considerable proportions on the Continent. The information given in this paper was of a general character, and we are glad to supplement our former review with the following abstract of a paper read by the same author at the recent meeting of the Iron and Steel Institute, which, in addition to fuller details as to the chemical properties of iron-silicon alloys, gives some interesting data on the influence of silicon on the magnetic properties of iron.

"Iron and silicon in combining give rise to three compounds, and it would seem to have been demonstrated that it is impossible to have any further combinations than these three, which are:—Fe_2Si, FeSi, and $FeSi_2$, unless it be below the lower limit Fe_2Si, or above the upper limit $FeSi_2$. The first and the last of these combinations crystallise definitely as prisms, and FeSi crystallises in clearly defined tetrahedra. Crystals have, indeed, been obtained measuring several millimetres to the side.

"Silicon is a metalloid which is in *no* way magnetic—that is to say, the field of an electro-magnet exerts no influence, and therefore exerts no attraction, on pure silicon. On the other hand, iron constitutes the typical magnetic metal. It appeared to the author that it would be of interest to ascertain if the variation of magnetic attraction was in simple proportion to the percentages of iron and silicon, or whether there were any modifications in the resultant of this electric phenomenon. A special research was made by the author to determine if such were the case, and a portion of this research has already been published by him in 1902, of which the following is a brief summary:—

"The principle involved is as follows: If iron, alloyed with varying proportions of silicon, is subjected to the influence of an electro-magnet excited by a current of constant intensity, the attractive power of the latter diminishes proportionally with the increase in the percentage of silicon in the alloy until the ratio of 20 per cent. of silicon, corresponding to the composition Fe_2Si, is reached, when there is a sudden inflexion in the curve. Beyond this point the magnetic susceptibility again decreases regularly until FeSi (33.33 per cent. Si) is reached, when another break occurs, and subsequently the same thing happens at $FeSi_{1\frac{1}{2}}$ (50 per cent. Si). Except at these three points, the magnetic susceptibility decreases proportionally to the increase of silicon, from 100 for pure iron to 0 for pure silicon.

"For the three compounds Fe_2Si, FeSi, and $FeSi_2$, the curve undergoes three distinct inflexions, as stated, and it is a remarkable thing that it undergoes no other modifications than these. It would therefore appear established beyond doubt that no other definite compounds of silicon and of iron exist other than Fe_2Si, FeSi, and $FeSi_2$. The preceding results were those obtained with pure alloys of iron and silicon, synthetically prepared, and entirely free from carbon. The percentage of carbon has an influence on the result obtained, and the author proposes in a future paper to study the variations produced by the amount of carbon present. It is necessary here to note the fact that the percentage of carbon for alloys rich in silicon is decidedly small, as there is marked antagonism betwen silicon and carbon when the percentage of the latter reaches in the neighbourhood of 15 to 20. An investigation of this phenomenon has been the object of the author's researches, which will be published in a future paper.

"As has been pointed out above, the increase in the percentage of silicon is accompanied by a diminution in that of the carbon, and the latter diminishes rapidly with percentages of silicon comprised between 15 and 20 per cent., and finally falls below 1 per cent. once 20 per cent. of silicon is reached. This probably explains why it is that ferrosilicons with a percentage of silicon averaging from 14 to 18 per cent. reveal numerous cavities filled with the graphite resulting from the dissolution of the carbon in the iron of the ferro-silicon during fusion. This carbon is subsequently almost entirely separated during cooling owing to the presence of silicon. The silicon confers on the iron peculiar properties which characterise it alone. The most characteristic property is the resistance of the iron to acids. The author has proved for some time past, and all analytical chemists who have to carry out analyses of alloys of iron and silicon have similarly established the fact, that these alloys do not dissolve in acids—except in hydrofluoric acid—even under special conditions, as in the Carius method, which consists of treating them, under pressure, in nitric acid. The author has often been impressed with the interest which would attach to these observations if this property could be utilised in the construction of vessels for use with acids. The researches detailed below are the result of six years' investigation of the subject.

"Not all the acids—and the author would define as an acid all bodies having an acid reaction with iron—react in the same manner on iron alloyed with silicon, and the true resistance to corrosion is not obtained until the proportions corresponding to Fe_2Si are exceeded—that is to say, it is necessary to exclude, to begin with, all silicon alloys prepared otherwise than in the electric furnace, inasmuch as it is this apparatus alone which permits of alloys with high percentages of silicon being obtained.

"The alteration in the susceptibility of the metal to attack by sulphuric acid is such that, under proper conditions, it is possible directly to concentrate dilute sulphuric acid at 20 degrees to 25 degrees Baumé to 66 degrees Baumé without changing the apparatus, and also without introducing any iron into the acid. Even in works where the contact method is employed, and where vessels of ordinary cast iron are but little corroded, there is an advantage in employing alloys of iron and silicon owing to the great resistance of such alloys as the life of the apparatus is very much lengthened.

"Tests have ben carried out on basins, tubes, pipes, tubs, and vats; some of the results are as follows:—

1. Silicon alloy (métillure), hot sulphuric acid (22 degrees Baumé). Loss after two months = 0.06 per cent.

2. Cast iron containing 3 per cent. of silicon. Loss in two hours = 44.6 per cent.

3. Ordinary cast iron. Loss in two hours = 46 per cent.

"The difference in these results is very marked, and it must be added that the alloy employed contained only 20.6 per cent. of silicon, while the cast iron contained 3.3 per cent.

"When dealing with nitric acid it is necessary to increase the percentage of silicon, as the corrosive action of nitric acid is considerably greater than that of sulphuric acid. The results obtained have nevertheless been remarkable. (A.) A pipe conveying 660 lbs, of nitric acid vapour at a temperature of 150 degrees to 200 degrees C. in 24 hours withstood successfully from March, 1903, and the loss on the original weight has been but a few ounces (about 3½ ounces on an original weight of 45 lbs.). (B.) It has been found possible directly to concentrate nitric acid from 36 degrees Baumé to 48½ degrees Baumé without the formation of nitrous oxides by means of these alloys. (C.) In a particular instance a ventilating fan has been constructed of silicon alloy, and delivers 250 cubic metres per minute of a mixture of nitric and sulphuric acid vapours.

"The results obtained with hydrochloric acid have been fewer on account of the lack of opportunities of testing, but the applications of the alloy already made have been of interest.

"The employment of the alloy for the construction of apparatus for acetic acid has given the following comparative results:—

COEFFICIENT OF CORRODIBILITY.

	Per cent.
Tin	0.8
Copper	11.0
Lead	19.0
Silicon alloy	2.0
Iron	44.0

"The alteration in the nature of the metal is such that in, for example, the drainage water from pyritic mines and in the bilge of ships, in dealing with which wrought or cast-iron pipes are rapidly attacked, it has been possible to replace them successfully by silicon alloys in the construction of drainage pumps."

M. Jouve gives a number of tables showing the results of commercial tests as to the chemical resistance of the "métillures" to corrosion. We reproduce a typical example:

IMMERSED IN VARIOUS ACIDS AFTER 24 HOURS.

Acid.	Weight, Kilogrammes.	Loss of Weight, Kilogrammes.
Nitric con.	42.1690	0.0060
Nitric 1 : 1	38.6405	0.0065
Sulphuric con.	32.6000	No change
Sulphuric, 1 : 1	27.9800	No change
Acetic, con.	19.5682	0.009
Acetic 1 : 1	14.873	0.014

"The results which are given above are derived from tests made from the actual commercial point of view, and the weights and dimensions of some of the apparatus fully demonstrate the value of the alloys. Thus, a vat of 6.8 feet in diameter, weighing about 2 tons, has been employed for a mixture of sulphuric and acetic acids. A stirrer weighing 770 pounds was employed for the same object. Pipes weighing about 1,760 pounds, and having a length of 9 feet, have also been employed for conveying sulphuric acid. An apparatus for the concentration of sulphuric acid permitted of a yield being obtained of 10 tons of acid concentrated from 50 to 52 degrees Baumé to 66 degrees Baumé per diem.

"In short, it may be seen from the foregoing examples that in cases where the silicon added to the iron attains a sufficiently high percentage, (1) the magnetic properties diminish, and (2) the resistance to the action of acids increases with the proportion of silicon. In the first instance they become nil, and in the second it becomes almost negligible."

REPAIRS AND DEPRECIATION IN MANUFACTURING PLANTS.

A SUGGESTED SYSTEM FOR TAKING CARE OF PLANT REPAIR AND MAINTENANCE, AND THE PRINCIPLES OF PROPER PROVISION FOR RENEWALS.

James E. Darbishire—Institution of Mechanical Engineers.

A VALUABLE paper on repairs, renewals, deterioration and depreciation of workshop plant and machinery, read before the Institution of Mechanical Engineers on October 16 by Mr. James Edward Darbishire, is presented in brief abstract below. In connection with his suggested scheme for taking care of maintenance and depreciation, of which an outline is here given, Mr. Darbishire exhibited a number of forms which it is impossible for us to reproduce. We present, however, the points in his paper which aroused most discussion and on which he laid special emphasis.

Proper provision for maintenance and depreciation is far from being a matter of mere accounting; in fact, the first reform in a great many cases should be to transfer the control of the machinery stock book and everything connected with it from the accountant to the engineer. The duty of maintaining, and providing for repairs to plant and machinery is generally assigned to the works manager. It is, however, very unusual for this official to have any knowledge of the money value of the plant he is dealing with, hence the advantage of placing the control of the repairs and renewals and of valuation in the same hands, and limiting the accountant's duty to the use in his profit and loss account and balance sheet of the valuation provided for him by the engineer.

"Under the suggested system the control of everything would be vested in the works manager, or, in the case of large works, in a special official. The limit of his powers, as regards incurring expenditure, would be defined by the general manager, directors or partners according to circumstances; he would be responsible for the upkeep of the whole of the machinery and plant, and it would be his duty to report his requirements when he found them to exceed his financial limit; but it is essential that he should have considerable latitude in incurring expendintures on repairs, because obviously time is of the utmost importance in most cases, and he ought not to be bound by too much red tape; in machinery repairs 'a stitch in time' often saves many times nine. There is no doubt whatever that if the right man be appointed there will be no difficulty on this point.

"His first step must be to prepare a proper schedule of the plant and machinery in his charge, entering each item in the machinery stock book, with its distinguishing number. Against each item there should be entered its present value, calculated according to its age, in the manner to be explained later. Also a figure representing its probable life in years; this second figure will be required when provision for depreciation comes under consideration. . . . .

"The next step must be to make provision for proper care of the various machines, and for repairs being executed when required without delay. To ensure this, each attendant or workman in charge of a machine or group of machines, being the actual attendant or operator, and not a foreman, would be made, in the first instance, responsible for its being maintained in the highest possible condition, the fireman for his boilers, the turner for his lathe, and so on. It would be his duty to report immediately to his shop foreman any defect becoming apparent, and to enter on a card the description and number of machine, nature of defect, date, and his (the attendant's) name.

"The foreman's duty would then be to inspect the machine, and if in his opinion the repairs are necessary, to initial the card, and submit it to the works manager for final authority, the works manager initialing and dating the card and assigning a Works Order Number to the job. The repairs would then be executed at once, and on their completion the machine would be inspected and passed by the works manager, and their execution certified (with date) on the card; to which would be also added the cost incurred. This system would ensure proper care by the attendants of every machine, and would prevent ill-usage, which used to be one of the workshop troubles, though in this respect the modern workmen is a great improvement on his predecessors, and the care of machines, especially machine tools, now leaves very little to be desired. It would also afford the works manager the opportunity of deciding when the time has come to replace instead of repairing, and it will be remembered that this official would have before him the 'stock book' valuation of the machine under consideration, and therefore would know how far the cost of renewal had been provided for. He would see the whole situation at a glance, and decide whether to replace, thoroughly repair, or partially repair.

"In addition to the workman's or attendant's daily watching of each machine, periodical inspection should be made by the works manager as a check upon workman and foreman, and each such inspection recorded."

In dealing with depreciation, "it is absolutely necessary to make provision for a fund by means of which the various items of a workshop equipment can be renewed from time to time, which provision obviously has to be made without any reference to the profits or losses of trade. It must be made as part of the working expenses of the businesss, and in this respect the author protests against the system frequently adopted by accountants of showing a so-called 'profit' out of which so much is set aside for depreciation, the amount apparently being at the discretion of the directors or the accountants, and frequently depending upon the amount of the so-called 'profit.' It is clearly wrong to make the provision for depreciation a charge on profits, for depreciation is really a loss of the capital assets, which has to be made good out of income, and is just as much a charge on revenue as rent or taxes; there is no escape from its incidence, and there is no profit until adequate provision for depreciation has been made. That the provision should be adequate goes without saying; the amount must be determined without reference to the result of trading but must be an absolute charge, so that the depreciation may be truly representative of the loss of value of the machinery which occurs whether trading is profitable or not."

The total loss by the depreciation of a machine is the difference between its purchase price and its ultimate scrap value This has to be written off during its life in gradually decreasing increments by fixing a percentage, dependent upon the estimated probable life, to write off each year from the previous year's value. The amount of depreciation on each item should be determined separately. When the depreciation has been calculated for each machine in the plant, the total on the whole plant must be charged against the year's income if the balance sheet is to show the actual value of the plant and the actual profit or loss. A separate account for each item in the plant makes it a simple matter to make allowances for replacements, the effect of improvements to machines, increases in productive capacity, etc.

"The results of unsound finance in dealing with depreciation are so serious that it may surely be said that every establishment ought to be put on a sound basis, the actual present value of the machinery and plant determined, and systematic provision made for depreciation, so that when renewals become necessary, their cost is provided for. It is often stated that when a business is working at a loss, there can be no provision for depreciation, which in a sense is true, but depreciation is going on all the same, and the accounts ought to show the loss fairly and squarely—that is, the depreciation sum should be written off, whatever the results of trade. If a recovery takes place, the position is sound; if not, continued losses mean the end of the business, and the valuation of the plant at its right figure will not affect this.

"The danger of under-provision for depreciation, and especially of allowing the amount to depend upon the results of any year's trading, is that in lean years what ought to be set aside for depreciation may be entirely or partially distributed in dividends, which is nothing more or less than paying dividends out of capital. This may be done in the expectation of better times to come, when the depreciation deficiency may be made up; but it is quite unsound, and in many cases has brought about the results which might have been expected. Even now, there are too many works equipped with machinery which is so out of date as to be a serious handicap in manufacturing, but which cannot be thrown away and replaced because past years have not provided the means to meet the expense. To raise fresh capital for this purpose, even if feasible, is absolutely unsound finance, for the new machinery has to produce sufficient to provide interest on the lost capital as well as on the new.

"In fact, over-valued machinery is one of the most dangerous enemies to financial safety; it would be far better to distribute less and set aside more for depreciation, than to live in a 'fool's paradise,' and awake to find that the time has come when machinery must be modernized to meet competition, and that the funds to do this are non-existent."

THE FUTURE OF THE PACIFIC CARRYING TRADE.

THE PRESENT CONDITIONS OF COMPETITION AND THE PROBABLE ASCENDENCY OF THE JAPANESE.

Edward G. Bogart—The World's Work.

IN the two previous numbers of THE ENGINEERING MAGAZINE we have referred in these columns to the enormously rapid development of shipowning and shipbuilding in Japan, and we noted in passing the gradual diversion of the carrying trade of the Pacific to the subsidized Japanese lines and the consequent decline in the tonnage carried by Canadian and American shipping. This subject is discussed at length in *The World's Work* for November by Mr. Edward G. Bogart, who predicts that in the near future practically all the Pacific trade will be carried in Japanese bottoms. Additional interest is lent to Mr. Bogart's discussion, which we abstract briefly below, by the recent announcement that the Canadian Pacific is about to inaugurate a rate war against the Japanese lines.

The tonnage of the United States ships, those of the Pacific Mail, the Boston Steamship Company and the Great Northern, far exceeds the combined tonnage of the ships of other nationalities engaged in the Pacific trade. The Japanese, Canadian and German lines together barely equal the tonnage capacity of the three largest American ships, the *Minnesota*, the *Manchuria* and the *Mongolia*. But the trade in American ships is a losing venture all around. About six years ago, when the huge liners of the Great Northern were put in service, Mr. Hill and his associates made enormous reductions in their rate schedules in an endeavor to divert traffic from the tramp steamers and from the Suez Canal route via New York to the Pacific line. A through rate was made from the eastern cities of the United States to Japan lower than that from those cities to Seattle, and by this means the Northern Pacific and the Great Northern secured a large amount of traffic at rates that either equalled or cut the rates via the Suez Canal.

In 1906, however, the passing of the Hepburn Act placed upon the railroads the necessity of giving thirty-days' notice of a change in rates. This provision made it quite impossible for the railroads to change their rates to meet the constant changes made by the Suez Canal lines and the latter, being unhampered by the Hepburn Act and knowing in advance what the railroads were able to do, secured the bulk of the traffic by cutting their rates to whatever figure was necessary. Very soon, too, the railroads, fearing that the Interstate Commerce Commission would order them to make domestic rates based on their export schedules, were obliged to make the regular domestic rate to the Pacific Coast the minimum rate to the Orient. The result was that the tonnage over the Great Northern and the Northern Pacific, which had reached nearly 300,000 tons in 1905, dropped to 89,599 tons in 1906, to 61,411 tons in 1907, and, it is probable, lower still in 1908.

Early in the present year the Interstate Commerce Commission was induced to modify the rule regarding advance notice of changes in rates; now the railroads have to give only three days notice of a reduction and ten days of an advance in rail and ocean rates. This restriction in itself would not prevent them from meeting successfully the competition of tramp steamers and the Suez Canal lines, were it not that they are obliged to file at Washington statements showing exactly the proportion in which the through rates they make to the Orient are divided between railroad and steamship. This, say the railroads, completely destroys the Oriental trade so far as inland shippers are concerned, for such schedules cannot be filed without running the risk of creating an agitation for the fixing of domestic rates on the same basis. Under these circumstances, and in the face of the competition of the Suez lines and tramps, the true growth of American exports to the Orient by way of the Pacific Coast will not come until the commodities imported from the United States by China and Japan, now largely produced or manufactured in the eastern States, are produced or manufactured west of the Rocky Mountains. That in the long run an immense tonnage of American goods will go to Japan and China may be taken for granted, but the real awakening of the Pacific trade awaits the growth of manufacturing in the West.

"Let it be granted that a huge American tonnage for the Orient will ultimately originate within striking distance of the Coast. Then, who will carry it? This is the second, and most significant, part of the problem. To-day, as I have pointed out, the American tonnage of liners far overtops the tonnage of all other nationalities combined. Is this a permanent condition, or must it change?

"All signs point to a change. That change will probably be brought about by the wholesale purchase of the American ships that now carry the Stars and Stripes, and their registry under another flag—the flag of Japan. The sale may not be made to-day, nor to-morrow. It will be made when the commercial genius of the Japanese decides that the time has come. Already the tonnage of the American fleets is quoted far below the cost of replacement.

"How much cheaper the Japanese may buy these ships no one can say. Perhaps they will never buy them. I don't know why they should, except at their own prices. Every student of Japan knows that to-day they can build great ships in the docks of Japan at prices that astonish us. When one takes up the Japanese report, and reads that the average wages of a Japanese shipbuilder are thirty-two cents a day, and that there are nearly twenty thousand men at work in two hundred and sixteen shipbuilding plants in the Empire, one ceases to wonder at the ability of the Japanese to turn out great ships in competition with American plants manned by builders at four dollars a day.

"In this matter of building ships, America has never excelled. That she can rival Japan, even to-day, cannot be entertained for a minute. The matter of wages is one insurmountable obstacle. Government bounties are paid in Japan to every Japanese who builds a ship of 700 tons or more. To-day the Government of Japan is straining every effort to make, at its foundry at Wakamatsu, the steel plates, rivets, beams, and other parts of great ships that hitherto the Japanese have had to import at high prices. Timber is cheaper than it is here, for Japan has more than 50,000,000 acres of standing timber, and labor ranges from nineteen dollars a year to ninety.

"This item, the cost of building ships, is merely the first item in the count against American shipping on the Pacific. There remains an even more important item, namely the cost of operating the ships when built. In this matter, America is hopeless. The average wages of an American able bodied seaman, according to the Bureau of Navigation, are from $15 to $45 a month, and found. It is probably quite conservative to average the entire crew, including officers, at $30 per month apiece. The average on a Japanese liner in the same service is less than $10. On top of this, there is a difference in the cost of feeding the crew, the American sailor demanding rations that cost from 200 to 300 per cent. more than the normal rations of a Japanese crew.

"Ten years ago, when the Japanese liners were new in the trade, they manned their ships with Americans, Japanese, and Chinese. The officers were mostly American, or English, and were paid the American scale. As time went on, the Japanese sailors learned the trade. For a time, the habit was to have two captains, one white, the other Japanese. To-day the white man is quite generally discarded. The crew and officers of the Nippon Yusen Kaisha and the Toyo Kisen Kaisha are Japanese and Chinese. They have no fights with labor unions.

"The Japanese and the American ships lie side by side at the docks of San Francisco. Both interchange freight and passengers with all the railroads, under contracts. Both get the same rates. At every important point, the Pacific Mail Steamship Company and the Japanese Companies have a 'joint agency' that takes contracts for both.

"The difference is simply this—that, while the Pacific Mail and the Occidental & Oriental, American and British lines, can barely make a living and keep their heads above water on the rates they get, the Japanese fleet getting the same rates, makes a good profit. Nobody attempts to deny this fact. It is written clearly enough in the annual reports of the Pacific Mail, and you may get it from the lips of any officer of the Pacific Mail whenever you care to ask. The mere fact that the company does a gross business of $5,000,000 or so a year and makes a profit, by hard figuring, that ranges from $100,000 to $300,000, speaks for itself. While the stock of the Pacific Mail reached a maximum price of 41½ per cent. in 1907, the stock of the Nippon Yusen Kaisha, on the bourse at Tokio, sold at 300 per cent. That is the difference.

"Everyone who knows anything about shipping knows that the British can build ships, man ships, and operate ships at a cost that cannot be equaled in America. For a half-century, British commerce has ruled the seas. Her merchantmen have carried from 60 to 70 per cent. of all the trade that flowed along the paths of the seven seas. Yet, within this past year, her mighty Peninsular & Oriental Steamship Company, the pioneer of the Orient, has dipped its flag to the flag of Japan. For half a century or more, the ships of the Peninsular & Oriental did a profitable business in the coasting trade in the Yellow and Japan Seas, back and forth from Japan to China, Korea, the Straits Settlements, India, and Australia, and thence by the Suez Canal to England. But to-day the directors of the Peninsular & Oriental admit that the Japanese new lines across and up and down the Yellow Sea can drive the Peninsular & Oriental out of the trade.

"Fifteen years ago there were hardly any Japanese trading ships afloat, except the little *sampans* that knocked about the coast, and the fishing fleets of open boats that toiled in the inlets. Japan, within the past twelve years, has put her vessels on the four great trade routes of the world, to America, England, India, and Australia. In addition, she has nine distinct trade routes to the litoral of Asia, with vessels making trips under steam at least once a week. Every single one of the lines engaged in all the traffic gets a subsidy from the Government, the amount of it depending on the distance run and the tonnage of vessels."

To sum up the factors in the Pacific situation: the huge American fleet, of possibly 175,000 tons, handles the bulk of the freight either at a dead loss or at infinitely small profits; the tramp steamers, mostly British, are making the bare living that satisfies the tramp captain the world over; the subsidized Canadian Pacific fleet is supplied by ten thousand miles of good railroad and with "fast freight" from England by its Atlantic fleet; and the half dozen comparatively small and insignificant vessels of the Japanese fleet are making money all the time. The American and Canadian fleets are maintained largely through patriotism; the tramps and the Japanese fleet are there on business. In the end, unless conditions change, the two business factors will carry the entire Pacific trade.

THE ELECTROLYTIC PRODUCTION OF IRON SHEETS AND TUBES.

METHODS AND COST OF PRODUCING FINISHED SHEETS AND TUBES BY DIRECT ELECTRO-DEPOSITION FROM CRUDE IRON OR ORE.

Sherard O. Cowper-Coles—Iron and Steel Institute.

A REVIEW in these columns in the issue of THE ENGINEERING MAGAZINE for October described the process invented by Sherard O. Cowper-Coles for the direct electrolytic production of copper tubes, sheets and wire. Besides his investigations on the electro-deposition of copper, Mr. Cowper-Coles has for a number of years conducted researches on the electrolytic production of pure iron from crude iron or ore, and he has recently developed a commercial process for producing finished sheets and tubes in one operation. Some details of the results and cost of his process were given by him in a paper read before the Iron and Steel Institute at the recent Middlesbrough meeting, from which we quote at length.

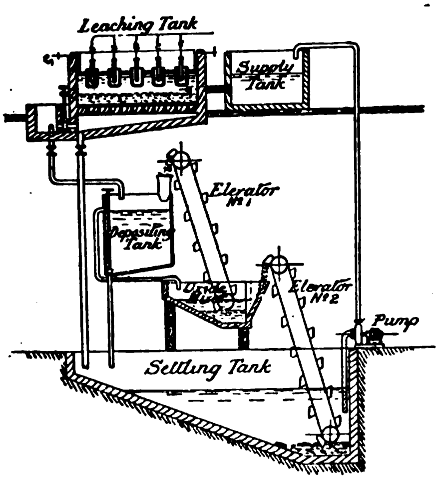
Iron was first produced electrolytically in 1846. In 1851 the cost of the most successful process then available was in the neighobrhood of one shilling per pound, and Smee predicted that the electro-deposition of iron would never be commercially employed except for very limited applications. Up to the present the process has been confined to the facing of engraved copper plates for fine printing or to the production of solid iron electrotypes for bank note printing.

"The author, in the year 1898, made a number of experiments on the production of electrolytic iron plates, and produced plates of considerable thickness, but in such a rough condition that they required smelting and rolling; the rate of deposition, moreover, was so slow as to render the process impracticable, and it was not until the year 1900 that he succeeded in obtaining some small tubes. The results obtained were a great advance on what had hitherto been effected, but were not far enough advanced to be turned to practical account; it was not until the present year that sheets and tubes were obtained of a quality equal to steel, and with a surface that required no after-treatment, such as rolling or drawing.

"An electrolytic iron-production process, to be of commercial value, must fulfil the following conditions, namely, the voltage between the terminals of the depositing cell must be low, the current density per square foot of cathode surface must be high, and the iron or steel deposited must be in such a form that it can be used for industrial purposes without smelting. An electrolytic process that fulfils these conditions must revolutionise many branches of the iron trade, as it will enable thin iron tubes and sheets in particular to be produced at a very low rate of cost and without the necessity of burning coal or carbon.

"The process briefly consists in placing crude iron (which may contain those elements which are at present so detrimental to the production of high-class iron or steel), or finely-divided iron ore, in suitable containing vessels in which an acid solution is circulated, using an insoluble anode material; or, further, the process may combine the use of soluble and insoluble anodes. The crude iron or iron ore being in each case connected to the positive pole of a dynamo, the iron goes into solution, and is deposited on cylinders or plates which may be either rotated or stationary, depending upon the class of finished product required.

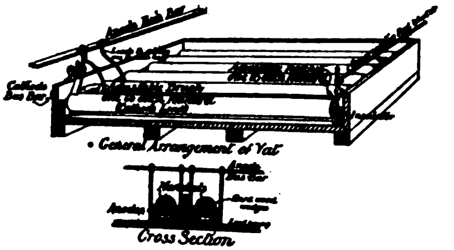
"When crude iron is used, it is arranged around the cathode; insoluble ore is arranged around anodes, of graphite, for example, a small electric current being employed to assist the leaching process. It is conceivable that in some cases iron might be recovered without mining, acid liquor being circulated over the ore deposits. The process lends itself



GENERAL ARRANGEMENT OF PLANT.

to the recovery of iron, more especially from carbonated ores, 'blue billy,' lake, and bog ores. An electric process will no doubt also prove to be a valuable adjunct where pig-iron is used for precipitating copper, enabling the iron to be recovered instead of running to waste.

Good results have been obtained from an ore containing:—Ferric oxide, 50.7 per cent.; lime, 3.8 per cent.; phosphoric acid, 1.51 per cent.; alumina, 10.0 per cent.; silica, 16.0 per cent. When it is desired to produce a highly finished sheet, a metal sheet of the desired surface is wrapped round the cathode, and held in position by means of grooves and wedges.



APPARATUS FOR THE DIRECT PRODUCTION OF TUBES.

"In this way sheets of large dimensions can be made, by employing a mandrel, say, 8 feet in diameter, a sheet 24 feet by 5 or 7 feet can be produced. When it is desired to produce tubes, iron mandrels somewhat smaller than the internal diameter of the finished tube are coated with lead by electro deposition, or by having lead drawn over them. Thus prepared, the mandrels are rotated in a special type of vat. When the desired thickness of iron has been deposited the mandrel is heated to a temperature sufficient to melt out the lead, and thus admit of its easy withdrawal.

"The electrolyte employed consists of a 20 per cent. solution of sulpho-cresylic acid saturated with iron. Sulpho-cresylic acid is a cresol-sulphonic acid containing approximately 108 parts of cresol and 98 parts of sulphuric acid. The cresol contains ortho, 35 per cent.; meta, 40 per cent.; and para, 25 per cent. This cresol is heated with sulphuric acid, yielding isometric cresol-sulphonic acids.

"In some cases it is advantageous to add small quantities of carbon-di-sulphide, the temperature of the solution being about 70 degrees C., the current density about 100 amperes per square foot. The solution is kept charged with iron oxide, which is kept in suspension in the electrolyte by means of stirrers, by moving one or both of the electrodes, or by circulating by means of a bucket pump. The specific gravity of the electrolyte having the iron oxide in suspension is about 1.32.

"Excellent results have also been obtained by depositing the iron in a closed cell with a vacuum of a few inches, and also with a chloride solution and porous cells, bleaching powder being produced as a by-product; or the chlorine utilised to form fresh iron chloride.

"The following are two typical analyses of electrolytic iron produced under the conditions described in this paper:—(1.) Carbon (by combustion), 0.060 per cent.; silicon, 0.011 per cent.; sulphur, 0.016 per cent.; phosphorus, 0.041 per cent.; manganese, traces; arsenic, 0.004 per cent. (2.) Combined carbon, under 0.05 per cent.; silicon, 0.048 per cent.; sulphur, 0.045 per cent.; phosphorus, 0.04 per cent.; arsenic, 0.01 per cent.; manganese, traces.

"A peculiar feature of electro-deposited iron is that it creeps to an extraordinary degree with a rounded, smooth edge, over any material; in fact, it is difficult to stop its spreading. Under certain conditions, when employing a rotating cathode, long tentacles form, 6 inches or more in length, in the direction of rotation, with approximately the same curvature as the mandrel.

"Amongst other applications the process can be applied to the production of bi-metallic tubing and plates; that is to say, to tubes or sheets coated on the one side with copper or other metals or alloys.

"The process can also be applied to the direct production of large sheets or strips representing the cutting surface of a file, and cut up into portions of the desired shapes, and secured to suitable backing, to form separate files. The prints are produced by making a continuous impression or a number of impressions from a suitable die, revolving roller, or reciprocating tool in a lead alloy. The matrix thus prepared is mounted on a revolving drum, and steel deposited by the process which has already been described.

"Electrolytic steel, with considerable variation in the percentage of carbon, can also be produced. Houllevigue observed that when iron is deposited from iron containing uncombined carbon, the product at the cathode was free from carbon; but when deposited from iron containing combined carbon, the cathode product also contained carbon. The author's observations confirm this statement, and at a future date he hopes to publish figures showing the results that can be obtained. The amount of silicon in the iron can also be considerably varied. An important feature of the electrolytic process will no doubt be the introduction of some new ferrous alloys, which cannot be made by fusion. Alloys of iron and nickel have already been produced electrolytically.

"Electrolytic iron sheets can be obtained with a highly-finished surface, can be readily welded, coated with tin and zinc by dipping in a molten bath of these metals, coated with zinc by the Sherardising process, or electro-galvanised.

"The structure of electrolytic iron varies considerably, and in some cases it is found to be amorphous; whilst in other instances it possesses a structure somewhat similar to that of wrought iron."

The properties of electrolytic iron seem to depend largely on the amount of hydrogen present, and therefore on the annealing which reduces or eliminates the occluded hydrogen. Hydrogen is always present in quantities varying according to the conditions under which the iron is produced, in some cases amounting to 110 times the volume of the iron. The greater the hydrogen content, the harder the iron and the more powerful its magnetization. "There are two distinct varieties of electrolytic iron, with varying percentages of hydrogen: the softer kind of iron is silver-grey in colour, whilst the other variety is very hard and brittle, breaking as readily as glass, and containing a higher percentage of hydrogen. The hardness varies between these two extremes. A surface can be obtained on the latter of a silvery whiteness, and with a mirror finish without polishing. Either quality can be produced at will by increasing or decreasing the electro-motive force at the terminals of the cell.

"Iron highly charged with hydrogen is very inert, and not readily attacked by acids. The softer quality is also comparatively inert. Equal surfaces of wrought iron and electrolytic iron were immersed in pure hydrochloric acid, 2 degrees Twaddell, for 18 hours. The electrolytic iron lost 2.48 per cent. of its weight, and the wrought iron 13.13 per cent. The temperature required for annealing electrolytic iron is slightly in excess of that required for ordinary rolled sheets. Electrolytic iron, when heated in a closed annealing-box, gives off large quantities of hydrogen; and if a pipe is fitted to the annealing-box the hydrogen flame can be kept burning during the whole process of annealing, and for a considerable time after the heat has been removed from the annealing box. This phenomenon has been turned to account for removing scale from ordinary rolled sheets by placing some sheets of electrolytic iron in an ordinary annealing-box with plates to be scaled. Electrolytic iron gives up considerable quantities of its hydrogen under 100 degrees C. without losing its brittleness, and also when boiled in water or oil."

Mr. Cowper-Coles estimates the cost of a plant to produce 5,000 tons of tubes, sheets and wire annually at 108,295*l*., and the cost of productiou per pound of finished material 0.56*d*.

THE ECONOMY OF EXHAUST-STEAM TURBINES.

A RECORD OF INCREASED CAPACITY AND DECREASED COST IN TWO LARGE GENERATING STATIONS.

Charles B. Burleigh—National Association of Cotton Manufacturers.

THE low-pressure steam turbine was the subject of a long and valuable paper read by Mr. Charles B. Burleigh at the recent meeting of the National Association of Cotton Manufacturers. The most striking features of his discussion were an abstract of a report on the economic possibilities of low-pressure turbines, made to the Cambridge Electric Light Company by Prof. I. R. Hollis of Harvard, and a review of the remarkable results obtained in service by the Philadelphia Rapid Transit Company and the Scranton Street Railway. With Prof. Hollis' report we have not space to deal, but we present below a few data on service results taken from an abstract of Mr. Burleigh's paper in the *Electric Railway Journal* for October 10.

"The Philadelphia Company in 1905 installed at its Thirteenth and Mt. Vernon Street power station an 800-kilowatt Curtis low-pressure turbine. This station was equipped with four 1,500 horse-power and one 2,200 horse-power Wetherill Corliss engines, which had previously been operated non-condensing on account of the lack of cooling water. An Alberger condenser with 8,000 square feet of cooling surface was installed for use in connection with the low-pressure turbine. The rotary pumps for circulating the cooling water are direct connected to a 120 horse-power interpole motor, and the average vacuum obtained is 28 inches. The 1,500 horse-power engines are each direct connected to a generator which develops about 2,000 amperes at 575 volts. The turbine takes steam from a common exhaust main at a pressure of about one pound above the atmosphere. Exhaust steam from one engine when delivering 2,000 amperes is sufficient to deliver an output from the turbine of 1,300 amperes at 575 volts, with no increase in back pressure upon the engine. As about 150 amperes are required to operate the auxiliaries, the net gain from the turbine is from 1,000 to 1,200 amperes, or about 66⅔ per cent. As the gain from a condenser without the turbine would not exceed 25 per cent, the latter produces a net gain of 41⅔ per cent.

"The generator used with the turbine

is a six-pole direct-current machine, making 1,200 revolutions per minute, but the set is not fitted with a governor. With the turbine taking steam at atmospheric pressure, with 2-inches absolute back pressure in the condenser, the guaranteed water rate is 36 pounds per kilowatt-hour at full load. If the engine-driven generators tend to take more than their share of the load, the engine governors admit an additional volume of steam to produce the necessary energy, and the engines in turn deliver more steam to the turbine, tending to speed it up, and thus raise its voltage to effect automatic regulation.

"As the load conditions demanded a further increase in capacity, a second 800-kilowatt unit of the low-pressure type was installed in 1906 under similar conditions, with condenser and cooling tower. All the auxiliaries required in the turbine installation are motor driven, with the exception of two dry-air pumps, one step-bearing pump and two discharge pumps, the exhaust from which is utilized for heating the feed water, and the power to operate them is about 14 per cent of the turbine output. The two turbines are run about 18 hours per day. The coal consumption for all purposes at this station was 4.48 pounds per kilowatt-hour the first six months of 1905, before the turbines were installed. The coal consumption for all purposes after the turbines were placed in operation was, for the first six months of 1906, 4.08 pounds per kilowatt-hour. This meant a saving of $24,414 per year in fuel cost with coal at $3 per ton. It is figured that when further increase is needed additonal low-pressure turbines will cut down the coal consumption of the engines to at least 3 pounds per kilowatt-hour, and pay a good return on the investment.

"Looking at this plant from the first-cost side, the original steam equipment cost about $100 per kilowatt, and to have increased the capacity on the original lines would have required an investment proportional to the original outlay. The low-pressure turbines, however, were installed at an expense of approximately $50 per kilowatt, and as the turbines were utilizing the energy of the steam previously unused, the fuel consumption was not increased a pound, 2,300 kilowatts being made available at no more expense as regards fuel and attendance than was previously necessary to deliver 1,500 kilowatts to the distributing mains. During the year 1904 the engines were operated alone under normal conditions with the following results:

Average kilowatt-hour output per month	2,475,000
Average cost per kilowatt-hour........	7.3 mills
Average cost of coal per kilowatt hour.	5.15 "
Average pounds of coal per kilowatt-hr.	4.6

"These conditions prevailed until January, 1905, when the first 800-kilowatt low-pressure turbine was placed in operation, and the conditions for the next year were as follows:

Average kilowatt-hours per month......	2,500,000
Average cost per kilowatt-hour.........	6.9 mills
Average cost of coal per kilowatt-hour.	4.97 "
Average pounds of coal per kilowatt-hr.	4.47

"The addition of the low-pressure turbine, amounting to an increase of about 10 per cent in station capacity, delivering 10 per cent increased average power, used less coal to the extent of 105 short tons per month, or, in other words, an expenditure of $40,000 enabled the purchaser to deliver 25,000 kilowatt-hours more per month and save 105 tons of fuel. In January, 1906, the second low-pressure turbine was installed. The following were the conditions:

Average kilowatt-hour output per month	2,957,500
Average cost per kilowatt-hour........	6.08 mills
Average cost of coal per kilowatt-hour.	4.5 "
Average pounds of coal per kilowatt-hr.	4.08

"During the year from 1906-7 the turbine averaged to carry 16.8 per cent of the load.

"Comparing the conditions during the year 1906, with the two turbines in operation, carrying but 16.8 per cent of the load, with the year 1904, before the turbines were installed, it was found that the station delivered an increased average amount of power to the extent of 19.5 per cent, or 482,500 kilowatt-hours per month, and that the total cost of the station output for the year 1904, with the engines, was $216,810, while the total cost for the year 1906, with engines and turbines delivering 5,790,000 kilowatt-hours more than in 1904, was $214,005. It thus cost $2,805 less to deliver 19.5

per cent more energy, incident to the low-pressure installation.

"The Scranton Street Railway was equipped with four simple non-condensing Corliss engines, of the following dimensions and capacities:

	Rated horse power.	Kilo-watts.
No. 1. Allis, 42 x 54 in., 97 r.p.m.	1,400	1,000
No. 2. Dickson, 26 x 48 in., 80 r.p.m.	400	300
No. 3. Cooper, 26 x 48 in., 80 r.p.m.	400	300
No. 4. Cooper, 30 x 38 in., 97 r.p.m.	750	500
	2,950	2,100

"The engines were operated at an initial pressure of 115 pounds. Nos. 1 and 4 were direct connected, and the others were belted to individual generators of the capacity named. The average output of this plant is 1,500 kilowatts while the maximum requirements of short duration taxed the entire plant to its utmost. The exhaust of these four engines led down into a common tee, from the top side of which emerges a 30-inch free outlet to the atmosphere.

"Early in 1906 a 500-kilowatt Curtis low-pressure turbine was installed, taking steam through a 14-inch pipe connected to the 30-inch outlet, and exhausting through a condenser supplied with cooling water from the Lackawanna River, a distance of 450 feet, with a lift of 54 feet to the condenser head, at mean height of the river. The turbine, therefore, works between atmospheric pressure and 28-inch vacuum at a water rate of about 38 pounds per kilowatt-hour, or less than 20,000 pounds of steam per hour at its full rated capacity, while the engines, aggregating about 3,000 horse power will, at 30 pounds per horse power, exhaust, when working at their rated capacity, 90,000 pounds in the same time. There is, therefore, an opportunity here for the installation of at least two or three similar low-pressure units as soon as the load conditions warrant. The method of using the turbine output is similar to that practised in Philadelphia."

THE METALLOGRAPHIC STUDY OF ORE DEPOSITS.

EXAMPLES OF THE APPLICATION OF THE METHODS OF MICROSCOPIC METALLOGRAPHY TO THE STUDY OF COMPLEX ORES.

Dr. William Campbell—Canadian Mining Institute.

A LONG paper on the engineering applications of metallography, read last March before the Canadian Mining Institute by Dr. William Campbell, has just been published in the *Journal* of the Institute. With Dr. Campbell's discussion of the industrial applications of metallography, to which the larger part of his paper is devoted, we do not propose to deal. This subject will be exhaustively treated by M. Jacques Boyer in our next issue. We give below, however, a few examples of the application of the methods of microscopic metallography to the study of ore deposits, taken from the concluding section of Dr. Campbell's paper.

"The latest development of metallography is its application to economic geology. By its aid we can distinguish the relative ages of the various opaque constituents of ore bodies much more easily than can be done by hand specimens or in the petrographic slide, when dealing with complex and compact masses.

"The ordinary specimens from Butte, Mont., are composed of iron-pyrites with more or less copper. Under the microscope the pyrite is clearly the oldest constituent. It has been broken and fractured and then eroded by solutions. Then in the interstitial spaces were deposited bornite and chalcocite. The chalcocite is apparently younger than the bornite for it cuts it in places. Very often when the specimen shows chalcopyrite this latter was the last to form because it is the groundmass of the pyrite, bornite and chalcocite.

"The silver deposits of Cobalt, Ont., have been studied in this way. We find that the first mineral to crystallize out in the vein was smaltite and this was followed by niccolite, for cubes of smaltite are found embedded in niccolite. Both the niccolite and the smaltite show signs of disturbance and are cut by veins of calcite. In a section from the La Rose mine rough smaltite is seen enclosed in smooth-polishing niccolite, both of which are cut by thin veins of calcite which appears black on account of the vertical illumination. Of later age still is the argentite which cuts the calcite; while the silver cuts both argentite and calcite. The bismuth came down with or a little later than the native silver. Thus we can establish the order: smaltite, niccolite, period of disturbance, calcite, then argentite, native silver and bismuth. In addition we find crystals of cobaltite incrusted on the rosettes of smaltite (cloanthite) embedded in the calcite, therefore, the cobaltite is slightly younger than the smaltite and older than the calcite. Mispickel occurs like cobaltite. It is well known that much of the silver in the Cobalt deposits is not pure. This is explained when it occurs as veins, for each vein has a thin envelope of a bluish harder substance which polishes somewhat in relief, probably a native alloy of silver.

"Nickeliferous pyrrhotites have long been the subject of discussion. Many hold that the nickel replaces the iron isomorphously. We have examined specimens from widely different localities and in each case the nickel occurred as pentlandite. Chalcopyrite usually occurs also and we find the following order of succession holds good: pyrrhotite, pentlandite, chalcopyrite. Secondly, their origin is much discussed. Are the deposits of direct igneous origin or have they been deposited through the agency of solutions? The specimens we have examined show such a structure that they could not have separated from an igneous mass. They show no resemblance to nickel mattes.

"The processes of decomposition and of secondary enrichment can be studied metallographically. . . . Another important line of work is the study of certain complex mineral species to determine their constitution. We can ascertain in many cases whether a mineral owes its peculiarity of formula to a definite combination or to the presence of foreign bodies as in the case of a mechanical mixture. In the majority of specimens examined there is found more or less admixture of foreign matter. Chalcopyrite includes chalcocite or pyrite, sometimes even galena. Tetrahedrite includes quite a number of other minerals and so on. Steel galena when examined is found in many cases to owe its fine structure to the presence of a second mineral. Each grain is surrounded by a fine film of quartz in one case, calcite in another, tetrahedrite in another, blende in another and so on. In many cases the galena was deposited, then crushed and the second constituent then deposited. Minerals often show the effects of strain when etched, especially galena and pyrrhotite."

THE UTILIZATION OF WASTE FURNACE GASES.

THE ECONOMY OF CO-OPERATION BETWEEN COKE-OVEN AND IRON-WORKS OWNERS AND ELECTRIC-POWER COMPANIES.

Charles H. Merz—Iron and Steel Institute.

IN the course of a long paper on electric power supply, with a special reference to its effect on the iron industries of the North-East Coast of England, presented before the Iron and Steel Institute at the Middlesbrough meeting, Mr. Charles H. Merz discussed in its economic aspects the problem of the utilization of waste furnace gases. We have from time to time referred in these columns and in leading articles to the various proposals for applying the waste heat of blast furnaces and coke ovens to the production of power, the last occasion being in our issue for December, 1907, when we reviewed Mr. B. H. Thwaite's pooling scheme. The method proposed by Mr. Merz, however, contains elements of difference from any advocated hitherto, since he believes that the most efficient means of utilization is to be found in co-operation with regularly established electric-power companies.

"The problem is one of great moment, and, however dealt with, will involve years of work before a complete solution can be achieved. It is, therefore, the more important that the efforts directed towards such a solution should proceed on a commercially sound basis and along correct engineering lines. On a rigorous analysis of the situation it will be found that financial and other practical considerations definitely limit the pace at which progress can be made, and, especially in the case of blast-furnaces, greatly reduce the amount of power immediately available.

"Many engineers, fascinated by the magnitude of the figures, have proceeded to calculate the commercial value of the gas; the more cautious of them by estimating the total heat units contained in the gas, and then calculating the value of the coal necessary to give the same heat units; others by first assuming the gas is utilized in gas engines, and then calculating the tonnage and value of the coal required to produce the same horse-power from steam-engines. The second method gives a result twice as great as the first, which is itself already much too high, having left out of account the fact that the gas or heat in question can only be regarded as of the same value as coal if it can be utilised as cheaply from a capital expenditure point of view, if it can be stored as conveniently, and if it be available where and when required; in short, the commercial value of these waste products bears no direct relation to their value arrived at by either of the above methods.

"Dealing first with the waste energy from coke-ovens, each separate group of ovens usually consists of between 40 and 120 ovens, rarely exceeding the latter figure. The batteries of ovens are widely scattered and are, for the most part, at relatively long distances from the populous centres—that is to say, from the centres of power demand. The gas might be piped to some central point, as is the practice followed in America with natural gas, which is transmitted in some cases 200 miles; but this natural gas has twice the calorific value of coke-oven gas, and it is usually available at a pressure of 50 pounds per square inch or upwards, rendering it practicable to transmit a large volume of energy through a relatively small pipe, whereas to transmit coke-oven gas any distance there would have to be installed an expensive compressing plant. Further, there is, in addition to the gas given off from the coke-ovens, a certain quantity of waste heat which can only be utilised locally under boilers; and in no calculations which the author has made has he been able to establish a case for the transmission of gas for power purposes as against the alternative of converting the gas into electricity and transmitting the power in this form. Admitting the desirability of converting the gas into electricity, the doubtful point then remaining is whether it is cheaper for an owner of coke-ovens to put down his own generating station and to utilise the electricity so produced for his mines; or, alternatively, to cooperate with a power company, which he can do either by selling them the whole of the gas and purchasing in return what electricity he needs; or by undertaking to provide a portion of the capital required for generating-stations, which, when erected, would be operated by the power company, and the profits shared between the parties.

"In all cases investigated by the author it has been found that a greater profit will accrue to the coke-oven owner by co-operating with a power company than by proceeding on independent lines. There are three reasons for this:—

1. When a private owner erects a generating plant independently he must install some reserve or spare plant, with a consequent heavier outlay of capital than is necessary to a power company, which, possessing a coal-fired station, need install no spare plant in any of their waste-heat stations, but can, instead, meet any variation of load by the

coal-fired station, which also acts as a stand-by against any breakdown.

2. This necessity of putting down spare plant results in smaller, and therefore more expensive and less efficient plant. To take a case—supposing 2000 horse-power is available, if the station is to be used in conjunction with the power company's system—one 2000-horse-power unit would be entirely satisfactory, the power system acting as stand-by. If it is to be used in a separate generating-station, one would probably install three 1000-horse-power units, two working and one spare. The gain in the former case in capital cost, running cost, and efficiency is obvious. As a matter of fact, the capital cost in the second case would be nearly double what it would be in the first.

3. The power company, having a market for current many times greater than the output of any individual waste-heat station, can run such a station continuously at maximum output, so utilising completely all the current that can be produced; whereas it is impossible to conceive the power requirements of an individual coke-oven and colliery-owner coinciding even approximately over twenty-four hours with the amount of gas or waste heat available. . . .

"It is more difficult to reach a decision in the case of blast-furnaces, as the conditions vary so widely. Of course, if a company produces pig iron only, and does not convert the iron into steel, co-operation with a power company is at present, practically speaking, the only outlet which it has for its surplus power. If, however, a blast-furnace works has a steel mill attached, it may be argued that the correct thing to do is to follow the plan adopted by many large works in Germany—namely, to install gas-engine blowers and gas-driven dynamos at the blast-furnaces, the latter plant producing the necessary power for driving the steel mills.

"In the case of the new works which the United States Steel Corporation are putting up at Gary, they are arranging to drive the whole of their steel-works electrically, and they reckon to get all the power required for the steel mills from the blast-furnace gas utilised in gas-engines, of which they are installing 27,000 horse-power; but—and this is an important consideration—they are putting down, to act as a spare to the gas-engines, steam plant, the boilers supplying which can be coal-fired. The resultant capital cost per useful horse-power of plant is therefore great, probably at least twice as much as it would have been had it been possible there to co-operate with a power supply company.

"Capital charges are invariably the controlling factor in the total cost of electricity, and the question raised above—namely, whether it is commercially sound for a blast-furnace owner to co-operate with a power company or not—can only be decided in each individual case after full consideration of the capital outlay involved, the amount of spare plant that has to be provided, and the degree of coincidence between supply and demand. It is clear that if it be decided to make the works self-contained, then the supply capacity must always be in excess of the possible demand, otherwise a risk is run of a portion of the works having to be stopped, and as the demand varies from time to time there must be a variable amount of gas utilised involving wastage when supply exceeds demand, or the burning of coal at certain periods when demand exceeds supply. Given an equitable arrangement, it is clear that the same general arguments in favour of co-operation which hold in the case of coke-ovens are applicable to blast-furnaces with steel works attached.

"As illustrating one aspect of the case, I quote from an article on the German Steel-Works Union, published in the Financial and Commercial Supplement to the *Times*, dated July 3, 1908: 'The latter concerns (the German iron and steel works) have grown up under the economic impulse to find and employ the cheapest method of production in order to secure iron at the lowest possible cost. They have erected blast-furnaces around their mills. . . . The gases formerly escaping from their furnaces and going to waste now supply a cheap motive power for their steel and rolling-mills. They make their own coke, and the coking process furnishes valuable by-products besides supplying, in many cases, an additional source of fuel-gas for the power plants.'

"Later on, in speaking of the big iron producers who form the Dusseldorf Syndicate, the writer says that in spite of dull trade 'the great works continue to smelt iron at almost the pace they set when the recent wave of prosperity was at its height. The economies involved in the situation almost compel them to do so. To a considerable extent they have long-term contracts for foreign ores for mixing with home ores; their coking-ovens must continue in operation for the sake of the by-products, and the coke produced would deteriorate in quality if stored. But more than this, the furnace gases are needed for driving their steel-mills, and it is often difficult to blow out a furnace or two without seriously disturbing the power supply.'

"It would therefore appear that even after a rough approximate balance has been secured between supply and demand it is readily upset by ordinary market fluctuations. The natural variation of trade thus furnishes a further argument in favour of the co-operative principle in the utilization of blast-furnace and coke-oven gases.

"The power companies in this district having their transmission cables interlacing the entire industrial area, and being in a position, with their large load already developed, to utilise any amount of electricity whenever and wherever produced, are arranging for waste-heat stations at different points, turning all the electricity so produced into a common network from which the colliery company, the coke-oven owner, or the blast-furnace owner can purchase any amount he may require, all spare plant and all plant to deal with exceptional peak loads being kept at the main central coal-fired station. Such a policy applied to other commodities is as old as the hills; it began in the most primitive market when a producer gave his raw material and received in exchange manufactured articles, but so far as the author is aware this is the first time it has been extensively applied to electricity, although the principle so applied is equally sound, and it appears that only in this way is it possible to conserve the full national value of the energy now being wasted."

THE ELMORE VACUUM PROCESS.

PRACTICAL NOTES ON THE OPERATION OF THE PROCESS IN THE CONCENTRATION OF SULPHIDE ORES.

R. Stören—The Engineering and Mining Journal.

ON another page of this isssue of THE ENGINEERING MAGAZINE Mr. Chas. C. Christensen describes in brief outline the Elmore vacuum process of ore concentration. We supplement here Mr. Christensen's necessarily brief note with a few paragraphs on the practical operation of the process, taken from a lengthy paper by Mr. R. Stören in *The Engineering and Mining Journal* for October 31.

"The size of the particles is of great importance in the operation, for it greatly affects the results obtained. The fineness to which the ore should be crushed depends upon the size and distribution of the mineral particles, a maximum of purely metallic mineral particles being the aim, or rather a minimum of middlings containing both metallic and non-metallic minerals in the same particle. There is a maximum and minimum size, between which ore is suitable for concentration by the oil-acid process. Classification may be advantageous, but it is not necessary except for removing the more plastic slime-forming material. The size of the particles ought not to exceed 20-mesh, or about 1 millimetre. Ten-mesh material has been tried, but particles of this size do not adhere readily to bubbles.

"The water supply must be in proportion to the size of the ore. The larger the particles the more water must be used in the feed pipe, to increase the velocity and to prevent lodging; this also increases the velocity in the concentrator and aids in holding the material in suspension. The settling of the tailings against the rising current limits the supply and the velocity of the feed water.

"The percentage of slime produced determines the degree of crushing permissible. The surface of the slime particles is very great in proportion to the volume. The fine material is easily brought into suspension, and long remains in that state. Still finer slime has a plastic consistence, which has an important effect upon the working of the process. When the volume of the minute slime particles approaches zero, the area must also approach zero; and the body which has practically no surface cannot adhere to anything. The finest slime, therefore, cannot be enriched by means of the adhesion process. The addition of acid, as already explained, has some regulative effect; but the finest slime, chiefly the pyrite particles not wetted by contact with oil in the mixer, passes into the concentrator, and by means of its plastic consistence hinders separation in the central region of the cone. This fine plastic material should, therefore, be removed before the ore enters the mixer. For this purpose a thickening tank has been employed.

"The pyrite slime which carries gold and silver may contain a higher proportion of those metals than the original ore. Tests on a Norwegian ore gave the following results:

	Copper, Per Cent.	Silver Grams per Ton.	Gold Grams per Ton.
Original ore	1.36	10	1
Slime	1.79	18	2

"An explanation of this phenomenon may be found in the mode in which the precious metals occur in the pyrite, as microscopical particles, often upon the surface of the crystals and between the pyrite particles and the inclosing rock minerals. The statement made by certain eminent authorities that the precious metals are bound to the sulphides, cannot be accepted without question. During the crushing a relatively large proportion of precious minerals will detach from the pyrite and, because of their extreme fineness and high specific gravity, partly pass into the slime, and partly into the tailings. The detached gold may be without bright surfaces, the so-called black gold, similar to that formed by the reduction of gold from a solution.

"The crystalline form of the minerals may play a rather important part in ore dressing by the adhesion process. The mode of crystallization may be divided into two types: Forms which produce numerous planes, such as prismatic and tabular crystals; and the more globular forms, polyhedrons, etc. The form may be of considerable importance when the individual crystals are small enough to pass 30- to 40-mesh screens; and also the cleavage planes of such minerals as molybdenite and mica.

"Although the so-called oil process was first brought into practical prominence by the introduction of the Elmore vacuum concentrator, the vacuum chamber is not the chief feature of the apparatus; the mixer remains the fundamental factor in the process. Errors made in the mixer, in crushing, in the addition of acid and oil, cannot be remedied in the concentrator. It would be quite as sensible to try to correct the mistake of feeding unclassified material to Wilfley tables by regulating the supply of water. It is, therefore, necessary to examine the ores carefully to determine the properties of their constituent minerals, which may require more or less adjustment in the mixer to obtain the best possible result in the concentrator.

"As stated before, the effect of the acid is chemical; it removes the weathered surface of the mineral. According to Elmore, mine water with acid reaction may be used instead of the dilute sulphuric acid. Ores with oxidized surfaces require more acid in the mixer than ores with fresh surfaces.

"Ore from a Norwegian mine which had been stored for some time and had become weathered, was treated with 0.45 per cent. raw petroleum and 0.9 per cent. acid, and concentrated in an Elmore apparatus. The ore before treatment contained 1.15 per cent. copper and

6.89 per cent. sulphur. The extraction of copper was 56 per cent. and sulphur 46 per cent. The same ore crushed and screened through 35-mesh, and treated with the same quantity of acid and oil yielded an extraction of 75 per cent. copper and 76 per cent. sulphur. The better extraction was due to the fresh fracture planes produced during crushing.

"A Swedish ore, also weathered, and containing 1.18 per cent. copper, 1.76 per cent. sulphur, and about 25 per cent. magnetite, after treatment with 0.8 per cent. Texas oil and 0.3 per cent. acid, yielded in the Elmore apparatus, an extraction of copper 65 per cent, and sulphur 15 per cent. Fresh ore from the same mine, with the same percentage of minerals and mixed with the same quantities of oil and acid, gave an extraction of 79 per cent. copper and 25 per cent. sulphur.

"Chalcopyrite resists surface oxidation better than iron pyrite; the latter requires more acid in the mixer, even when the surfaces are rather fresh. The presence of magnetite in large proportions causes low extraction of iron pyrite, for it neutralizes the acid leaving the particles of pyrite covered with a coating of amorphous oxide. In this case it is better to remove the magnetite by means of magnetic separation before treatment by the Elmore process.

"In the regular operation of the process it has been remarked that ores with pyrites oxidized on the surface are concentrated by acid as much as by oil. The gas bubbles, formed during the solution of the coating, adhere to the cleaned surface and float the particles with the expenditure of less oil than in the case of fresh pyrites. It may be said, that chalcopyrite is separated by means of oil; iron pyrite, by means of acid. It is important that the agitation in the mixer be not so violent as to destroy the gas bubbles formed on the pyrite particles by the acid.

"The treatment of bornite in the mixer should be similar to that outlined for pyrite ores. Bornite belongs to that class of minerals which, when exposed to the air, are soon covered with a coating. A larger proportion of acid is required than for chalcopyrite and, as in the case of iron pyrite, bornite ore is best treated when fresh. By using more acid and warm water in the mixer, bornite ore should give as good extraction as chalcopyrite.

"Concerning the quantity of oil to be used, it may be said in general that a minimum of oil gives a clean concentrate, but also rich tailings. This is, of course, due to the fact that the cleanest pyrite particles have better adhesion to the oil foam than the particles which contain gangue minerals. If a large proportion of oil is used, the middlings will begin to float, and, after still greater additions of oil, some rock minerals, chiefly mica, enter the tailings as well as magnetite and hematite.

"The use of warm water in the mixer aids the action of the acid; it also increases the tendency of oils to foam. Heating the water for the feed pipe of the concentrator outside the mixer is, however, not to be recommended, for heat causes the emission of more or less of the absorbed air, and this air furnishes bubbles required in the concentrator."

RECENT RESULTS WITH THE STASSANO ELECTRIC FURNACE.

DATA OF POWER CONSUMPTION IN THE PRODUCTION OF STEEL FROM THE ORE AND FROM SCRAP, SPECIAL STEELS AND SPECIAL ALLOYS.

M. Stassano—Revue de Métallurgie.

SOME interesting results of Stassano electric-furnace operation at the Turin arsenal and the works of the Société Forni Thermoelettrici Stassano at Turin are given in a long paper by M. Stassano in the *Revue de Métallurgie* for September. Besides reporting the results of recent tests, M. Stassano goes into a long discussion of the general subject of the electrometallurgy of iron and steel and of the design and merits of his furnace, which space will not permit us to reproduce. We present below a few data on power consumption in the production of steel direct from ore and from scrap, special steels and special alloys, taken from M. Stassano's detailed tables.

The general design of the Stassano furnace is well known. It will be remembered that it is of the vertical cylindrical type, the heat being produced by an arc between carbon electrodes projecting through the walls above the charge. The latest furnaces designed by Stassano rotate upon a circular rail placed on an inclined plane, to secure thorough mixing of the charge. A 200 horse-power furnace was built in 1903 at the Turin arsenal for making projectile steel and more recently there have been installed in the works of the Société Forni Thermoelettrici Stassano in the same city two fixed 100 horse-power furnaces, one rotating 200 horse-power furnace, one tilting 200 horse-power furnace, and two 1,000 horse-power furnaces, one fixed and one rotating; and at the works of the Bonner Froeserfabrik at Bonn, a 250 horse-power revolving furnace.

In the four tests on direct ore reduction, of which M. Stassano gives the results, the charges consisted of 1,000 kilogrammes of ore containing oxide of iron, 68.70 per cent; oxide of manganese, 3.22 per cent; silica, 17.15 per cent; alumina, 2.0 per cent; lime, 1.0 per cent; magnesia, 5.67 per cent; phosphorus, 0.15 per cent; and sulphur, 0.12 per cent; together with 350 kilogrammes of limestone, 240 kilogrammes of charcoal, 80 kilogrammes of an aqueous solution of silicate of soda, and 50 kilogrammes of calcium carbide. The products of the four heats had the following analyses, the variation in the last being due to recarburization by the addition of some hematite pig iron:

	1.	2.	3.	4.
Carbon	0.25	0.26	0.30	0.80
Manganese	0.12	0.21	0.24	0.30
Silicon	0.07	0.03	0.14	0.22
Phosphorus	0.01	0.01	0.015	0.015
Sulphur	0.065	0.04	0.07	0.045

Power consumption in these four cases was, respectively, 4.5, 4.3, 4.0 and 4.2 kilowatt-hours per kilogramme of product. The steel produced in the second and third heats showed a tensile strength of 55 kilogrammes per square millimetre and an elongation of 23 per cent. In the fourth heat these values were changed to 86.3 kilogrammes and 13 per cent respectively.

A large amount of work has been done in the production of soft steel castings from scrap material. Analyses of the products of six heats using the same weight and composition of charge in each case follow:

No	C.	Si.	S.	P.	Mn.
1..........	0.20	0.33	0.050	0.088	1.02
2..........	0.22	0.10	0.045	0.030	0.42
3..........	0.22	0.17	0.052	0.026	0.50
4..........	0.26	0.09	0.048	0.025	0.49
5..........	0.26	0.28	0.040	0.035	0.44
6..........	0.25	0.20	0.050	0.035	0.41

The castings produced had an average tensile strength of about 42 kilogrammes per square millimetre and showed an average elongation of about 18 per cent. Power consumption for this class of work averaged over the whole of 1907 1.26 kilowatt-hours per kilogramme of metal. The production of projectile steel from scrap at the Turin arsenal takes about the same amount of power.

Special tungsten alloys containing from 58 to 69.7 per cent tungsten have been obtained for an expenditure of power of 6 to 7.5 kilowatt-hours per kilogramme. The power consumption in the production of silico-manganese with approximately 60 per cent manganese and 20 per cent silicon was 7.4 kilowatt-hours per kilogramme. Very satisfactory results have been obtained also in the manufacture of special steels, a product of the desired composition being obtained with very little difficulty.

M. Stassano gives the consumption of the electrodes at 10 kilogrammes per ton of steel produced and the cost of furnace lining at 10 francs per ton except in very exceptional cases. The labor necessary to operate a furnace up to 300 horse-power capacity is three men. For a 1,000 horse-power furnace four men are required when using liquid metal or ore, and five or at most six when using cold stock.

THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE"

The following pages form a descriptive index to the important articles of permanent value published currently in about two-hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

CIVIL ENGINEERING

BRIDGES.

Cantilever.

The Sydney Harbor Bridge, New South Wales. C. O. Burge. Describes approved designs for a proposed bridge to North Sydney with a main cantilever span of 1,350 ft. and a minimum headway of 170 ft. at the centre. 3200 w. Eng Rec—Oct. 10, 1908. No. 95742.

Columns.

Nickel Steel for Bridges. Editorial review of a recent paper by A. J. Waddell. 2000 w. Engng—Oct. 16, 1908. No. 96-055 A.

Concrete.

Moving Loads on Concrete Bridges. Daniel B. Luten. The advantage of the low ratio of live load to fixed load. 600 w. R R Age Gaz—Oct. 30, 1908. No. 96237.

Culverts.

See Reinforced Concrete, under Bridges.

Drawbridges.

An Effective Drawbridge Compensation. A. D. Cloud. Account of method to facilitate the working of bridge couplers. 1500 w. Sig Engr—Sept., 1908. No. 95817.

We supply copies of these articles. See page 579.

Erection Travelers.
See Cranes, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Failures.
Fall of the B. & O. Susquehanna Bridge. William Allen. Description of the failure of the falsework and temporary span. Illus. 1000 w. Sci Am—Oct. 10, 1908. No. 95691.

Girders.
Riveting for Built-up Girders. Mathematical study, illustrated by example. 1500 w. Am Mach—Vol. 31, No. 44. No. 96209.

Masonry.
The Masonry Arch Bridge Across the Connecticut River at Hartford. Illustrated description of a fine example of this type. 1200 w. Eng News—Oct. 22, 1908. No. 96012.

Quebec.
See Testing Materials, under MEASUREMENT.

Reinforced Concrete.
Reinforced Concrete Highway Bridges and Culverts. Owen McKay. From Pro. Assn. of Ontario Land Surveyors. Plans and descriptions of bridges and culverts constructed in 1907. 2000 w. Can Engr—Oct. 16, 1908. No. 95907.

A Combined Concrete and Steel Girder Bridge, Monroe St., Brookland, D. C. W. J. Douglas, and W. P. Darwin. Illustrated description of a somewhat unusual type. 1500 w. Eng News—Oct. 29, 1908. No. 96218.

Bridge Reconstruction on Columbus and Lake Michigan Railway. Dan'l B. Luten. Description of reinforced concrete bridges replacing wooden trestles and truss bridges built while maintaining traffic. 1800 w. Elec Ry Jour—Oct. 3, 1908. No. 95592.

Steel.
Statistics as to the Life of Steel Railway Bridges. Discusses life of 10 American railway bridges. 1000 w. Engng-Contr—Oct. 7, 1908. No. 95731.

Data on 14 Steel Bridges (Highway and Railway) Including Weights, Cost, etc. Discusses the weight of long span, swing and lift bridges. 2500 w. Engng-Contr—Oct. 7, 1908. No. 95730.

Replacing the Clyde River Bridge of the West Shore Railroad. Illustrated detailed description of work at Lyons, N. Y. 2500 w. Eng Rec—Oct. 24, 1908. No. 96035.

See also Failures, and Girders, under BRIDGES.

Suspension.
A Temporary Suspension Bridge. Illustrates and describes a footbridge with a span of 120 ft. in the town of Sulphur, Okla. 800 w. Eng Rec—Oct. 17, 1908. No. 95937.

Trestles.
Reinforced Concrete Trestle and Stone Bins. Account of combined trestle and stone bins into which is dumped crushed stone used in paving, Springfield, Mass. Ills. 850 w. Ry & Engng Rev—Oct. 10, 1908. No. 95807.

Viaducts.
The Harrison Avenue Viaduct at Cincinnati. Illustrated detailed description of this steel structure. 2200 w. Eng Rec—Oct. 17, 1908. No. 95931.

CONSTRUCTION.

Bins.
See Trestles, under BRIDGES.

Brick.
Bond in Brickwork. Ernest Alfred William Phillips. Gives results of practical experience, with diagrams. 3000 w. Inst of Civ Engrs—No. 3652. No. 95490 N.

Campanile.
The Campanile of St. Mark. Abstract translation from *Le Génie Civil*, giving a summary of the principal works of engineering interest involved in the reconstruction. Ills. 3000 w. Engr, Lond—Sept. 18, 1908. No. 95408 A.

Concrete.
See Conveyors, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Contracts.
Time Penalties on Contracts. J. A. King. Paper read before Am. Public Works Ass'n.; discusses legal aspects of various contracts. 9000 w. Eng Rec—Oct. 3, 1908. No. 95620.

Excavation.
The Value of Cost Keeping; a High Cost of Wheel Scraper Work and a Lesson. Discusses cost keeping in excavation and the advantages of comparing different methods of work. 1300 w. Engng-Contr—Sept. 30, 1908. No. 95582.

The Cost of Excavating Earth in Small Quantities with a Steam Shovel. Analysis of cost where less than 100 yds. daily was to be moved. 900 w. Engng-Contr—Oct. 7, 1908. No. 95726.

The Cost of Excavating Earth and Hauling in Small Steel Cars. Describes use of 1½ yard all steel cars on a 30-in. gage track for excavating and transporting earth. 800 w. Engng-Contr—Sept. 30, 1908. No. 95582.

Factories.
Concrete and Steel Workshop in Canada. Illustrated description of a factory building at Peterborough, Ontario. 1400 w. Engr, Lond—Oct. 9, 1908. No. 95994 A.

Foundations.
Building the Foundations of the Grau du Roi Station Buildings on "Simplex" Piles (Notice sur l'Exécution des Fondations des Bâtiments de la Gare du Grau

du Roi sur "Pilotis Simplex"). M. Colombaud. Illustrated description of the work of preparing the foundations of a number of large buildings. 3800 w. Rev Gen des Chemins de Fer—Sept., 1908. No. 96111 G.

Gas Holders.

Raising and Supporting a Gas Holder. W. R. Phillips. Describes the renewing of the foundation of a large gas holder and the straightening of the tank. Illus. 3300 w. Eng Rec—Oct. 3, 1908. No. 95619.

Piling.

See Cofferdams, under WATERWAYS AND HARBORS.

Reinforced Concrete.

Reinforced Concrete and Its Practical Application. M. Kahn. Illustrated account of features of British practice with discussion. 12000 w. Trans Int Eng & Ship in Scot—Vol. 51, Feb. 18, 1908. No. 95608 N.

Reinforced Concrete. J. Monash. Read before the Roy. Victorian Inst. of Archts. Considers the factors upon which the economy of modern concrete construction depends. 2500 w. Surveyor—Sept. 18, 1908. No. 95436 A.

Reinforced Concrete Construction by the Works Construction Force. Warren H. Miller. Discussion of costs and methods including mixtures to be used. Ills. 3500 w. Eng Rec—Oct. 10, 1908. No. 95739.

Approximate Formulæ for Reinforced-Concrete Design (Annäherungsformeln für Eisenbetonbauten). O. Domke. Mathematical examples of their derivation and application. Ills. Serial. 1st part. 2500 w. Beton u Eisen—Sept. 2, 1908. No. 96175 E.

Reinforced Concrete Warehouse at Tempelhof on the Teltow Canal (Eisenbeton-Speicher im Tempelhofer Hafen am Teltowkanal). Illustrated description of a large six-story building. Serial. 1st part. 1600 w. Beton u Eisen—Sept. 24, 1908. No. 96176 E.

See also Trestles, under BRIDGES; Well Sinking, under WATER SUPPLY; Gas Engine Foundations, under MECHANICAL ENGINEERING, COMBUSTION MOTORS; and Stamp Mills, under MINING AND METALLURGY, ORE DRESSING AND CONCENTRATION.

Steel Buildings.

The Fifth Avenue Building, New York. Illustrated description of the unusual features of design and construction of this steel-cage structure. 2200 w. Eng Rec—Oct. 17, 1908. No. 95929.

Tall Buildings.

The Tall Building Question. F. W. Fitzpatrick. Suggestions for avoiding the canyon-like streets and securing light and air, etc. 2000 w. Archt, Lond—Sept. 25, 1908. No. 95897 A.

Tunnels.

Construction of the St. Paul Pass Tunnel; Chicago, Milwaukee & St. Paul. Account of the construction of a tunnel 8,750 ft. long through the Bitter Root Mts. Ills. 1500 w. R R Age Gaz—Oct. 9, 1908. No. 95754.

Difficult Tunneling for Water Supply. H. R. Mason. Illustrates and describes a tunnel through solid limestone to provide a large power station with condensing water. 3500 w. Power—Oct. 20, 1908. No. 95971.

The Rotherhithe Tunnel Under the Thames, London (Le Tunnel de Rotherhithe, sous la Tamise, à Londres). Edmond Henry. Illustrated description of the method of construction. 4000 w. Génie Civil—Sept. 26, 1908. No. 96128 D.

Underpinning.

Permanent Underpinning for the Paris Subway of the Paris and Orleans Ry. Illustrated detailed description of this interesting work and the methods of carrying it out in the face of very heavy traffic. 1200 w. Eng News—Oct. 15, 1908. No. 95958.

Wind Pressure.

Experiments on Wind-Pressure. Thomas Ernest Stanton. An account of research work and results, describing methods. Also discussion. Diagrams. 18500 w. Inst of Civ Engrs, No. 36905—Dec. 3, 1907. No. 95494 N.

MATERIALS OF CONSTRUCTION.

Cement.

The Commercial Value of Fine Grinding of Portland Cement. Richard K. Meade. Gives results of experiments to determine commercial value of fine grinding. Abstract of paper read before the Am. Soc. for Testing Materials. 2800 w. Engng-Contr—Sept. 30, 1908. No. 95581.

Paints.

Painting Cement Surfaces. P. W. Nelson. A paper read before Ohio State Assn. of Master House Painters and Decorators. A practical discussion of methods and materials. 1000 w. Munic Engng—Oct., 1908. No. 95523.

Reinforced Concrete.

Tests on Reinforced Concrete Beams. E. Brown. Describes tests made at McGill University, of different methods of reinforcement, particularly the Kahn and Johnson bars. Ills. 3500 w. Can Soc of Civ Engrs—Oct. 15, 1908. No. 95463 N.

Tests of Reinforced-Concrete Columns (Versuche mit Säulen aus Beton-Eisen). Fritz von Emperger. Gives results of four tests on concrete-filled iron columns. Ills. 2500 w. Beton u Eisen—Sept. 2, 1908. No. 96174 E.

Steel.

Nickel Steel for Bridges. J. A. L. Waddell. A report of experimental investigations upon the comparative values of nickel steel and carbon steel for bridge building and the results. Ills. 30000 w. Pro Am Soc of Civ Engrs—Sept., 1908. No. 95484 E.

Timber Preservation.

The Open-Tank Method of Preserving Timber. Howard F. Weiss. Brief discussion of the history, theory, and application of the open-tank or non-pressure process. 2500 w. Elec Ry Jour—Oct. 17, 1908. No. 95926.

The Comparative Value of the Antiseptics Used in Timber Preservation (Valeur comparative des Antiseptiques employés pour la Préservation des Bois). E. Lemaire. Gives the results of researches on eight of the commonly employed impregnating materials. Ills. 4000 w. Génie Civil—Sept. 19, 1908. No. 96127 D.

See also same title, under MINING AND METALLURGY, Mining.

MEASUREMENT.

Cement Testing.

Portland Cement Testing. W. C. Reibling and L. A. Salinger. A discussion of modern cement specifications. 14000 w. Philippine Jour of Science—June, 1908. No. 96099 N.

Surveying.

Levelling of Precision on the Panama Canal. Abstract of a report by W. G. Comber describing work and results. 1400 w. Ry & Engng Rev—Oct. 10, 1908. No. 95808.

Bench Levelling for the Board of Water Supply, New York. Illustrated description of method used in a continuous level line from Schoharie Co., N. Y., to N. Y. City and Suffolk Co., Long Island. 6500 w. Eng Rec—Oct. 3, 1908. No. 95616.

Diurnal Atmospheric Variation in the Tropics, and Surveying with the Aneroid. Theodore Graham Gribble. 2000 w. Inst Civ Engrs—No. 3741. No. 95495 N.

Testing Laboratories.

The Testing Laboratory of the Detroit River Tunnel Company. Description of apparatus for testing materials employed in the construction. Illus. 1800 w. Eng Rec—Oct. 3, 1908. No. 95617.

Testing Materials.

Test of a Model of the Quebec Bridge. Illustrated description of test of model of the chord that failed on compression testing machine of the Phoenix Iron Co. 5500 w. R R Age Gaz—Oct. 2, 1908. No. 95565.

MUNICIPAL.

Abattoir.

A Municipal Abattoir in South Africa. R. A. Webster. Brief description of Krugersdorp municipal slaughter house, the first in South Africa, from the *Surveyor*. 1000 w. Munic Engng—Oct., 1908. No. 95527 C.

Garbage Disposal.

Garbage Collection and Disposal at Cleveland. W. J. Springborn. Illustrated description of plant for treating city garbage. 1800 w. Dom Engng—Oct. 3, 1908. No. 95703.

The New Refuse Destructor at West New Brighton, N. Y. Illustrated description of the plant with summary of official tests. 4400 w. Eng Rec—Oct. 3, 1908. No. 95621.

Richmond Borough Refuse Destructor. Report of J. T. Fetherston giving the latest information of this very important plant. Ills. 3000 w. Munic Jour & Engr —Sept. 30, 1908. No. 95477.

A 40-Ton Garbage Incinerator at Oak Park, Illinois. Describes a plant for a suburban town of about 20,000 population. Ills. 1400 w. Eng Rec—Oct. 10, 1908. No. 95737.

The Disposal and Utilization of Household Refuse (L'Evacuation et l'Utilisation des Ordures ménagères). P.-Aristide Bergès. Suggests an improved method of dealing with the garbage disposal problems of Paris. 3500 w. Génie Civil—Sept. 26, 1908. No. 96129 D.

Manholes.

Method and Cost of Constructing Wooden Form for Concrete Manholes. P. W. England. Illustrated description of a simple type. 500 w. Engng-Con—Oct. 28, 1908. No. 96233.

Parks.

Park Systems for Great Cities. H. V. Lanchester. Suggestions with special reference to London. Plans. 5000 w. Builder—Oct. 3, 1908. No. 95896 A.

Pavements.

Iron-Slag Block for Street Paving. Description of its use and qualities; extent used in American cities. Also editorial. 2200 w. Eng News—Oct. 8, 1908. No. 95749.

Roads.

More Concerning English Highways. The contrasts in conditions in England and the United States are discussed and points worthy of study by American engineers. 1500 w. Eng News—Oct. 15, 1908. No. 95960.

Road Construction Work by Grading Camp Maintained by County. Describes operations of a grading gang in Dallas Co., Iowa, working continuously. 900 w. Engng-Contr—Sept. 30, 1908. No. 95583.

Methods and Cost of Constructing Tar-Macadam, Tar-Pitch-Macadam and Tar-Asphalt-Macadam Roads in Rhode Island. 3700 w. Engng-Contr—Oct. 7, 1908. No. 95727.

The Maintenance of Macadam and Other Roads. Ira O. Baker. An informal discussion of facts and theories, difficulties, etc. Ills. 6500 w. Pro Am Soc of Civ Engrs—Sept., 1908. No. 95486 E.

The Maintenance of Highways in View of the Advent of the Motor Vehicle. Clifford Richardson. Read at the Int. Roads Congress at Paris. The effect on macadam and gravel roads is especially considered, and the best ways yet found for meeting the problem. 4800 w. Eng Rec—Oct. 17, 1908. No. 95933.

The Effect of Automobiles on Macadam Roads. L. W. Page. Abstract of address of Director U. S. Office of Public Roads before Buffalo Legislative and Good Roads Convention. 2000 w. Munic Engng—Oct., 1908. No. 95532 C.

The Destructive Effect of an Automobile Race on Roads. Translation of a paper in the *Annales des Ponts et Chaussées* by M. Salle, engineer-in-chief of bridges and highways. Discusses damage to roads in the Department of Sarthe by the *Grand Prix* of 1906. 1700 w. Eng Rec—Oct. 10, 1908. No. 95734.

Road Improvements and Resurfacing Experiments. Harold A. Hosking. Extract from a report to the St. Germans Rural District Council in which the damage due to heavy and fast motor vehicles is discussed, as well as different binding materials. 3700 w. Surv—Oct. 2, 1908. No. 95884 A.

The Selection of Dust Preventives. Abstract of a monograph by Prevost Hubbard of the U. S. Office of Public Roads. 8000 w. Eng Rec—Oct. 3, 1908. No. 95618.

Surface Treatment of Roads with Reference to Dust Laying. Reginald Brown. Deals with methods of treating existing road surfaces for the prevention of dust. 2500 w. Jour Roy San Inst—Oct., 1908. No. 95898 B.

The Oiled Roads of Santa Monica, Cal. C. B. Irvine. Brief illustrated description of the construction and oiling of more than 30 miles of oiled paved streets. 1000 w. Munic Engng—Oct., 1908. No. 95526 C.

Sanitation.

The Transmission of Typhoid Fever. H. E. Jordan. Brief description of nature of the disease and its prevention. Abstract from paper before Indiana Sanitary & Water Supply Assn. 2500 w. Munic Engng—Oct., 1908. No. 95530 C.

Details in Municipal Engineering Work. Harold G. Turner. Gold medal paper read before the Inst. of San. Engrs. Discusses details of buildings, roads and streets, etc. Ills. 5000 w. Surveyor—Oct. 16, 1908. Serial. 1st part. No. 96048 A.

An Investigation of the Sanitary Condition of the Gowanus Canal, Brooklyn, New York. Charles F. Breitzke. Describes the study made of the unsanitary conditions. Ills. 8000 w. Tech Qr—Sept., 1908. No. 96076 E.

Sewage Disposal.

Report of the Royal Commission on Sewage Disposal. Abstract of Fifth Report. 2600 w. Engr, Lond—Sept. 25, 1908. No. 95671 A.

Incongruities of the Sewage Problem. W. D. Scott-Moncrieff. Comments on the fifth report of the Royal Commission. 4000 w. Surv—Oct. 9, 1908. No. 95978 A.

The Royal Commission on Sewage Disposal. Considers some of the more important conclusions and recommendations of the Commissioners. 4500 w. Builder—Sept. 19, 1908. No. 95430 A.

Sewage Disposal in Columbus, O. Description of new system under installation with plan of sewage disposal plant. 4000 w. Munic Engng—Oct., 1908. No. 95522 C.

Bacterial Sewage-Disposal. William Ransom. Describes the scientific principles upon which this system is founded. 1200 w. Inst of Civ Engrs—No. 3581. No. 95499 N.

Drying Sewage Sludge in Centrifugal Machines. Describes sludge treatment in favor in Germany. 1200 w. Eng Rec—Oct. 17, 1908. No. 95936.

Drying in Sewage Disposal Practice (Schlammtrocknung für städtische Kanalisationsanlagen). G. ter Meer. Illustrates and describes the apparatus and methods of several German cities, especially the Schäfer-ter Meer centrifugal sewage-drying machine. 4700 w. Zeitschr d Ver Deutscher Ing—Sept. 5, 1908. No. 96190 D.

The Reinforced Concrete Sewer in Avenue A, Borough of the Bronx. Account of large triple sewer of rectangular-barrel system built on marsh land. Plans and diagrams. 3300 w. Eng Rec—Oct. 3, 1908. No. 95613.

The Cost of Constructing a Brick Sewer in Water-Soaked Sand at Gary, Ind. Discussion of the cost of excavating and constructing a sewer 4,258 ft. in length. 1700 w. Engng-Contr—Oct. 7, 1908. No. 95728.

A Large Concrete Sewer Constructed with Adjustable Metal Forms. John M. Bruce. Description of construction of reinforced-concrete outfall sewer in Bronx Borough, N. Y. City. Ills. 3000 w. Eng News—Oct. 8, 1908. No. 95748.

Cost Reducing Concrete Forms. John M. Bruce. Illustrates and describes methods employed in building two concrete sewers in the Borough of the Bronx, New York City. 1500 w. Cement Age—Oct., 1908. No. 96081 C.

Sewer Traps.

Are Intercepting Traps Necessary? E. B. B. Newton. Read before the Roy. Inst. of Pub. Health. Considers reasons for and against their use. 2500 w. Surveyor—Sept. 18, 1908. No. 95435 A.

WATER SUPPLY.

Conduits.

Progress on the Works of the Southern California Mountain Water Co. Description of a large water supply project for San Diego, Cal. Ills. 3500 w. Eng Rec—Oct. 10, 1908. No. 95740.

Dams.

Development of a Practical Type of Concrete Spillway Dam. Richard Muller. A study based on Bazin's work, "Experiences sur l'Ecoulement en Devorsoir." 1800 w. Eng Rec—Oct. 24, 1908. No. 96034.

Method and Cost of Constructing a Rubble Concrete Dam in the Central States. Describes the earthwork and concrete construction of a water power plant in the Middle West. 2000 w. Engng-Contr—Oct. 7, 1908. No. 95669.

Methods and Costs of Building Earthen Dikes on the Belle Fourche Project and Comments on Spreading Earth. Discusses the construction of a dam for the U. S. Reclamation Service in S. Dak. 3700 w. Engng-Contr—Oct. 7, 1908. No. 95667.

The Yuma Irrigation Dam. Day Allen Willey. Describes the work for the reclamation of arid lands in the southwest, and the problems relating to it. Ills. 1500 w. Sci Am—Oct. 31, 1908. No. 96222.

Construction on the Pathfinder Dam, North Platte Project, U. S. Reclamation Service. E. H. Baldwin. Illustrated description and information concerning the construction of this large masonry dam. 3000 w. Eng News—Oct. 29, 1908. No. 96217.

Filtration.

Infiltration Plant Under Construction at Ironton, Ohio. Philip Burgess. Reviews the history of the water supply, and describes the proposed works, now under construction. 2500 w. Eng Rec—Oct. 17, 1908. No. 95935.

Indiana.

Condition of Indiana Water Supplies. H. A. Barnard. Extract of paper before Indiana Sanitary and Water Supply Assn. Summarizes results of large number of analyses of public and private water supplies. 2000 w. Munic Engng—Oct., 1908. No. 95525 C.

Irrigation.

Irrigation. An informal discussion of the subject by W. W. Follett, Gardner S. Williams, and F. C. Finkle. 6500 w. Pro Am Soc of Civ Engrs—Sept., 1908. No. 95487 E.

Irrigation in South Africa. A summary of a report by a commission appointed by Lord Milner to investigate inter-colonial irrigation. 2500 w. Engr, Lond—Sept. 18, 1908. No. 95413 A.

Orifices.

Orifices for the Measurement of Water. Franklin Van Winkle. A discussion of the discharge of liquids into air or under water, with reference to the suppression of contraction and the effects of differently framed apertures and ajutages. Ills. 3500 w. Power—Oct. 13, 1908. No. 95837.

Pipe Cleaning.

Methods and Results of Cleaning Water Mains in Pittsburg, Pa. C. O. Daughaday. A paper read before the Central States Water-Works Association. 1400 w. Engng-Contr—Oct. 7, 1908. No. 95729.

Pipe Flow.

Curve Resistance in Water Pipes. George Jacob Davis, Jr. A discussion of the paper by Ernest W. Schoder, describing experiments and considering results. Ills. 2500 w. Pro Am Soc of Civ Engrs—Sept., 1908. No. 95488 E.

See also Valves, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

Pipe Lines.

The Construction of Pipe Lines for Gas and Oil. Ulrich Peters. Reviews early work in the United States, the advantages of pipes of different materials, costs, etc. Ills. 1200 w. Min Wld—Sept. 26, 1908. No. 95450.

Pipes.

Cast-Iron Pipe Standard Specifications. Gives two reports issued by the British Engineering Standard Committees, dealing with the standard dimensions, weights, etc., of cast-iron pipes. Ills. 1400 w. Ir & Coal Trds Rev—Oct. 9, 1908. No. 95998 A.

Reservoirs.

The Reinforced-Concrete Covered Reservoir for the Indianapolis Water Co. William Curtis Mabee. Illustrated description of this reservoir and the construction methods. 1500 w. Eng News—Oct. 15, 1908. No. 95956.

Stream Flow.

Flowing-Water Problems. Edgar Charles Thrupp. A study of flow in rivers, particularly the ratio of mean velocity to the maximum surface velocity. 4000 w. Inst of Civ Engrs—No. 3738. No. 95496 N.

Tunnels.

The Blue Island Ave. Tunnel of the Chicago Water-Works System. Illustrated description of the latest tunnel of the distribution system. 2000 w. Eng News—Oct. 22, 1908. No. 96014.

Water Works.

Water Works of Cleveland, Ohio. Information of interest selected from the last annual report. Ills. 3000 w. Munic Jour & Engr—Oct. 14, 1908. No. 95904.

Progress on the Buffalo Water-Works Improvement. Illustrated description including the construction of a new intake crib in Lake Erie, from which a tunnel 6500 ft. long leads to a new pumping station. Ills. 5000 w. Eng Rec—Oct. 10, 1908. No. 95733.

Well Driller.

The Keystone Gasoline Well Driller. Illustrated description of a driller intended for use where fuel or water is scarce. 1500 w. Ir Age—Oct. 22, 1908. No. 95999.

Well Sinking.

A Concrete Caisson Well. G. E. P. Smith. Illustrated description of a well at Tucson, Arizona. 1000 w. Cement Age—Oct., 1908. No. 96080 C.

WATERWAYS AND HARBORS.

Barge Canal.

The New York State Barge Canal. Illustrated description of work with account of progress made. 1800 w. Sci Am—Oct. 3, 1908. No. 95533.

Breakwaters.

See Caissons, and Piers, under WATERWAYS AND HARBORS.

Caissons.

Reinforced-Concrete Caissons for a Breakwater at Algoma, Wis. W. V. Judson. Describes a novel system of construction in the harbor improvements. Ills. 800 w. Eng News—Oct. 15, 1908. No. 95961.

Cleveland, O.

Development of the Upper Cuyahoga River, Cleveland, Ohio. C. M. Belding. Description of the development of the upper river, including dredging a new channel and dock construction. Ills. 2000 w. Marine Rev—Oct. 18, 1908. No. 95794.

Coast Protection.

Effective Beach Protection. Lewis M. Haupt. Describes various methods in use on the Atlantic Coast. Ill. 2100 w. Cassier's Mag—Oct., 1908. No. 95663 B.

Cofferdams.

A Large Steel-Pile Cofferdam for a Ship Lock at Buffalo, N. Y. Describes an original form of sheet piling used in constructing a ship lock at Black Rock Harbor. Ills. 1500 w. Eng News—Oct. 8, 1908. No. 95750.

Docks.

King's Dock, Swansea. Illustrated description of the important harbor works in course of construction for the port of Swansea. Ills. 2800 w. Engr, Lond—Oct. 2, 1908. No. 95751 A.

Dry Docks.

Floating Dock for Callao. Illustrated account of a new floating dock capable of lifting vessels up to 7,000 tons with a proposed fourth section to be added giving a capacity up to 9,500 tons. 1100 w. Marine Rev—Oct. 1, 1908. No. 95697.

See also Shipbuilding, under MARINE AND NAVAL ENGINEERING.

Europe.

What Europe Is Doing with Waterways. J. A. Ockerson. Abstract of paper read at the Deep Waterway Convention. giving a review of work in this field. 1200 w. Eng News—Oct. 22, 1908. No. 96016.

Floods.

Forests and Floods: Extracts from an Austrian Report on Floods of the Danube, with Applications to American Conditions. H. M. Chittenden. An elaborate discussion, with lengthy editorial. 12500 w. Eng News—Oct. 29, 1908. No. 96219.

Floods in Southern India. Joseph Melville Lacey. Deals with the floods in the Penner river due to the cyclone of November, 1903. Map. 1800 w. Inst of Civ Engrs—No. 3690. No. 95497 N.

Harbors.

See Cleveland, O., Piers, and Tranmere Bay, under WATERWAYS AND HARBORS.

Lighthouses.

Reinforced Concrete Lighthouse. Illustrated description of the new lantern in the Straits of Malacca. 2500 w. Sci Am Sup—Oct. 24, 1908. No. 96017.

Niagara.

Spoliation of the Falls of Niagara. Dr. J. W. Spencer. A study of the physics of the river, the effects of water diversion for power purposes, and the steps necessary for the preservation of the falls. Ills. 5500 w. Pop Sci M—Oct., 1908. No. 95461 C.

Ohio River.

The Improvement of the Ohio River for Navigation. Description of its physical features and of the various engineering works designed to aid navigation. Ills. Also editorial. 5600 w. Eng News—Oct. 8, 1908. No. 95745.

Proposed Reservoir System in Ohio River Basin. H. C. Newcomer. Discussion of a paper by M. O. Leighton advocating reservoirs to control navigation on the Ohio River. The present paper argues against the practicability of the system. Ills. 6000 w. Eng News—Oct. 8, 1908. No. 95744.

Panama Canal.

Impressions Gained from a Visit to the Work on the Panama Canal (Persoonlijke Indrukken van een Bezoek aan de Werken aan het Kanaal van Panama). J. C. Loman. A general review of conditions, methods, progress, etc. 6500 w. De Ingenieur—Sept. 12, 1908. No. 96244 D.

Piers.

The Improvement of the Harbor of Milwaukee, Wis. Illustrates and describes reconstruction of piers and breakwater. 3000 w. Eng Rec—Oct. 24, 1908. No. 96033.

The Extension, Widening and Strengthening of Folkestone Pier. Hugh Torrance Ker. Brief history of the harborworks and conditions, with description of the new works and their construction. Ills. Discussion. 31000 w. Inst of Civ Engrs, No. 3688—Nov. 12, 1907. No. 95492 N.

Pollution.

The Disposal of the Waste Products of

Gas Works. Discusses the objectionable results from their discharge into streams, and methods of treatment to avoid the trouble. 5000 w. Eng Rec—Oct. 17, 1908. No. 95932.

See also Sanitation, under MUNICIPAL.

River Regulation.

Forests and Reservoirs in Their Relation to Stream Flow, with Particular Reference to Navigable Rivers. H. M. Chittenden. A discussion of this question giving arguments supporting the writer's conclusions. Ills. 25000 w. Pro Am Soc of Civ Engrs—Sept., 1908. No. 95485 E.

See also Ohio River, under WATERWAYS AND HARBORS.

Sea Walls.

The Extension of Governors Island, New York Bay. Describes the sea wall construction, the dredging and filling operations which will add about 101 acres to the island. Ills. 3000 w. Eng Rec—Oct. 24, 1908. No. 96036.

Shore Protection.

The David Neale System of River Improvement and Bank Protection. Charles H. Miller. Information from various papers concerning the woven and fascine types of mattress work, the David Neale system, and other classes of protection used on the Mississippi and Missouri Rivers. 6500 w. Eng News—Oct. 22, 1908. No. 96013.

Tranmere Bay.

The Tranmere Bay Development Works. Somers Howe Ellis. Describes works on the River Mersey, comprising two graving docks, two floating basins, and two sewer culverts. Ills. Discussion. 16000 w. Inst of Civ Engrs, No. 3649—Nov. 26, 1907. No. 95493 N.

Water Powers.

Water Power in the Andes. C. Reginald Enock. Discuss the power potentiality of the streams and rivers of the Andine Slopes. 1300 w. Engr, Lond—Sept. 25, 1908. No. 95666 A.

Developed and Undeveloped Water Powers of Georgia. A review of the various rivers showing the unimproved opportunities. 4500 w. Elec Wld—Oct. 24, 1908. No. 96010.

Economic Problems in the Utilization of German Water Powers (Wasserwirtschaftliche Aufgaben Deutschlands auf dem Gebiete des Ausbaues von Wasserkräften). Theodor Koehn. The first part discusses the practice of other countries. Serial. 1st part. 3200 w. Die Turbine—Sept. 5, 1908. No. 96178 D.

MISCELLANY.

Forestry.

Notes on Canadian Forestry. Stanislas Gagné. A general discussion of this subject. 6000 w. Can Soc of Civ Engrs—Oct., 1908. No. 96072 N.

ELECTRICAL ENGINEERING

COMMUNICATION.

Radio-Telegraphy.

Determination of Wireless Wave Fronts. Greenleaf W. Pickard. An account of a wireless survey at Amesbury, Mass., to determine the distortion of wireless waves. Ills. 900 w. Elec Rev—Oct. 3, 1908. No. 95882.

The Knudsen Wireless Typewriter. Illustrated description of the invention of Hans Knudsen. 1200 w. Sci Am—Oct. 31, 1908. No. 96221.

The Artom System of Wireless Telegraphy (Sistema Radiotelegraphico Artom). Prof. Alessandro Artom. Illustrated description and theoretical discussion of the system invented by the author. 5000 w. Riv Marit—Sept., 1908. No. 96130 E + F.

See also Oscillations, under ELECTRO-PHYSICS.

Telegraph Printers.

The Creed Telegraph Printer. Describes printing device used in the Creed system to reproduce from a perforated tape received messages in printed characters on a tape. Ills. 1000 w. Elec Rev, Lond—Sept. 25, 1908. No. 95774 A.

Telephone Lines.

See Railway Motors, under DYNAMOS AND MOTORS.

Telephony.

The Telephone Repeater. L. A. Lindsey. A suggestion for constructing a satisfactory repeater. 1000 w. Elec Wld—Oct. 17, 1908. No. 95967.

Telepost.

The Telepost. Report of the Franklin Institute on Science and the Arts on a System of Automatic Telegraphy devised by Patrick B. Delany. Ills. 2400 w. Jour Fr Inst—Oct., 1908. No. 95693 D.

DISTRIBUTION.

Insulators.

Home-Made Insulator Fixtures. George R. Voit. Describes and illustrates a method that will give dependable fixtures. 1500 w. Elec Wld—Oct. 3, 1908. No. 95518.

Wiring.

Wiring and Lighting Equipment of the Stock Room of the New York Public Library. J. F. Musselman, Jr. Illustrated description of the distribution and conditions. 2000 w. Elec Wld—Oct. 17, 1908. No. 95965.

DYNAMOS AND MOTORS.

A. C. Dynamos.

See Long Distance, under TRANSMISSION.

A. C. Motors.

Improvements in Alternating-Current Motors. Describes four recent patents for improvements in alternating-current motors of the induction, synchronous, series-commutator and series-repulsion types. Ills. 1000 w. Elec Wld—Oct. 10, 1908. No. 95871.

D. C. Motors.

2000-Horse-Power Direct-Current Motor for Driving Converter Blower. Description of a large direct-current motor constructed by the Felten and Guilleaume-Lahmeyerwerke A.-G., Frankfort. 1500 w. Engng—Sept. 25, 1908. No. 95640 A.

Dynamo Sheets.

The Dependence of the Magnetic Properties of Dynamo Sheets on the Direction of Rolling and Their Treatment (Ueber die Abhängigkeit der magnetischen Eigenschaften des Dynamobleches von Walzrichtung und Bearbeitung). E. Gumlich and E. Volthardt. Results of tests at the German Reichsanstalt. Ills. 4400 w. Elektrotech Zeitschr—Sept. 17, 1908. No. 96241 B.

Heating.

The Fundamental Laws of Heating in Electric Machines (Die Grundgesetze der Erwärmung elektrischer Maschinen). Rud. Goldschmidt. An exhaustive mathematical discussion. Ills. Serial. 1st part. 4000 w. Elektrotech Zeitschr—Sept. 10, 1908. No. 96240 B.

Induction Motors.

See Slip Indicators, under MEASUREMENT.

Railway Motors.

Alternating-Current Railway Motors of the Oerlikon Company and Their Effect on Telephone Lines (Ueber Wecksel-strombahnmotoren der Maschinenfabrik Oerlikon und ihre Wirkungen auf Telephonleitungen). Hans Behn-Eschenburg. Discusses the inductive effect on telephone lines of the single-phase system and extended investigations by the Oerlikon Company. Ills. Serial. 1st part. 3000 w. Elektrotech Zeitschr—Sept. 24, 1908. No. 96242 B.

Speed Regulation.

The Theory of Regulators (Zur Theorie der Regulatoren). R. v. Mises. A mathematical discussion of regulators as related to the driving at constant speed of electric dynamos. Ills. 4000 w. Elektrotech u Maschinenbau—Sept. 13, 1908. No. 96188 D.

Speed Regulation of Prime Movers (Die Tourenregulierung von Kraftmaschinen mit Hilfe einer Leitgeschwindigkeit mit möglichster Vermeidung der periodischen Schwankungen). Friedrich R. v. Merkl. Refers particularly to the speed regulation of turbine-driven dynamos. Ills. 4000 w. Elektrotech u Maschinenbau—Sept. 6, 1908. No. 96187 D.

Synchronous Motors.

Improving Power Factor by Means of Synchronous Motors. Gives opinions given in the discussion before the Am. St. & Int. Ry. Assn., with comments. 1200 w. Elec Wld—Oct. 17, 1908. No. 95968.

Windage Losses.

Tests on Model Electric Generators for Power Absorbed by Windage. Describes tests made to get an idea of the power lost by windage in the 5000-k.w. generators being installed at Redondo, Cal. Ills. 2500 w. Cal Jour of Tech—Sept., 1908. No. 95519.

ELECTRO-CHEMISTRY.

Electro-Metallurgy.

Electric Furnaces for the Manufacture of Calcium Carbide and Ferrosilicon. Abstract translation of a paper by Dr. Walter Conrad, and discussion. Restricted to an exposition of these industries in Europe. Ills. 6000 w. Elec-Chem & Met Ind—Oct., 1908. No. 95457 C.

Electro-Metallurgy at the Marseilles Exposition (L'Electrométallurgie à l'Exposition de Marseille). M. de Kermond. Brief descriptions of the products and plants of the various exhibitors, especially the Société Electrométallurgique Française. 3000 w. L'Elec'n—Sept. 5, 1908. No. 96115 D.

Electroplating.

The Re-Plating of Old Steel Knives. Detailed description of the work. 3500 w. Brass Wld—Oct., 1908. No. 96083.

The Broderick Automatic Electroplating Machine. Illustrated account of the first attempt to use automatic labor-saving machinery in plating as installed at two large hardware factories. 2000 w. Ir Age—Oct. 8, 1908. No. 95880.

Niagara Falls.

The Industries of Niagara Falls. Raymond H. Arnot. An illustrated review of the industries which have made this region an important electrochemical center. 1800 w. Pop Sci M—Oct., 1908. No. 95462 C.

Nitrogen.

The Utilization of German Water Powers for the Fixation of Atmospheric Nitrogen (Ausnutzung der deutschen Wasserkräfte für die Gewinnung von Luftstickstoff). Herr Dubislav. A plea for the extension of this industry in Germany to supply the demand for nitrate fertilizers. Serial. 1st part. 2200 w. Zeitschr f d Gesamte Turbinenwesen—Sept. 20, 1908. No. 96183 D.

ELECTRO-PHYSICS.

Arcs.

The Electric Arc Between a Solid and a Liquid Electrode. G. Athanasiadis.

Trans. from *Comptes Rendus.* Experimental study to determine the conditions under which an arc may be struck and maintained. 900 w. Elect'n, Lond—Sept. 18, 1908. No. 95440 A.

Oscillations.

High-Frequency Oscillations. William Duddell. From a presidential address before the Roentgen Soc., London. Reviews the methods of producing them. 3500 w. Sci Am Sup—Oct. 31, 1908. No. 96223.

Rodio-Activity.

Present Knowledge of Radio-Activity (L'Etat actuel de nos Connaissances sur la Radio-Activité). A. Debierne. The two parts discuss the discovery and transformations of radio-active bodies. Ills. Serial. 2 parts. 1600 w. Rev Gen des Sci—Sept. 15 and 30, 1908. No. 96113 each D.

GENERATING STATIONS.

Accumulators.

The Regulating Plant at Sandviken, Sweden (L'Impianto di Compensazione di Sandviken, Svezia). Illustrates and describes the storage battery and booster installations and gives results obtained in service. 3600 w. Elettricita—Aug. 27, 1908. No. 96134 D.

See also Power Plants, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

Central Stations.

Columbus Municipal Lighting Plant. Describes growth and operation of 3300 h.p. power plant. 4000 w. Munic Jour and Eng—Oct., 1908. No. 95701.

Recent Power Plant Development of the Brockton Edison Company. Illustrated description of the new steam-turbine generating plant. 2000 w. Elec Wld—Oct. 3, 1908. No. 95510.

The Power Development of the Northern Colorado Power Company. Illustrated detailed description of a plant producing electric power directly at the coal mine and transmitting to towns and cities. 2000 w. Elec Age—Sept., 1908. No. 95504.

Report of the Committee on Power Generation, Am. St. & Int. Ry. Assn. (Abstract.) The subjects considered are the practical operation of steam turbines, steam motors, and flue gas analyzers. 6500 w. Elec Ry Jour—Oct. 15, 1908. No. 95922.

The Reconstruction of an Electric Lighting Scheme. C. M. Shaw. Read before the Incor. Munic. Elec. Assn. Describes methods adopted at Worcester, Eng. 1700 w. Mech Engr—Sept. 18, 1908. Serial. 1st part. No. 95428 A.

Rules Governing the Installation of Electrical Machinery and Apparatus (Instructions sur le Montage des Installations électriques). The text of regulations adopted by several of the important manufacturers' associations in France. Serial. 1st part. 6000 w. L'Elec'n—Sept. 5, 1908. No. 96117 D.

Depreciation.

The Obolescence of Electric Lighting Plant. F. Fernie. Describes an insurance fund against obolescence. Diagrams. 2400 w. Elec Rev, Lond—Sept. 25, 1908. No. 95775 A.

Design.

The Lay-Out of Central Station Plant with a View to Reliability. J. Salisbury and W. S. Burge. Suggestions for central station design. 1500 w. Elec Rev, Lond —Oct. 9, 1908. No. 95984 A.

Economies.

The Contractor and the Central Station. Samuel J. Robinson. The importance of the electrical contractor and his relation to the central station. 1200 w. Elec Wld —Oct. 3, 1908. No. 95517.

Hydro-Electric.

The Most Important Hydro-Electric Installation in Europe. Enrico Bignami. Illustrated detailed description of the Brusio station and its equipment. 3500 w. Engineering Magazine—Nov., 1908. No. 96202 B.

Hydro-Electric Power Plant of the Inland Empire System. Illustrated description of new generating station for the Spokane & Inland Empire R. R. Co. on the Spokane River. 4400 w. Elec Ry Jour —Oct. 10, 1908. Special No. No. 95674 C.

The Nine-Mile Hydro-Electric Development on the Spokane River. Illustrated description of a large power plant on the Spokane River for the Spokane and Inland Railroad Co. Ills. 4200 w. Eng Rec —Oct. 10, 1908. No. 95735.

Discussion on "Water Power Development in the National Forests. A Suggested Government Policy." Reports a discussion at Atlantic City, N. J., June 29, 1908. 7000 w. Pro Am Inst of Elec Engrs—Oct., 1908. No. 95521 D.

Isolated Plants.

Large Oil-Engine Electrical Plant. Illustrated description of plants erected to supply energy for lamps and motors at two phosphate mines. 1500 w. Elec Wld —Oct. 3, 1908. No. 95512.

Electricity in Factories. Alexander Colin Anderson. Considers the design and general lay-out of an electrical installation, without dealing with the cost. 6000 w. Inst of Civ Engrs—No. 597. (Students' paper.) No. 95500 N.

Power for a Large Manufacturing Works. Osborn Monnett. Illustrated description of the Western Electric Co.'s plant at Chicago. 3000 w. Power—Oct. 27, 1908. No. 96067.

Lighting Country Homes by Private Electric Plants. T. H. Amrine. Traces the design of a private electric plant of sufficient size to light a country home with 25-volt tungsten lamps. Also gives a lighting scheme for a medium sized private residence. 11000 w. Univ of Ills, Bul. No. 25—July 13, 1908. No. 95460 N.

Japan.

Modern Steam and Hydraulic Generating Stations in Japan. M. Kawara. Describes two typical modern plants. Ills. 1500 w. Elec Wld—Oct. 24, 1908. No. 96011.

Labor.

Labor Requirements in Representative Massachusetts Central Station Organizations. Summary of statistics submitted to the Mass. Board of Gas and Electric Light Commissioners for ten representative companies. 2100 w. Elec Wld—Oct. 10, 1908. No. 95875.

Rates.

Charges for Electrical Energy. James L. Roberts. A discussion of "rates" and "ratings." 1600 w. Elec Wld—Oct. 3, 1908. No. 95516.

Rates and the Use of Rates. H. H. MacPherson. Discusses flat rates and sliding-scale rates, readiness-to-serve rates, etc. 1600 w. Elec Wld—Oct. 3, 1908. No. 95515.

Switchboards.

High-Tension Switchboard Practice in America. Stephen Q. Hayes. Illustrated detailed description of plants employing three-phase circuits, and obtaining the high voltage by means of transformers. 5500 w. Elec Age—Sept., 1908. No. 95502.

LIGHTING.

Arc Lamps.

See Street, under LIGHTING.

Illumination.

See Mercury Vapor, under LIGHTING; and Wiring, under DISTRIBUTION.

Incandescent Lamps.

Public Lighting by Incandescent Lamps. Brief discussion of best system to meet conditions. 1400 w. Elec Rev, Lond—Oct. 9, 1908. No. 95983 A.

Metallic Filament Lamps (A propos des Lampes à Filament Métallique). M. Henry. Discusses their possible effect on the development of private lighting plants. 2000 w. L'Elec'n—Sept. 5, 1908. No. 96116 D.

The Influence of Excess Voltages on the Life of Metallic Filament Lamps (Einfluss von Spannungsüberschreitungen auf die Lebensdauer von Metallfaden-Glühlampen). H. Remané. A record of the results of elaborate tests. Ills. 2800 w. Elektrotech Zeitschr—Sept. 3, 1908. No. 96197 B.

Mercury Vapor.

Illumination Calculations for Mercury Vapor Lamps (Beleuchtungsberechnungen für Quecksilberdampflampen). N. Norden. Develops formulæ for the distribution of light from linear incandescent bodies. Ills. 2000 w. Elektrotech Zeitschr—Sept. 10, 1908. No. 96199 B.

Photometry.

The Photometric Standard of the Natural Physical Laboratory. R. T. Glazebrook. A report presented to Section A of the British Association, giving a description of the use of the 10 c.p. Vernon Harcourt pentane lamp certified by the Gas Referees and its relation to the Hefner standard. 2000 w. Elect'n, Lond—Sept. 25, 1908. No. 95780 A.

Street.

American and European Street Lighting. Dr. Louis Bell. A comparison, unfavorable to America. 1200 w. Elec Wld—Oct. 3, 1908. No. 95509.

Electric Lighting. W. L. Puffer. Discusses statistics of comparative costs in Massachusetts cities as compiled from the Report of the Mass. Gas & Electric Light Commission for 1907. 1000 w. Munic Jour & Eng—Oct. 7, 1908. No. 95702.

The Arc Lighting System of Portland, Oregon. B. C. Coldwell. Brief description of new installation of magnetite lamps supplied from constant current transformers and mercury vapor rectifiers. Abstract from Gen. Elec. Review. 900 w. Munic Engng—Oct., 1908. No. 95531 C.

Tunnels.

See Subway Lighting, under STREET AND ELECTRIC RAILWAYS.

MEASUREMENT.

Instruments.

Measurements with Portable Instruments. F. P. Cox. Discusses the care of instruments and the measurement of potential, current, energy, and time. 2800 w. Elec Rev, N Y—Oct. 17, 1908. No. 95911.

Meters.

A Two-Armature Meter (Compteur à deux Induits sans Démarrage). M. Willot. Illustrated description and discussion of the theory of the Paulet meter. 5000 w. Soc Belge d'Elec'n—Sept., 1908. No. 96101 E.

Meter Testing.

The Calibration of Portable Watt-Hour Meters. Charles F. Hunter. Describes methods of testing, especially one which checks the standard as used. 500 w. Elec Wld—Oct. 31, 1908. No. 96215.

Power Factor.

The Measurement of Power Factor. Charles V. Drysdale. Notes on methods of Dr. Lulofs for accurate alternate-current testing. 1100 w. Elect'n, Lond—Sept. 18, 1908. No. 95441 A.

Slip Indicator.

Measuring the Slip and Speed of Induction Motors. Charles A. Perkins. Describes the design and operation of a slip indicator. 800 w. Elec Wld—Oct. 31, 1908. No. 96213.

Units.

The International Conference on Electrical Units and Standards. An account of the conference in London to establish a universal system of standards. 4000 w. Engng—Oct. 16, 1908. Serial. 1st part. No. 96056 A.

TRANSMISSION.

Cables.

Advantages in the Use of High-Tension Underground Cables. Henry Floy. Considers some of the advantages and their reliability. 1000 w. Elec Wld—Oct. 31, 1908. No. 96216.

Insulating and Sheathing High-Tension Underground Cables. Henry Floy. Describes methods used for such conductors. 2500 w. Elec Wld—Oct. 3, 1908. No. 95513.

Grounding.

Grounding a Transmission System Through a Special Transformer. Description of grounding transformer and diagram showing its connection with the high tension of the distributing system, as used on the Twin City Rapid Transit system. 700 w. Elec Ry Jour—Oct. 3, 1908. No. 95589.

Insulation.

The Fatigue of Insulation. A. S. Langsdorf. An account of research work, with editorial. 2500 w. Elec Wld—Oct. 31, 1908. No. 96212.

Line Design.

Long Distance Transmission (Les Grandes Transmissions d'Energie Electrique). E. Barthélemy. A general review of the principles of transmission line design, choice of current and voltage, line location and construction, etc. 7200 w. Rev Gen des Sci—Sept. 30, 1908. No. 96114 D.

Overhead Lines. H. B. Gear and P. F. Williams. Detailed description of the best American practice. Ills. 4000 w. Elec Age—Sept., 1908. No. 95503.

Lines.

Steel Tower Transmission Line. Illustrates and describes interesting features of a line under construction at Milwaukee, Wis. 1000 w. Elec Wld—Oct. 3, 1908. No. 95511.

Long Distance.

Long-Distance Electrical Transmission. C. J. Spencer. Considers the need of a new type of generator and suggest methods for overcoming present limitations of distance. Illus. 3000 w. Cassier's Mag—Oct., 1908. No. 95664 B.

Poles.

Reinforced-Concrete Poles. Recent European experiments by Siegwort for making reinforced-concrete poles for telegraph, telephone and power lines. Illustrated description of machinery and poles. and pipes made by the process. 1300 w. Sci Am Sup—Oct. 3, 1908. No. 95534.

Rotary Converters.

Voltage Variation in Rotary Converters. F. D. Newbury. Traces the development of methods of direct-current variation involving a change in the a. c. voltage, and compares the booster method with the split-pole method. Ills. 5000 w. Elec Jour—Nov., 1908. No. 96455.

Transformers.

Care and Operation of Transformers. Fred. Dubell. Discusses points relating to safety, efficiency, etc. 1800 w. Elec Wld—Oct. 3, 1908. No. 95514.

Magnetic Reluctance of Joints in Transformer Iron. H. Bohle. Abstract of a paper before the Institution of Electrical Engineers. 1200 w. Elect'n, Lond—Oct. 2, 1908. No. 95785 A.

The Effect of Wave Form Upon the Voltage Ratio of Transformers. Morton G. Lloyd. Gives results of experimental tests showing there is a small change in the ratio, though negligible for practical purposes. 1000 w. Elec Wld—Oct. 17, 1908. No. 95966.

The Combination of Voltage and Current Transformers (Die Vereinigung von Spannungs- und Stromtransformatoren). Robert Moser. A mathematical discussion. Ills. Serial. 1st part. 5000 w. Elektrotech u Maschinenbau—Sept. 27, 1908. No. 96189 D.

See also Grounding, under TRANSMISSION.

Underground.

High-Potential Underground Transmission. P. Junkersfeld and E. O. Schweitzer. A discussion of this system with a view of pointing out some lessons taught by experience and tests and of suggesting further investigation. 6000 w. Pro Am Inst of Elec Engrs—Oct., 1908. No. 95520 D.

See also Cables, under TRANSMISSION.

MISCELLANY.

Agriculture.

The More Extended Application of Electricity in Agriculture (Die erweiterte Anwendung des elektrischen Betriebes in der Landwirtschaft). Kurt Krohne. The first part reviews the present use of electricity on farms in Germany, discusses its possibilities for usefulness, and begins a description of motor-driven plows. Ills. Serial. 1st part. 3500 w. Elektrotech Zeitschr—Sept. 24, 1908. No. 96243 B.

Contracts.

Contracts for Electrical Work and Machinery. Discusses contracts for the erection of plant and machinery from a legal point of view. 4000 w. Engr, Lond—Oct. 30, 1908. No. 96444 A.

Marseilles Congress.

The Electrical Congress at Marseilles. Outline account of Congress held Sept. 13-20, 1908. 2700 w. Elec Rev, Lond—Oct. 2, 1908. No. 95777 A.

International Congress of the Applications of Electricity (Congrés international des Applications de l'Electricité). J. A. Montpellier. A report of the proceedings. Serial. 1st part. 10000 w. L'Elec'n—Sept. 26, 1908. No. 96118 D.

INDUSTRIAL ECONOMY

Accounting.

Commercial Engineering. First of a series of articles dealing with the efficient management of the commercial side of an engineering business. 1500 w. Mech Wld—Oct. 2, 1908. Serial. 1st part. No. 95900 A.

Apprenticeship.

Second Annual Conference of the Apprentice Instructors, N. Y. Central Lines. Abstract of proceedings of conference held at Depew, N. Y., Sept. 3, 1908. Gives papers and reports describing methods and results. 16000 w. Am Eng & R R Jour—Oct., 1908. No. 95538 C.

The Crisis of Apprenticeship (La Crise de l'Apprentissage). A discussion of conditions in France. Serial. 1st part. 2000 w. Monit Indus—Sept. 19, 1908. No. 96121 B.

Cost Estimation.

Estimating and Rate-Fixing for Fitting and Machine Shops. A. E. Ragot. Discusses method of estimating costs of production. Serial. 1st part. 2100 w. Engr, Lond—Sept. 25, 1908. No. 95672 A.

Cost Systems.

Systematic Foundry Operation and Foundry Costing. C. E. Knoeppel. This second article of a series considers the importance of correct burden apportionment. 5000 w. Engineering Magazine—Nov., 1908. No. 96204 B.

Education.

The New Engineering Laboratories and Workshops at the Heriot-Watt College, Edinburgh. Describes mechanical equipment. 1200 w. Elect'n, Lond—Oct. 2, 1908. No. 95783 A.

The Relation of American Mining Schools to the Mineral Industry. L. E. Young. Discusses present status of the industry and the importance of technical training. Ills. 4500 w. Pro St Louis Ry Club—Sept. 11, 1908. No. 95692.

High School Instruction in Naval Engineering in Germany (Der Hochschulunterricht auf schiffbautechnischen Gebieten in Deutschland). O. Flamm. A discussion of courses of instruction, facilities, and conditions. 10000 w. Deutscher Schiffbau—1908. No. 96159 N.

Germany.

Machine Tool Industry in Continental Europe. G. L. Carden. Review of the special investigations conducted by the U. S. Dept. of Labor during the past six months. 2500 w. Am Mach—Vol. 31. No. 44. No. 96211.

Industrial Betterment.

"Welfare Work" on American Railroads. William Menkel. Illustrated account of efforts to improve conditions of railroad employees. 7000 w. Am Rev of Rev—Oct., 1908. No. 95598.

See also Employees, under STREET AND ELECTRIC RAILWAYS.

Labor.

Industrial Peace and Industrial Efficiency. Abstract of a speech by Sir Christopher Furness, before a conference of trades union representatives submitting proposals for the prevention of labor troubles. 4000 w. Engr, Lond—Oct. 9, 1908. No. 95995 A.

Management.

Efficiency as a Basis for Operation and Wages. Harrington Emerson. This fifth article of a series describes a successful attempt to apply staff and standards to a particular shop. 3500 w. Engineering Magazine—Nov., 1908. No. 96201 B.

A Cost System for a Large Manufacturing Plant. Oscar E. Perrigo. This tenth and final article in a series on Shop Management and Cost Keeping, describes requirements of a good cost system and the classifications of accounts. Ills. 6000 w. Ir Trd Rev—Oct. 1, 1908. No. 95585.

Organization of the Personnel of an Engineering Works. Matthew Lang. First part of a paper read before the Institute of Engineers in which is discussed the factors making for efficient organization. 1800 w. Mech Wld—Oct. 2, 1908. No. 95869 A.

Securing the Co-operation of the Workman in the Improvement of Workshop Methods, etc. R. W. Kenyon. Abstract of paper read before the British Found. Assn. Outlines the scheme in operation at Accrington. 3000 w. Ir & Coal Trds Rev—Sept. 18, 1908. No. 95438 A.

See also Pattern Shops, under MECHANICAL ENGINEERING, MACHINE WORKS AND FOUNDRIES.

Patents.

The Recent Change in British Patent Law. Discussion by an "English Barrister" of the recent alteration of the law and its benefits and disadvantages to the foreign inventor. 2200 w. Elec Wld—Oct. 10, 1908. No. 95873.

Trusts.

A German Manufacturers' Protective Organization. A short account of the German Kartell from the German point of view. 2500 w. Elect'n, Lond—Oct. 9. 1908. No. 95985 A.

Wages.

Different Plans of Paying Employees. Harrington Emerson. Discusses their advantages and disadvantages. 2500 w. Ir Age—Oct. 22, 1908. No. 96004.

We supply copies of these articles. See page 579.

MARINE AND NAVAL ENGINEERING

Armor.

Armor-Piercing Projectiles (Ueber die Wirkungsweise der Panzergeschosse). J. Castner. A discussion of modern armor and projectiles inspired by Capt. Tressider's paper before the Inst. Nav. Archs. Ills. 2800 w. Stahl u Eisen—Sept. 2, 1908. No. 96137 D.

Barges.

A Barge for Transporting and Unloading Coke, New York Harbor. Illustrated description of a 420-ton barge fitted with conveying machinery for the discharge of its cargo. Ills. 2100 w. Eng Rec—Oct. 10, 1908. No. 95738.

Battleships.

H. M. Battleships "Agamemnon" and "Lord Nelson." Brief description with plates of boilers and engines. 300 w. Engng—Sept. 25, 1908. No. 95645 A.

Cable Steamers.

The Cable Steamer Guardian. Illustrated description of a twin screw cable-repairing steamer of the Central and South American Telegraph Co. of N. Y. for work in the South Pacific. 500 w. Int Marine Engng—Oct., 1908. No. 95553 C.

Cruisers.

Russian Armored Cruiser "Admiral Makaroff." J. G. Peltier. Illustrated description of 7877-ton cruiser built in France. 1000 w. Int Marine Engng—Oct., 1908 No. 95552 C.

Davits.

The Handling of Battleship Boats. Proposed installation of Welin quadrant davits on U. S. Battleships. Ill. 1200 w. Int Marine Engng—Oct., 1908. No. 95551 C.

Development.

Presidential Address of Sir William Matthews. Refers particularly to branches of engineering work associated with oversea traffic. 17500 w. Inst of Civ Engrs—Nov. 5, 1907. No. 95491 N.

Dredges.

A Novel Pneumatic Dredge. Illustrated description of a dredge in use at Sacramento, Cal. 1100 w. Compressed Air—Oct., 1908. No. 96086.

Education.

See same title, under INDUSTRIAL ECONOMY.

Electric Power.

Electric Propulsion of Ships with Note on Screw Propellers. Henry A. Mavor. Paper and discussion with plans and diagrams. 2500 w. Trans Inst Eng & Ship in Scot—Vol. 51, Feb. 18, 1908. No. 95607 N.

The German Shipbuilding Exposition, Berlin, 1908 (Deutsche Schiffbau-Ausstellung Berlin, 1908). F. Thilo. Illustrated description of the exhibits of electrical machines and apparatus. Serial. 1st part. 2400 w. Elektrotech Zeitschr—Sept. 10, 1908. No. 96198 B.

Electricity on Shipboard (Elektrische Schiffsanlagen). C. Arldt. Discusses the various appliances and illustrates and describes various types of apparatus for light, power, and communication plants. Ills. 7500 w. Deutscher Schiffbau—1908. No. 96164 N.

See also Ferry Boats, under MARINE AND NAVAL ENGINEERING.

Exhibitions.

The Berlin Marine Exhibition. Max A. R. Bruenner. Illustrated description of the exhibition of 1908 with comments on the growth of German maritime industries. 3500 w. Cassier's Mag—Oct., 1908. No. 95659 B.

Ferry Boats.

An Electric Ferry-Boat on the Rhine. Dr. M. Erb. Illustrated detailed description of the largest electrically-propelled boat on German waters. 1200 w. Elec Engng—Oct. 8, 1908. No. 95981 A.

Fire Boats.

Fire Fighting Equipment for Tugboats. R. H. Newbern. Description of fire pumps for railroad and other tugboats as used on the Atlantic Seaboard. Ills. 2400 w. Marine Rev—Oct. 1, 1908. No. 95699.

Gas Engines.

Gas-Engines in H. M. S. "Rattler." Brief description of 500 h.p. suction producer and marine gas engine for a gunboat 165 ft. long. 1800 w. Engng—Oct. 2, 1908. No. 95716 A.

Marine Gas Engines (Ueber Schiffsgasmaschinen). F. Romberg. A general review of the application of combustion motors to marine propulsion, their advantages and economy, and the leading types. Ills. 14000 w. Deutscher Schiffbau—1908. No. 96158 N.

Gasoline Engines.

New Austrian Patrol Boat Engines. Illustrated description of 300 h.p. gasoline engines for two iron Danube patrol boats with results of tests. 800 w. Int Marine Engng—Oct., 1908. No. 95547 C.

German Navy.

The Development of the German Navy (Die Entwicklung des schwimmenden Materials der deutschen Marine). J. Rudloff. An illustrated historical review of progress in warship construction since 1843. 10000 w. Deutscher Schiffbau—1908. No. 96154 N.

Germany.

See Education, and Shipbuilding, under MARINE AND NAVAL ENGINEERING.

Mauretania.

The Electrical Equipment of the Cunard Express Steamer "Mauretania." W. C. Martin. Paper and discussion with plans and diagrams. 9000 w. Trans Inst Eng & Ship in Scot—Vol. 51, March 31, 1908. No. 95606 N.

Motor Boats.

Development of the Motor Life-Boat. Brief illustrated description of a vessel of the self-righting type. 700 w. Sci Am Sup—Oct. 24, 1908. No. 96018.

Sea-Going Motor Boats (Seegehende Motorboote). Carl Pillepich. The first part discusses the basis of measurement of boats for competitions, giving the formulæ used by several clubs. Ills. Serial. 1st part. 2300 w. Zeitschr d Mit Motorwagen Ver—Sept. 30, 1908. No. 96169 D.

Naval Organization.

The Effectiveness of the Bureau System in Naval Organization. Shows that the efficiency of the systems has been proved. 4000 w. Engineering Magazine—Nov., 1908. No. 96200 B.

Oil Engines.

100-Brake-Horse-Power Paraffin-Motor. Illustrated description of the Parsons motor for marine purposes. 500 w. Engng—Sept. 18, 1908. No. 95417 A.

Propellers.

See Electric Power, under MARINE AND NAVAL ENGINEERING.

Salvage Steamer.

New Life-Saving Steamer Snohomish. Description of a 795 ton vessel designed for saving life and maritime property in the Pacific Northwest. Ills. 1000 w. Naut Gaz—Oct. 8, 1908. No. 95870.

Salving.

The Salving of H. M. Cruiser "Gladiator." An illustrated detailed account of the methods used to salve this battleship sunk by the "St. Paul." Plates. 5200 w. Engng—Oct. 9, 1908. No. 95993 A.

Shipbuilding.

New shipbuilding works of Smith's Dock Company, Ltd. The present part describes the general character of two graving docks on the Yorkshire side of the Tees. Ills. 1800 w. Engng—Oct. 2, 1908. Serial. 1st part. No. 95709 A.

The New Yarrow Yard at Scotstown, Glasgow. Illustrated description of a new 12-acre yard on the Clyde for the construction of torpedo boats and torpedo-boat destroyers and shallow draft steamers. 1100 w. Int Marine Engng—Oct., 1908. No. 95550 C.

A German Shipbuilding Yard. Description of the Stettin yard of the Stettiner Maschinenbau Aktien Gesellschaft Vulcan. Illus. 3000 w. Engr, Lond—Sept. 25, 1908. No. 95668 A.

German Dockyards (Werftanlagen). W. Laas. A review of German dockyards and shipbuilding works, their extent, organization, capacity, equipment, etc. Ills. 7500 w. Deutscher Schiffbau—1908. No. 96161 N.

The German Shipbuilding Industry (Die deutsche Schiffbau-Industrie). F. Meyer. A review of its development and present condition, statistics of the various firms and their present activities, etc. Ills. 10000 w. Deutscher Schiffbau—1908. No. 96163 N.

The German Iron and Steel Industry and German Shipbuilding (Die deutsche Eisen- und Stahlindustrie und der deutsche Schiffbau). Fritz Lürmann. Discusses the relations between the steel and shipbuilding industries, the production of shipbuilding materials, etc. Ills. 5500 w. Deutscher Schiffbau—1908. No. 96160 N.

Ship Design.

The Weights of Vessels. A. R. Liddell. Discussion of possible reductions in the weight of large steamships and the effect on the general design. 3200 w. Int Marine Eng—Oct., 1908. No. 95546 C.

Ship Equipment.

Ships' Equipment (Ausstattung und Ausrüstung). Fr. Jappe. Discusses and describes types of equipment for heating ventilating, anchor chains, davits, refrigerating machines, etc. Ills. 9000 w. Deutscher Schiffbau—1908. No. 96165 N.

Ship Heating.

The Heating and Ventilating of Ships. S. F. Walker. Illustrated description of ventilating fans and discussion of power and heat required. Serial. 1st part. 4200 w. Int Marine Engng—Oct., 1908. No. 95545 C.

Ship Ventilation.

Ventilation and Sanitation. A. E. Battle. Read at Olympia before the Inst. of Marine Engrs. Discusses ventilation, heating, and berthing arrangements on board ship. 4000 w. Marine Rev—Oct. 15, 1908. No. 95905.

See also Ship Heating, under MARINE AND NAVAL ENGINEERING.

Steam Boilers.

The Use of Sea Water in Marine Boilers. James Shirra. A paper read before the Institute of Marine Engineers which discusses its use and its dangers. 1200 w. Marine Rev—Oct. 18, 1908. No. 95795.

The Use of Lime in the Modern Marine High Pressure Boiler. Discusses the use of lime to counteract the effects of harmful lime salts, acids from oils and various free gases. Illus. 4500 w. Marine Rev—Oct. 1, 1908. No. 95700.

Marine-Boiler and Auxiliary-Machinery Construction in Germany (Entwickelung und Stand des Schiffskessel- und Schiffshilfsmaschinenbaues in Deutschland). Walter Mentz. An illustrated review of progress and present practice. 5000 w. Deutscher Schiffbau—1908. No. 96157 N.

Steam Engines.

The Machinery of H. M. Battleships "Agamemnon" and "Lord Nelson." Drawings and description of the main engines. Plate. 700 w. Engng—Sept. 18, 1908. No. 95420.

The Modern Construction and Future Prospects of the Marine Reciprocity Engine (Die Schiffskolbenmaschine, ihre moderne Konstruktion, ihre Aussichten für die Zukunft). P. Krainer. A general review, discussing the competition of the steam turbine and of the internal-combustion engine. Ills. 7500 w. Deutscher Schiffbau—1908. No. 96155 N.

Steamships.

A New Patrol Steamer for Fishery Duties. Illustrated description of the SS. James Fletcher, a 420-ton vessel built for Lancashire and Western Sea Fisheries Committee. 2200 w. Int Marine Engng—Oct., 1908. No. 95549 C.

The New Italian Steamship Europa. D. Attilio. An illustrated description of a 11,575-ton passenger steamship for the Veloce Company of Genoa. 1500 w. Int Marine Engng—Oct., 1908. No. 95544 C.

The Atlantic Liner Chicago. J. G. Peltier. Illustrated description of 14,500-ton steamship of the trans-Atlantic fleet of the Compagnie Generale Transatlantique. 1200 w. Int Marine Engng—Oct., 1908. No. 95548 C.

Launch of the White Star Dominion Liner Laurentic. Illustrated account of a new steamship for the Canadian trade 565 ft. long and 14,500 tons gross. 1500 w. Marine Rev—Oct. 1, 1908. No. 95698.

The Turbine Steamships "Heliopolis" and "Cairo" of the Egyptian Postal Company (Les Paquebots à Turbines "Heliopolis" et "Cairo" de la Compagnie Postale Egyptienne). L. Piaud. Illustrated description. Ills. 2000 w. Génie Civil—Sept. 12, 1908. No. 96123 D.

Steam Turbines.

Impulse or Reaction Turbines (Druck- oder Ueberdruckturbine)? Felix Langen. A discussion of the comparative efficiency and economy of the two types. 3200 w. Schiffbau—Sept. 9, 1908. No. 96153 D.

The Steam Turbine for Ship Propulsion (Die Dampfturbine im Schiffsbetriebe). H. Schmidt. Reviews the types now used for marine propulsion, the advantages and disadvantages of steam turbines, etc. Ills. 12000 w. Deutscher Schiffbau—1908. No. 96156 N.

Water Supply.

A New Method of Sterilizing Drinking Water on War Ships (Di un nuovo Sistema di Sterilizzazione dell' Acqua potabile a Bordo delle Navi da Guerra). A. Delogu. Discusses sterilization with ozone. 4000 w. Riv Marit—Sept., 1908. No. 96131 E + F.

MECHANICAL ENGINEERING

AUTOMOBILES.

Armstrong-Whitworth.

18-22 H.P. Armstrong-Whitworth Chassis. Illustrated description. 900 w. Autocar—Oct. 10, 1908. No. 95974 A.

Brasier.

The 1908 Brasier Petrol Cars. Illustrated detailed description. 1500 w. Auto Jour—Oct. 10, 1908. Serial. 1st part. No. 95976 A.

Cabs.

Motor Cabs in Long Island Efficiency Test. Illustrated description of a test of cabs held by N. Y. Automobile Trade Association in a run from Brooklyn to Montauk and back. 650 w. Com Veh—Oct., 1908. No. 95578.

Motor Cabs (Automobildroschken). Max R. Zechlin. Discusses their operating expenses, revenues, and profits in Berlin. 3200 w. Zeitschr d Mit Motorwagen Ver—Sept. 15, 1908. No. 96167 D.

Clutches.

The Utility of Automobile Clutches. Thomas J. Fay. Considers types, design, materials, etc. Ills. 4000 w. Automobile—Oct. 15, 1908. Serial. 1st part. No. 95913.

Commercial Vehicles.

Recent Developments in Motor Vehicles for Industrial Purposes. Harry Wilkin Perry. This first of two articles deals mainly with mechanical improvements and operating expenses. Ills. 3500 w. Engineering Magazine—Nov., 1908. No. 96205 B.

Improved Steam Wagon. Illustrated description of an English built vehicle. 1000 w. Engr, Lond—Oct. 9, 1908. No. 95996 A.

Electric Vehicle Construction and Operation. Loftus G. Coade. Introductory chapter of a series of articles on causes of trouble in electric vehicle installations. 2500 w. Com Veh—Oct., 1908. No. 95580.

Development of the Motor Cycle Van. Describes various forms of motor vehicles for the delivery of light packages. Ills. 1100 w. Com Veh—Oct., 1908. No. 95575.

Commercial Vehicles in French Army Maneuvers. Illustrated description of use of 70 motor vehicles by two army corps for the daily transport of bread. 550 w. Automobile—Oct. 1, 1908. No. 95560.

We supply copies of these articles. See page 579.

Delivery Operation in Pittsburg. Illustrated description of the operation of 1-ton Frayer-Miller 4-cylinder delivery wagons for a department store. 800 w. Com Veh—Oct., 1908. No. 95577.

See also History, under STREET AND ELECTRIC RAILWAYS.

Competitions.

The Four-Inch Race. Gives descriptions of some of the competing cars. Ills. and map. 5500 w. Autocar—Sept. 19, 1908. No. 95432 A.

Design.

What Constitutes a Handsome Car? Interesting discussion of the designs of automobile bodies. Ills. 1500 w. Autocar—Oct. 3, 1908. No. 95887 A.

See also Ball Bearings, under MACHINE ELEMENTS AND DESIGN.

Drive Axle.

The Dieterich Universal Drive Axle. Illustrated description of the mechanism and its action. 2200 w. Ir Age—Oct. 22, 1908. No. 96002.

Elmore.

The 1909 Models of the Two-Cycle Elmore. Illustrated description. 600 w. Automobile—Oct. 1, 1908. No. 95557.

Farm Motors.

Agricultural Tractor Trials at Winnipeg. Illustrated description of competitive tests of agricultural tractors with wagons and plows. 1300 w. Com Veh—Oct., 1908. No. 95579.

See also Agriculture, under ELECTRICAL ENGINEERING, MISCELLANY.

Fuels.

Mixed Fuels for Automobile Engines. T. L. White. Discusses additions of various substances to alcohol with particular reference to the admixture of acetylene. 3000 w. Automobile—Oct. 1, 1908. No. 95555.

Benzol or Benzine (Benzol contra Benzin). Otto Lüders. The comparative economy of these two fuels for automobiles is discussed. 1800 w. Zeitschr d Mit Motorwagen Ver—Sept. 30, 1908. No. 96168 D.

Fuel Testing.

A Simple Method of Testing Petrols. J. E. Stacey Jones. Describes simple tests with apparatus at hand. Ills. 1500 w. Autocar—Oct. 10, 1908. No. 95975 A.

Gears.

The Donkin Differential. Illustrated description of a differential mechanism without gear wheels. 2000 w. Auto Jour—Sept. 26, 1908. No. 95650 A.

Haynes.

Haynes 1909 Model. Illustrated description of Model X, a car of medium power, size and price. 1600 w. Automobile—Oct. 1, 1908. No. 95556.

Ignition.

High Tension Magneto-Ignition Systems. Describes and illustrates the Nieuport, a French high tension magneto. 1500 w. Auto Jour—Sept. 26, 1908. No. 95648 A.

Motor Rating.

The Rating of Motor-Car Engines. Discusses a report of a sub-committee of the Society of Motor Manufacturers and Traders, objecting to the rules of the Royal Automobile Club. 1000 w. Engng —Sept. 25, 1908. No. 95643 A.

Motors.

Concerning the Silent Knight Motor. Thomas J. Fay. An illustrated discussion of this motor and its claims. 2000 w. Automobile—Oct. 22, 1908. No. 96020.

The New Daimler Slide Valve Motor-Car Engine. Views and description of the construction. 1200 w. Mech Engr—Oct. 16, 1908. No. 96049 A.

The 1909 Daimler Engine. Illustrated description of a new design of 4-stroke motor having cylindrical sliding valves. 1800 w. Autocar—Sept. 19, 1908. No. 95431 A.

Motor Timing.

What Is the Best Motor Timing? Louis Lacoin. An examination of timing arrangements and regulations. 2500 w. Automobile—Oct. 29, 1908. Serial. 1st part. No. 96234.

Napier.

The 45 H.P. 1909 Six-Cylinder Napier Car. Illustrates and describes special features. 1200 w. Autocar—Sept. 19, 1908. Serial. 1st part. No. 95433 A.

Omnibuses.

The Electrobus a Success in London. Illustrated description of mechanical equipment and summary of cost of operation. 1000 w. Com Veh—Oct., 1908. No. 95576.

Peugeot.

The 12-16 H.P. Live-Axle Peugeot Car. Illustrated detailed description. 2000 w. Autocar—Oct. 17, 1908. No. 96045 A.

Taximeters.

The Mechanism of a Taximeter. J. F. Gairns. Detailed description of "Aron" taximeter as fitted by the Gen. Elec. Co., Ltd., of London. Illus. 2000 w. Cassier's Mag—Oct., 1908. No. 95661 B.

Tractors.

Tests of a Lanz Superheated Steam Locomobile with Lentz Valves (Leistungsversuche an einer Lanzschen Heizdampf-Locomobile mit Ventilsteurung, Bauart Lentz). E. Josse. Describes, and reports tests on, a 140-170 horse power tractor. Ills. 4400 w. Zeitschr d Ver Deutscher Ing—Sept. 12, 1908. No. 96193 D.

Wheel Slip.

Wheel Slip at the Road. Description of Experiments by S. F. Edge on Brooklands Track to determine amount of slip at the point of contact between the road and the wheels. Ills. 800 w. Autocar—Oct. 3, 1908. No. 95888 A.

COMBUSTION MOTORS.

Compression.

The Utility of Compression in Combustion Motors (Sur l'Utilité de la Compression dans les Moteurs à Explosion). L. Lecornu. A theoretical explanation. Ills. 1700 w. Rev de Mécan—Sept., 1908. No. 96110 E + F.

Fuels.

Fuel for Power Generation. Edward C. Warren. Gives radical suggestions for a departure from the "carbon cycle." 4500 w. Engineering Magazine—Nov., 1908. No. 96207 B.

Gas Cleaning.

Sulphur in Gaseous Fuels. F. Louis Grammer. Notes on blast-furnace gas, producer gas, and the removal of sulphur. 700 w. Bul Am Inst of Min Engrs—Sept., 1908. No. 95473 C.

Gas-Engine Foundations.

Concrete Foundations for Gas Engines H. M. Nicholls. The fundamental principles of such foundations are discussed. Ills. 3000 w. Gas Engine—Oct., 1908. No. 96084.

Gas Engines.

The Temperature of the Walls of a Gas-Engine Cylinder. E. G. Coker. A report of experimental work and results. 2500 w. Engng—Oct. 16, 1908. No. 96-054 A.

Buckeye Gas Engine. Illustrated account of a new four-cycle type gas engine. 1400 w. Elec Ry Jour—Oct. 3, 1908. No. 95596.

Large Gas Engine for Fuel of Low Calorific Value. Illustrated description of double-acting two-cycle gas engine of 1,300-1,500 h.p. for a German copper works, built by the M. A.-G. v. Gebrüder Klein. 1000 w. Ir & Coal Trds Rev—Oct. 2, 1908. No. 95858 A.

See also same title, under MARINE AND NAVAL ENGINEERING.

Gasoline Turbines.

Some Possibilities of the Gasolene Turbine. Frank C. Wagner. Compares methods of reducing the temperature of the gases and considers how such comparison is affected by variations in the efficiencies of the turbine and air compressor. 2500 w. Jour Am Soc of Mech Engrs—Oct., 1908. No. 96041 F.

Gas Power Plants.

Power Plant Operation on Producer Gas. Discussion of a paper by Godfrey M. S. Tait. Illus. 1500 w. Jour Am Soc Mech Engs—Oct., 1908. No. 95603 F.

Suction Gas Producer Power. L. P. Tolman. Reviews the development, the government tests and the advantages, illustrating and describing a power plant. 4500 w. Pro Age—Oct. 1, 1908. No. 95501.

A Large Suction Gas Producer Power Plant. Illustrated description of a large plant at Beloit, Wis., with reference to special features of engine and producer design. 1600 w. Power—Oct. 27, 1908. No. 96069.

Gas Producers.

In Defense of the Gas Producer. Frank P. Peterson. Remarks on early designs, rating, etc. 2000 w. Power—Sept. 29, 1908. No. 95456.

The Reliability of the Producer Gas Plant. Thos. L. White. Defines conditions of reliability and discusses various tests. 2500 w. Cassier's Mag—Oct., 1908. No. 95665 B.

Bituminous Producer Plants. Elbert A. Harvey. Illustrated discussion of updraft producers where the heavy hydrocarbons are removed in a rotary gas washer. 10000 w. Jour Am Soc Mech Engs—Oct., 1908. No. 95605 F.

Gas Producers for Bituminous Coal. Oskar Nagel. Describes various producers designed to burn coals having much volatile matter. Illus. 1000 w. Cassier's Mag—Oct., 1908. No. 95660 B.

Loss of Fuel Weight in a Freshly Charged Producer. N. T. Harrington. Gives results of a test to determine the relation between the coal fired and actually consumed. Illus. 1200 w. Jour Am Soc Mech Engs—Oct., 1908. No. 95604 F.

The Production of Cheap Power by Suction Gas Plants. Philip W. Robson. A paper read before Section G of the British Association at Dublin; discusses costs and operation of a suction producer plant. Ills. 6000 w. Elect'n, Lond—Sept. 25, 1908. No. 95778 A.

Further Experiments Upon Gas Producer Practice. W. A. Bone and Richard Vernon Wheeler. A paper read before the Iron & Steel Institute describing a method for obtaining a rich gas of high carbonic-oxide content for either power or heating. 10000 w. Ir & Coal Trds Rev—Oct. 2, 1908. No. 95856 A.

Design for a 25-Horse-Power Gas Producer. F. C. Tryon. Instructions and specifications of the materials. Ills. 2000 w. Power—Oct. 20, 1908. No. 95969.

Gas Turbines.

Explosion or Combustion Gas Turbines (Explosions-Gasturbine oder Verbrennungs-Gasturbine)? Dr. Wegner-Dallwitz. A comparative discussion of the two types. Serial. 1st part. 1600 w. Die Turbine—Sept. 20, 1908. No. 96179 D.

Oil Engines.

See Isolated Plants, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

HEATING AND COOLING.

Fans.

Tests on a 35-Inch Exhaust Fan. Charles H. Chase. Gives results of tests made to determine to what extent the loss of power may be decreased by using ball bearings. Ills. 1500 w. Power—Sept. 29, 1908. No. 95454.

Gas Heating.

Modern Methods of Heating. H. R. Basford. Read before the Pacific Coast Gas Assn. Especially considers the automatic gas water heater. 3000 w. Am Gas Lgt Jour—Oct. 19, 1908. No. 95908.

Hot-Air Heating.

Mechanical Furnace Heating in a Residence. Describes an unusual installation with large fan and trunk air pipes. 3000 w. Met Work—Oct. 3, 1908. No. 95909.

Hot-Water Heating.

Indirect Hot Water Radiation in a Large Residence. Illustrated description of work, explaining a method of determining sizes. 4500 w. Met Work—Oct. 24, 1908. No. 96028.

Some Facts and a Few Theories Concerning the Operation of a Central Station Hot Water Heating and Electrical Generating Plant. J. D. Hoffman. Describes a successful plant, giving facts relating to its operation. 2500 w. Heat & Vent Mag—Oct., 1908. No. 96088.

Self-Regulation of Hot-Water Heaters (Ueber die Selbstregulierung von Warmwasserheizkörpern). P. Hase. A discussion of the conditions under which it is successful. Ills. 7700 w. Gesundheits-Ing—Sept. 19, 1908. No. 96172 D.

Damage Caused by Water Containing Air in Central Heating Plants (Die Zerstörungstätigkeit lufthaltigen Wassers in Zentralheizungen). Paul Pakusa. Discusses the corrosion of boiler tubes and water pipes. 3300 w. Gesundheits-Ing—Sept. 12, 1908. No. 96171 D.

See also Station Heating, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

Refrigeration.

The First International Congress of Cold. A report of the meeting at Paris to consider modern requirements and methods of this industry. 3500 w. Engng—Oct. 16, 1908. Serial. 1st part. No. 96057 A.

Proposals Submitted to the Congress Concerning the Standardization of Refrigerating Measures and the Trial Methods of Refrigerating Machines. Maurice Lablanc. Read before the 1st Int. Cong. of Refrig. Ind. at Paris. Deals with the choice of units, and the capacity, efficiency and testing of refrigerating machines. 7000 w. Cold Storage & Ice—Oct., 1908. No. 96065 C.

Apartment House Refrigeration. Illustrated account of a refrigerating plant in the Lessing Apartments, Chicago, installed in 1898. 1300 w. Ice & Refrig—Oct., 1908. No. 95611 C.

A New Ice-Making Machine for Domestic Use. Illustrated description of a simple machine invented by Audiffren of Paris which can be operated by a small motor. 1500 w. Sci Am—Oct. 17, 1908. No. 95893.

Busy Bee Candy Factory and Bakery. Detailed description of refrigerating and freezing plant for candy and ice cream factory, bakery, ice making system and restaurant. Diagrams and other illustrations. 3200 w. Ice & Refrig—Oct., 1908. No. 95612 C.

Ventilation.

Systems of Mechanical Ventilation and Refrigeration for the Carnegie Safe Deposit Co.'s Vaults. J. Byers Holbrook. Illustrated description of the system of ventilation designed to insure a constant supply of fresh cool air and removal of vitiated air. 2200 w. Am Archt—Oct. 14, 1908. No. 95903.

Methods of Testing the Efficiency of Ventilation. Ellen H. Richards, E. Marion Wade, Royce W. Gilbert, Carl E. Hanson, James M. Talbot. Describes methods of ascertaining the quality of air in rooms, shops, etc., which are sufficiently reliable, giving some results. Ills. 2500 w. Tech Qr—Sept., 1908. No. 96077 E.

The Heating and Ventilation of Restaurants and Cafés (Die Heizung und Lüftung von Restaurationen und Cafés). H. Roose. Outlines the general principles on which plants should be designed. 2200 w. Gesundheits-Ing—Sept. 5, 1908. No. 96170 D.

HYDRAULIC MACHINERY.

Centrifugal Pumps.

A High-Duty Turbine Pump. General description of tests made by James E. Denton. 2000 w. Can Engr—Oct. 16, 1908. No. 95906.

A High Efficiency Turbine Pump. Illustrated account of La-Degen 2-stage centrifugal pump with result of tests by James E. Denton, of Stevens Institute. 2240 w. Ir Trd Rev—Oct. 8, 1908. No. 95886.

The Choice and Examination of Centrifugal Pumps (Ueber die Auswahl und Beurteilung der Zentrifugalpumpen). P. Hartmann. A mathematical discussion of the selection and design of a pump for given conditions. Ills. 3500 w. Glückauf—Sept. 12, 1908. No. 96148 D.

See also Electric Pumping, under HYDRAULIC MACHINERY.

Electric Pumping.

Electric Pumping at the Duluth Waterworks. Illustrated description of a high efficiency centrifugal pump plant of 13,000,000 gallons capacity. Comparative cost of steam and electric pumping. 1000 w. Elec Wld—Oct. 10, 1908. No. 95872.

Orifices.

See same title, under CIVIL ENGINEERING, WATER SUPPLY.

Piping.

See Steam Pipes, under STEAM ENGINEERING.

Pump Capacity.

Determining the Capacity of a Power Pump. W. H. Wakeman. Gives a practical method of calculating displacement and delivery. 1500 w. Power—Oct. 27, 1908. No. 96068.

Pumping Engines.

Tests of Screw Pumping Engines at Chicago. Describes the official duty tests made recently on the engines in the 39th St. sewage pumping station. Ills. 3000 w. Eng Rec—Oct. 17, 1908. No. 95930.

Surge Tanks.

Surge Tanks in Water Power Plants. Discussion of a paper by Raymond D. Johnson. Illus. 25000 w. Jour Am Soc Mech Engs—Oct., 1908. No. 95599 F.

Turbine Plants.

Water-Power Plants by the Combined Kander and Hagnek Companies, Bern (Wasserkraftanlagen der Vereinigten Kander- und Hagnek A.-G. in Bern). The first part of the serial describes the hydraulic installation at the Speiz electric plant. Ills. Serial. 1st part. 2500 w. Schweiz Bau—Sept. 12, 1908. No. 96152 D.

Hydraulic Installations of the Société Romande d'Electricité, at Aigle, Vouvry and Montreux (Installations hydrauliques créées par la Société romande d'électricite, à Aigle, Vouvry et Montreux). J. Michaud. Illustrated description of these important Swiss plants. Serial. 1st part. 2300 w. Bul Tech d l Suisse Romande—Sept. 25, 1908. No. 96120 D.

Turbine Testing.

Brake Tests of Hydraulic Turbines. C. Everett Quick. Describes methods of testing with brakes having disk friction plates. Ills. 1800 w. Eng News—Oct. 18, 1908. No. 95746.

Valves.

Influence of Valves on the Flow of Water. Fred Pillmore. Discusses the effect the amount of closing of a valve has on the flow of water. Ills. 700 w. Power—Oct. 13, 1908. No. 95835.

Water Wheels.

The Form of Tangential Buckets (Die Tangentialschaufelform). Otto Graf. Illustrates and discusses the form of bucket employed by various makers. 2000 w. Zeitschr f d Gesamte Turbinenwesen—Sept. 20, 1908. No. 96182 D.

MACHINE ELEMENTS AND DESIGN.

Ball Bearings.

The Simplification of Ball Bearings (Vereinfachungen in den Kugellagerungen). August Bauschlicher. A discussion of their standardization for automobiles. Ills. 4000 w. Zeitschr d Mit Motorwagen Ver—Sept. 15, 1908. No. 96166 D.

Cams.

Method of Laying Out Cutting Cams. Herbert C. Barnes. Discussion of the method of laying out a cam and description of a process for making the master cam. Ills. 2000 w. Mach, N Y—Oct., 1908. No. 95720 C.

Clutches.

Clutches. Discussion of a paper by Henry Souther. Ills. 1400 w. Jour Am Soc Mech Engrs—Oct., 1908. No. 95600 F.

Crankshafts.

Designing and Fitting Crankshafts. H. S. Brown. Discusses good and bad design and construction. Ills. 2500 w. Ir Age—Oct. 22, 1908. No. 96003.

Drills.

The Design of Twist Drills. A. T. Weston. Explains the principles involved, discussing the extent to which they can be put in practice. 2500 w. Engr, Lond—Sept. 18, 1908. No. 95409 A.

Gears.

Diagrams for Designing Spiral Gears. Francis J. Bostock. Describes a graphical method for designing spiral gears. Diagrams. 1800 w. Mach, N Y—Oct., 1908. No. 95718 C.

Truth About the Hindley Worm and Wheel. Oscar J. Beale. A discussion of the tooth contact, showing that they bear in every groove of worm. Ills. 1800 w. Am Mach—Vol. 31, No. 40. No. 95507.

A Note on the Design of Gear Wheels (Beiträge zur Berechnung der Zahnräder). Emil Vidéky. A mathematical discussion of deformation stresses, etc., and the method of design. Ills. 3000 w. Zeitschr d Oest Ing u Arch Ver—Sept. 4, 1908. No. 96173 D.

Graphical Charts.

The Construction of Graphical Charts. John B. Peddle. Considers their use and construction. 3800 w. Am Mach—Vol. 31. No. 44. No. 96210.

The Laying Out and Use of Calculating Charts. T. B. Morley. Description of various charts for solving engineering problems, with plates showing specimen charts. 5000 w. Trans Inst Eng & Ship in Scot—Vol. 51, Feb. 4, 1908. No. 95609 N.

Link Motions.

A Link Motion Designed and Analyzed. Frank W. Merrill. Describes a method for use in the drafting room and explains the action of the link. Ills. 5600 w. Power—Oct. 6, 1908. No. 95831.

MACHINE WORKS AND FOUNDRIES.

Brass Founding.

The Use of a Chloride of Zinc Flux in Melting Aluminum and Its Alloys. Describes the use of this flux and its good effect. 1300 w. Brass Wld—Oct., 1908. No. 96082.

Case Hardening.

Case-Hardening by Means of Gas. Illustrations of Machlet's plant for case hardening by carburizing gas, with brief description. 350 w. Engng—Oct. 9, 1908. No. 95991 A.

Castings.

Warped or Distorted Castings—Methods of Prevention. Jabez Nall. Discusses the causes and remedies. Ills. 1800 w. Foundry—Oct., 1908. No. 95802.

Production of Pump Castings. Wm. Roxburgh. Discussion of molds, cores, and method of manipulation. Ills. 1800 w. Foundry—Oct., 1908. No. 95800.

Making Fine Detail Castings in Sand. Walter J. May. Suggestions for fine detail work. 1200 w. Prac Engr—Oct. 2, 1908. No. 95899 A.

Engineering Castings. Arthur Caddick. Describes the constituents of cast-iron and their effects. Ills. 1500 w. Prac Engr—Oct. 9, 1908. Serial. 1st part. No. 95979 A.

Chain Making.

Borsig Chains and Shackles (Borsigketten und Kenterschäkel). Max Krause. An illustrated description of the method of making Borsig chains and a discussion of their advantages. 3000 w. Stahl u Eisen—Sept. 23, 1908. No. 96142 D.

Cupolas.

Cupola Construction and Operation. Thos. D. West. A paper read before the New England Foundry Men's Assn. Discusses conditions of operation and repairs. 3000 w. Foundry—Oct., 1908. No. 95801.

Foundries.

A Modern Steel Foundry and Machine Shop. C. A. Tupper. Illustrated description of a large steel foundry for the making of general castings, at Milwaukee, Wis. 3500 w. Elec-Chem & Met Ind—Oct., 1908. No. 95459 C.

The Ehrhardt & Sehmer Foundry in Schliefmühle-Saarbrücken (Die Giesserei der Firma Ehrhardt & Sehmer, G. m. b. H., in Schleifmühle-Saarbrücken). J. Treuheit. Illustrated description of a large and well equipped plant for the production of heavy castings. Serial. 1st part. 2800 w. Stahl u Eisen—Sept. 2, 1908. No. 96136 D.

Foundry Furnaces.

The Application of the Electric Furnace in the Foundry (Die Verwendung des elektrischen Ofens in der Giesserei). A general discussion, referring in the first part to Moldenke's advocacy of the electric furnace. Serial. 1st part. 1200 w. Elektrochem Zeitschr—Sept., 1908. No. 96135 D.

Foundry Materials.

Grading Pig Iron, Alloys and Coke. A classification prepared by Eliot A. Kebler, manager of sales of Matthew Addy & Co., Cincinnati. 4800 w. Foundry—Oct., 1908. No. 95803.

Foundry Practice.

Gaging Metal in Steel Ladles. Joseph Bretaud. Table giving the weight of steel in ladles at varying depths and discussion of methods employed in constructing the table. Tables. 1300 w. Foundry—Oct., 1908. No. 95797.

Furnaces.

Heat Treating Furnaces and Their Location. Illustrated description of the annealing, hardening, tempering and carbonizing furnaces of the Chicago Flexible Shaft Co. 1200 w. Am Mach—Vol. 31. No. 42. No. 95948.

Heating and Melting Furnace Work. Ulrich Peters. Considers shape, brick and methods of calculating requirements. 1700 w. Ir Age—Oct. 15, 1908. No. 95915.

Gear Cutting.

4-Ft. 6-In. Universal Gear-Cutting Machine at the Franco-British Exhibition. Joseph Horner. Illustrated detailed description of the machine and its operations. 2500 w. Engng—Oct. 16, 1908. No. 96058 A.

Jigs.

Jigs for Machining an Oil Pump Body. A. J. Baker. Describes tools designed for expeditious manufacture of geared oil pumps. Ills. 1500 w. Am Mach—Vol. 31. No. 43. No. 96007.

Lathes.

Railway Axle Lathe. Illustrated description of an English lathe for turning the ends of railway, wagon and carriage axles. 600 w. Engng—Sept. 18, 1908. No. 95418 A.

Machine Tools.

Historic Machinery. W. J. Blackmur. Illustrated descriptions of a metal planer, and a screw-cutting lathe in the Patent Museum, England. 1200 w. Ir Age—Oct. 15, 1908. No. 95914.

Some Machine Tools Built in English Shops. Joseph G. Horner. Illustrates and describes tools of recent design shown at the Franco-British exhibition. 4000 w. Am Mach—Vol. 31. No. 41. No. 95941.

Milling Machines.

Horizontal Boring, Tapping, and Milling Machine. Illustrated description of a very heavy machine constructed by De Fries & Co. of Dusseldorf. Plates. Engng—Sept. 25, 1908. No. 95646 A.

Molding.

Molding a Large Gear Wheel. W. W. Carter. Drawings and description. 600 w. Am Mach—Vol. 31. No. 42. No. 95946.

Molding a Cast Steel Cylinder. H. T. McCaslin. Discusses the construction of a mold for a cast steel hydraulic cylinder. Ills. 2100 w. Foundry—Oct., 1908. No. 95804.

The Molding of Locomotive Cylinders. Louis Luhrsen. Description of methods of overcoming imperfections and making the patterns and metal mixtures. Ills. 2200 w. Foundry—Oct., 1908. No. 95798.

Molding Machines.

Molding Machines for Large Work.

Describes use of jarring machines in the plant of the Filer and Stowell Co. Ills. 1200 w. Foundry—Oct., 1908. No. 95796.

Molding Machines for Machine Tool Castings. John Edgar. Considers the kind of machine adapted to this work, etc. Ills. 2000 w. Am Mach—Vol. 31. No. 40. No. 95508.

Pattern Shops.

The Pattern Shop Store Room. Oscar E. Perrigo. Discusses the proper conduct of this department and methods of charging lumber and supplies. Ills. 3500 w. Foundry—Oct., 1908. No. 95799.

Planers.

Method of Leveling and Alining Planers. James J. Thompson. Illustrated description of the methods employed in the shops of the Am. Tool Works Co. 1800 w. Am Mach—Vol. 31. No. 43. No. 96005.

Rigidity Test of a 24 x 24-Inch x 8-Foot Planer. James A. Pratt. Outlines a test made of the amount of spring in the machine when making heavy cuts and using a high-speed steel cutting tool. Ills. 4500 w. Am Mach—Vol. 31. No. 42. No. 95944.

Sand Blast.

Foundry and Pattern Shop Equipment. Discusses sand blast equipment, for treating small castings. Ills. 1300 w. Foundry—Oct., 1908. No. 95805.

The Jorn Sand Blast Apparatus. Illustrated account of a new continuous acting machine for metal and glass workers. 900 w. Ir Age—Oct. 8, 1908. No. 95879.

Shop Design.

Design and Construction of Metal-Working Shops. Discusses arrangement of plant and describes typical shops. Ills. 5500 w. Mach, N Y—Oct., 1908. No. 95717 C.

Shop Heating.

Shop Heating and Ventilation. Illustrated description of a system used in the Abendroth & Root Mfg. Co.'s plant at Newburgh, N. Y. 1500 w. Ir Age—Oct. 22, 1908. No. 96000.

The Heating and Ventilating of Machine Shops. Illustrates and describes two heating plans, affording examples of the direct air-heated and steam air-heated systems. 2000 w. Engr, Lond—Oct. 16, 1908. No. 96063 A.

Shop Hygiene.

Lockers, Wash and Bath Rooms for Shops and Manufactories (Vestiaires, Lavabos et Bains pour les Usines et Ateliers). Henri Mamy. Describes typical appliances and arrangements. Ills. 2500 w. Génie Civil—Sept. 5, 1908. No. 96122 D.

Shops.

A Modern Lamp-Making Works. An interesting description of the new factory of the Westinghouse Lamp Company at Watsessing, N. J. Ills. 2800 W. Elec Rev—Oct. 3, 1908. No. 95883.

The Works of Cammell Laird & Company, Limited. Illustrated description of works for iron and steel manufacture. 1500 w. Ir & Coal Trds Rev—Oct. 9, 1908. No. 95997 A.

See also Foundries, under MACHINE WORKS AND FOUNDRIES.

Steam Hammers.

The Steam Hammer and Its Use. James Cran. Describes most practical method for its use. Ills. 2500 w. Mach, N Y—Oct., 1908. No. 95721 C.

A New Steam Hammer Design. Drawings and description of a combined handing and self-acting type, with improved controlling gear. 1600 w. Mech Engr—Sept. 18, 1908. No. 95429 A.

Welding.

Art and Science of Autogenous Welding. E. S. Foljambe, before the Soc. ot Auto. Engrs. Discusses oxy-acetylene autogenous welding and its applications and cost. 1800 w. Boiler Maker—Oct., 1908. No. 95483.

Schaap Autogenous Welding Process. Describes burner and apparatus and some of the work done. Ills. 1200 w. Am Mach—Vol. 31. No. 42. No. 95947.

The Oxy-Acetylene Process of Cutting and Welding Metals. Illustrated account of application of this process to the repair of locomotives and other railway equipment. 2200 w. Ry & Engng Rev—Oct. 3, 1908. No. 95673.

Oxy-Acetylene Process of Metal Cutting and Autogenous Welding. Describes use of the oxy-acetylene torch in mechanical operations. Mach, N Y—Oct., 1908. No. 95722 C.

See also Locomotive Repairs, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Woodworking Machines.

Accidents with Planing Machines and the Carstens Shaft (Les Accidents occasionnés par la "Dégauchisseuse," et "l'Arbre Carstens"). A. Beauquis. The danger to workmen in planers with square shafts, safety devices, and the advantages of the Carstens cylindrical shaft. Ills. 4000 w Rev d'Econ Indus—Sept. 16, 1908. No. 96100 D.

MATERIALS OF CONSTRUCTION.

Alloys.

Influence of Silicon on Iron. Adolph Jouve. Read before the I. and S. Inst. Considers its influence on the physical and chemical properties of iron. 1500 w. Engng—Oct. 16, 1908. No. 96060 A.

Influence of Silicon on the Physical and Chemical Properties of Iron. Adolphe Jouve. A paper presented to the Iron & Steel Institute dealing especially with the diminishing of the magnetic properties and the increased resistance to the action of acids. 3500 w. Ir & Coal Trds Rev —Oct. 2, 1908. No. 95850 A.

Magnalium: Its Strength, Weight and Uses. Rules for molding, forging, rolling, and machining. Ills. 2000 w. Am Mach—Vol. 31. No. 41. No. 95942.

Brass.

The Effect of Impurities on Brass Intended for Rolling. Erwin S. Sperry. A résumé indicating the effect of the various metallic and non-metallic elements. 4000 w. Mech Engr—Oct. 16, 1908. No. 96050 A.

Brass Analysis.

The Complete Analysis of Brass. Albert J. Hall. Gives details of analysis in full. 5000 w. Elec-Chem & Met Ind—Nov., 1908. No. 96094 C.

Cast Iron.

Castings versus Forgings. James H. Baker. Discusses the development of the respective fields of cast and wrought iron and steel. Ills. 2500 w. Ir Age—Oct. 1, 1908. No. 95505.

Copper.

A Relation Between the Hardness, Limit of Stretching Strain, and Internal Energy of Ductile Metals (Eine Beziehung zwischen Härte, Streckgrenze und der inneren Energie zäher Metalle). Alfred Kürth. A discussion based on the results of tests on copper. Ills. 5000 w. Zeitschr d Ver Deutscher Ing—Sept. 26, 1908. No. 96196 D.

Heat Insulation.

See Packings, under MATERIALS OF CONSTRUCTION.

Malleable Iron.

Malleable Cast Iron: Its Evolution and Present Position in the Metallurgical World. W. H. Hatfield. Paper and Discussion. Ills. 7000 w. Trans Inst Eng & Ship in Scot—Vol. 51, March 17, 1908. No. 95605 N.

Metallography.

Metallography Applied to Engineering. William Campbell. On the methods of microscopic examination of metals and the use of the knowledge obtained to engineers. Ills. 5000 w. Jour Can Min Inst —1908. No. 96248 N.

Note on a Workshop Microscope. J. E. Stead. Read before the I. and S. Inst. Describes a simple instrument for examining metals and alloys. Ills. 1000 w. Engng—Oct. 2, 1908. No. 95715 A.

The Freezing Point of Iron. H. C. H. Carpenter. A paper read before the Iron and Steel Institute giving a résumé of pyrometric measurement of the freezing point of iron and summary of results. 3700 w. Ir & Coal Trds Rev—Oct. 2, 1908. No. 95849 A.

The Constitution of Carbon Steels. E. D. Campbell. A paper read before the Iron & Steel Institute which discusses the chemical composition. 7000 w. Ir & Coal Trds Rev—Oct. 2, 1908. No. 95852 A.

Gas Occluded in a Special Nickel Steel (Gaz occlus dans un Acier au Nickel Spécial). M. G. Belloc. Gives the result of researches carried out by the author. Ills. 1000 w. Rev de Métal—Sept., 1908 No. 96105 E + F.

An Optical Method for the Determination of the Hardness of the Constituents of Alloys (Méthode optique pour la Détermination de la Dureté des Constituants des Alliages). M. Ziegler. Describes the method and its application to iron-sulphur alloys. Ills. 1700 w. Rev de Métal—Sept., 1908. No. 96104 E + F.

Packings.

Packings and Heat-Insulating Materials (Ueber Dictungen, Packungen und Wärmeschutzeinrichtungen im Maschinenwesen). Herr Tanneberger. Describes various materials, their uses, and methods and appliances for applying them to various classes of machinery. Ills. Serial. 1st part. 5500 w. Glasers Ann—Sept. 1, 1908. No. 96184 D.

Rubber.

The International Rubber Exhibition at Olympia. An account of the exhibits. 2500 w. Engng—Sept. 18, 1908. No. 95419 A.

Wrought Iron.

See Cast Iron, under MATERIALS OF CONSTRUCTION.

MEASUREMENT.

Averaging Instruments.

An Averaging Instrument for Polar Diagrams. W. F. Durand. A description of the instrument and its use. 1500 w. Jour Am Soc of Mech Engrs—Oct., 1908. No. 96039 F.

Chain Testing.

An Up-to-Date German Chain-Testing Plant. Alfred Gradenwitz. Illustrates and describes the plant and methods at the Borsig works. 1000 w. Am Mach—Vol. 31. No. 43. No. 96006.

Dynamometers.

Development of the Alden Absorption Dynamometer. G. Everett Quick. Illustrated description. 700 w. Elec Wld—Oct. 31, 1908. No. 96214.

Gages.

Constant and Progressive Tolerances for Gages. C. E. Johansson. On the importance of gaging systems, the difficulties, etc. 2000 w. Am Mach—Vol. 31, No. 41. No. 95940.

The Calibrating of Twelve Ames Dial Gages. Walter Gribben. An account of the method and the results. Ills. 1200 w. Am Mach—Vol. 31. No. 42. No. 95945.

Hardness.

The Ball Method of Testing Hardness as a Means of Estimating Resistance to Rupture (Evaluation de la Dureté par la Méthode de la Bille considérée comme Mesure de la Résistance à la Rupture). A. Kürth. A mathematical discussion based on tests. Ills. 5000 w. Rev de Mécan—Sept., 1908. No. 96109 E + F.

Propeller Testing.

Testing of Airship Propellers in the Testing Laboratory of the Conservatoire National des Arts et Métiers (Essai des Hélices Aériennes au Laboratoire d'Essais du Conservatoire National des Arts et Métiers). M. Boyer-Guillon. A mathematical description of method, giving results. Ills. 3000 w. Rev de Mécan—Sept., 1908. No. 96108 E + F.

Pyrometry.

Technical Thermometer. J. H. Hart. Considers especially the types of thermometers available for utilization in molding and casting of different metals, their principles, advantages, operation, cost, etc. 2500 w. Elec-Chem & Met Ind—Nov., 1908. No. 96096 C.

The Measurement of Temperature (La Misura della Temperature). Ugo Bordoni. A general review of thermometric and pyometric methods and apparatus. Ills. Serial. 2 parts. 10500 w. Ann d Soc d Ing e d Arch Ital—Aug. 15 and Sept. 1, 1908. No. 96132 each F.

Tachometers.

Liquid Tachometers. Illustrates and describes the Veeder tachometer, its operation, construction and method of testing. 3500 w. Jour Am Soc of Mech Engrs—Oct., 1908. No. 96037, F.

Testing Machines.

Reverse-Torsion Testing-Machine. Brief illustrated description. 700 w. Engng—Oct. 10, 1908. No. 95992 A.

Testing Machines at the Glasgow Technical College. Descriptive of new machines including a 100-ton horizontal testing machine, a tension-torsion machine and a reverse-torsion testing machine. Ills. 2400 w. Engng—Sept. 25, 1908. No. 95639 A.

See also Rails, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

Testing Methods.

Torsion Tests (Essais de Torsion). Pierre Breuil. Discusses torsion tests as a basis for the selection of metals, and the relation between torsion and tension, giving results of comparative tests. Ills. 6300 w. Bul d Lab d'Essais—No. 14. No. 96103 N.

Standards and Specifications for the Testing and Acceptance of Iron Materials (Norme e Condizioni per le Prove e per l'Accettazione dei Materiali ferrosi). The test of the specifications of the Italian Soc. of Engrs. & Architects. Ills. 5000 w. Ann d Soc d Ing e d Arch Ital—Sept. 1, 1908. No. 96133 F.

POWER AND TRANSMISSION.

Air Compression.

Air Compression at High Altitudes. S. B. Redfield. Discusses reasons for greater quantity of compressed air at greater pressure and considers power required. Ills. 3000 w. Power—Oct. 6, 1908. No. 95829.

Air Compressors.

A Novel Hydraulic Air Compressor. Describes the invention of George C. MacFarlane. Ills. 1100 w. Compressed Air—Oct., 1908. No. 96087.

Air Compressors. C. S. Vesey Brown. General review of types of machine now on the market and description of chief characteristics. 4000 w. Cassier's Mag—Oct., 1908. No. 95662 B.

Chain Driving.

Chain Driving. Discussion of the advantages of chain driving as shown by tests in the factory of Hans Renold, Ltd., Manchester, in comparison with belt drive. Ills. 2500 w. Mech Engr—Sept. 25, 1908. No. 95891 A.

Electric Driving.

Some Notes on Electric Driving. Theodore Parsons. Describes installations for electric driving and advantages of the system. 6000 w. Trans Inst Eng & Ship in Scot—Vol. 51, March 3, 1908. No. 95610 N.

Electric Drive for Metal Working Shops. Norman G. Meade. Discussion of essential factors and advantages and consideration of various types of motors. Ills. 1700 w. Power—Oct. 6, 1908. No. 95826.

See Textile Mills, under MISCELLANY; and Rolling Mills, under MINING AND METALLURGY, IRON AND STEEL.

Power Plants.

Breakdowns of Power Plant Machinery. Extract from the Annual Report of Michael Longridge, Inspector for the British Engine, Boiler and Electrical Insurance Co. Ills. 4500 w. Power—Oct. 13, 1908. No. 95841.

Electricity in the Production of Spelter and Sulphuric Acid. Describes a plant at Danville, Ill., which treats concentrated ore from the Joplin fields. Ills. 1500 w. Elec Rev, N Y—Oct. 10, 1908. No. 95723.

The Power Plant of the Falk Company, Milwaukee, Wis. Illustrated description of a large plant where machinery is operated by compressed air or electrically. 1600 w. Eng Rec—Oct. 3, 1908. No. 95622.

New Power Plant of the Pennsylvania R. R. Warren O. Rogers. Illustrates and describes the principal features of the installation at Ashtabula Harbor, Ohio, with special reference to the storage battery. 2000 w. Power—Sept. 29, 1908. No. 95453.

See also Textile Mills, under MISCELLANY.

STEAM ENGINEERING.

Air Pumps.

The Starting and Operation of Air Pumps. G. H. Gibson. General discussion. Ills. 1500 w. Power—Oct. 6, 1908. No. 95827.

Boiler Design.

Bracing Flat Surfaces in Steam Boilers. Discusses the causes of deformation, washout holes and their location, effects of deformation on the stays, purpose of head and nuts on stays. 2000 w. Boiler Maker—Oct., 1908. No. 95480.

Boiler Furnaces.

Furnace Design in Relation to Fuel Economy. E. G. Bailey. Read before the Boston Soc. of Civ. Engrs. Briefly considers the losses affecting the heat value. 2500 w. Boiler Maker—Oct., 1908. No. 95479.

For Burning Shavings and Sawdust. Orosco C. Woolson. A discussion of the best methods for burning shavings and sawdust and the furnaces best suited for this purpose. Ills. 1800 w. Power—Oct. 13, 1908. No. 95838.

Boiler Management.

The Emptying and Cooling of Boilers. Remarks on the best methods, showing the need of care. 1500 w. Prac Engr—Oct. 9, 1908. No. 95980 A.

The Scientific Control of Fuel Consumption. Henry E. Armstrong. A paper read before the British Iron & Steel Institute which discusses the exhaustion of the coal supply and means for its control. 4300 w. Col Guard—Oct. 2, 1908. No. 95866 A.

The Heating of Air by Flue-Gases. George Edward Tansley. Describes a series of experiments to determine the most suitable form of tube and heater for the utilization of the heat in flue-gases. Ills. 2500 w. Inst of Civ Engrs—No. 3681. No. 95498 N.

Boiler Settings.

Recent Improvements in Boiler-Setting in Great Britain. Improvements in methods of testing boiler-flue gases have led to better practice in furnace construction, etc. 1500 w. Boiler Maker—Oct., 1908. No. 95482.

Boiler Tubes.

The Slipping Point of Rolled Boiler Tube Joints. O. P. Hood and G. L. Christensen. Information concerning the behavior of such joints. Ills. 1600 w. Jour Am Soc of Mech Engrs—Oct., 1908. No. 96040 F.

Boiler Waters.

Feed Water Practice in Western Australia. C. J. Mathews. Information concerning the kind of water that boiler owners must contend with and the best means of treating. 2500 w. Aust Min Stand—Sept. 16, 1908. No. 96228 B.

Water Softening and Practice at Broken Hill Proprietary. Leslie Bradford. An account of practice where the problem is more than usually difficult. 3000 w. Aust Min Stand—Sept. 23, 1908. No. 96229 B.

Condensers.

Air Leakage in Steam Condensers. Discussion of a paper by Thomas McBride. 2500 w. Jour Am Soc Mech Engs—Oct., 1908. No. 95602 F.

The "Contraflo" System of Condensation. Describes a method for the regulation, within limits, of the volumetric efficiency of the air-pump by the control of its temperature. Ills. 1000 w. Engng—Oct. 2, 1908. No. 95711 A.

Condensers and Air Pumps. W. H. Booth. Discussion of a paper presented by M. Maurice Leblanc to the Association Technique Maritime of Paris. Considers vacuum conditions for steam turbines and reciprocating engines. 2200 w. Power—Oct. 6, 1908. No. 95832.

Design.

An Engineer's Notes on the Design of Steam Engines. Discusses designs to meet stated work and conditions. 1800 w. Mech Wld—Oct. 2, 1908. Serial. 1st part. No. 95901 A.

Determination of the Best Weight of Reciprocation of Parts in Steam Engine Design. E. L. Weber. A mathematical discussion of the best weights for high speed engines. Ills. 1700 w. Power—Oct. 6, 1908. No. 95828.

Engine Economy.

The Influence of Vacuum and Superheating on the Steamship Consumption of Reciprocating Engines and Turbines (Der Einfluss von Vakuum und Dampfüberhitzung auf den Dampfverbrauch von Kolbendampfmaschinen und Dampfturbinen). A. Rojinsky. Theoretical. Ills. Serial. 1st part. 2000 w. Die Turbine—Sept. 5, 1908. No. 96177 D.

Engine Governing.

Increasing the Power of an Engine. A. J. Dixon. Discusses the effect of changing the weight of the governor counterpoise in a Corliss engine. Ills. 2000 w. Power—Oct. 13, 1908. No. 95836.

Engines.

Design of an English High-Speed Steam Engine. Philip Bellows. Illustrated discussion of an engine of the semi-superposed type. 4500 w. Am Mach—Vol. 31, No. 43. No. 96008.

Engine Tests.

Economy Tests of High Speed Engines. Discussion of a paper by Messrs. Dean and Wood. Illus. 1500 w. Jour Am Soc Mech Engs—Oct., 1908. No. 95601 F.

History.

The Practical Evolution of the Steam Engine (Evolution pratique de la Machine à Vapeur). M. A. Mallet. An exhaustive historical discussion of the development of the steam boiler, superheating, surface condensers, steam jackets, and the theory of heat interchanges. Ills. 92000 w. Serial. 2 parts. Mem Soc Ing Civ de France—Aug. and Sept., 1908. No. 96102 each G.

Injectors.

Sellers' Non-Lifting 1908 Injector. Describes the results obtained by this recently brought out apparatus. 1800 w. R R Age Gaz—Oct. 30, 1908. No. 96239.

Automatic Injector Information. Frank O'Leary. General discussion with description of practical test of Penberthy automatic injector. Ills. 2200 w. Power—Oct. 6, 1908. No. 95833.

Smoke Prevention.

Smoke Prevention. Discusses the design of furnaces, and the proper firing to prevent smoke, and related subjects. 2000 w. Boiler Maker—Oct., 1908. No. 95481.

Steam Calorimetry.

A Method of Obtaining Ratios of Specific Heats of Vapors. A. R. Dodge. Describes a method, using the throttling calorimeter for determining the ratios, without using the steam tables. 2000 w. Jour Am Soc of Mech Engrs—Oct., 1908. No. 96038 F.

Steam Pipes.

Water Hammer in Pipes. S. K. Patteson. Explanation of the phenomenon and methods for its elimination in steam and water pipes. 2400 w. Power—Oct. 6, 1908. No. 95830.

Allowing for the Expansion of Steam Pipes. William D. Ennis. The effects of temperature rise are considered. An argument in favor of pipe bends. Ills. 3500 w. Power—Oct. 20, 1908. No. 95970.

The Piping System of High Pressure Plants. Charles L. Hubbard. Directions for arranging steam and water piping, showing the best methods for various conditions. 3500 w. Power—Sept. 29, 1908. No. 95455.

Steam Traps.

Steam Traps. Gordon Stewart. Deals with the principles upon which the various makes rely for their proper working, giving illustrations and descriptions of how these principles are employed. 2500 w. Elec Rev, Lond—Sept. 18, 1908. Serial. 1st part. No. 95439 A.

Stokers.

Chain Grate Stokers at Coventry. Illustrated description of the chain grate stokers and conveyors for handling fuel at the electricity station. 1700 w. Engr, Lond—Sept. 18, 1908. No. 95415 A.

Superheating.

See Engine Economy, under STEAM ENGINEERING.

Turbine Governing.

See Speed Regulation, under ELECTRICAL ENGINEERING, DYNAMOS AND MOTORS.

Turbines.

A Study of Low-Pressure Turbine Possibilities. Synopsis of a report by Ira R. Hollis on the plant of Cambridge Electric Light Co. 3500 w. Eng Rec—Oct. 3, 1908. No. 95614.

Exhaust Steam Turbine Results in Philadelphia and Scranton. Abstract of a paper by C. B. Burleigh on the low pressure steam turbine; gives power output and cost. 1500 w. Elec Ry Jour—Oct. 10, 1908. Special No. No. 95677 C.

Development of the Double Flow Steam Turbine. R. N. Erhart. Description of the design and use of double flow turbines for generators of very large power and high speeds. Ills. Also editorial by B. G. Lamme. 1800 w. Elec Jour—Oct., 1908. No. 95844.

A Mammoth Turbine for Buenos Aires. Franco Tosi. Description of Parsons type of turbine with low-pressure Fullager compensator built by the Tosi firm. It develops 12,000 h.p. and operates on 13.86 lbs. of steam per kilowatt hour. Ills. 2800 w. Power—Oct. 13, 1908. No. 95834.

The Musgrave-Zoelly Steam Turbine. Illustrated account of the first Zoelly steam turbine made entirely in Great Britain, with section and elevation. Ills. 2200 w. Elect'n, Lond—Oct. 2, 1908. No 95781 A.

The Development of the Zoelly Turbine (Die weitere Entwicklung der Zoelly-Turbine). I. Weishäupt. Illustrates and describes turbines of this type by various makers, giving results of tests. 3900 w. Zeitschr d Ver Deutscher Ing—Sept. 5, 1908. No. 96191 D.

A Note on the General Turbine Theory (Beiträge zur allgemeinen Turbinen Theorie). Viktor Fischer. A mathematical discussion of systems of coördinates. Ills. 2000 w. Zeitschr f d Gesamte Turbinenwesen—Sept. 10, 1908. No. 96180 D.

Graphical Calculation of a Multi-Stage Reaction Turbine (Graphische Berechnung einer vielstufigen Ueberdruckturbine). W. J. Jasinsky. Mathematical. Ills. Serial. 1st part. 2000 w. Zeitschr f d Gesamte Turbinenwesen—Sept. 20, 1908. No. 96181 D.

TRANSPORTING AND CONVEYING.

Coal Handling.

Recent Electric Discharging Plants (Neuere Verladebrücken mit elektrischem Antrieb). F. Janssen. Illustrated description of several large coal and ore hoists in Germany. 3000 w. Elek Kraft u Bahnen—Sept. 4, 1908. No. 96185 D.

Mechanical Conveying of Coal in the Rhein-Westphalian Mines (Maschinelle Fördereinrichtungen vor Ort auf rheinisch-westfälischen Gruben). Herr Forstmann. Describes the conveying devices used in several of the mines of this district. Ills. 5000 w. Glückauf—Sept. 5, 1908. No. 96147 D.

See also Barges, under MARINE AND NAVAL ENGINEERING.

Conveyors.

Handling Concrete with Belt Conveyors. Abstract from the Barge Canal Bulletin which describes the transportation of large quantities of mixed concrete. Ills. 1500 w. Eng Rec—Oct. 10, 1908. No. 95741.

Cranes.

The Design of Jib Cranes. R. W. Valls. A theoretical treatise of the typical crane and its construction from a commercial standpoint. Ills. 6000 w. Mach, N Y—Oct., 1908. No. 95719 C.

Electric Travelling Cranes in Car Maintenance. Illustrated account of repair work in the Cottage Grove Avenue car house of the Chicago City Railway Company. 1200 w. Elec Ry Jour—Oct. 10, 1908. Special No. No. 95676 C.

New Car-Handling Crane in the Kansas City Shops. Illustrated description of a travelling crane whose carriage and hoist were improvised from materials on hand at the shops. 600 w. Elec Ry Jour—Oct. 3, 1908. No. 93588.

A Traveler for Viaduct Erection. L. L. Jewell. Describes a 15-ton traveler of unusual size and type and operated by electricity employed in erecting heavy single track viaducts. Ills. 1800 w. Eng News—Oct. 8, 1908. No. 95743.

Cranes at the German Marine Exhibition, 1908 (Zur Kranschau auf der deutschen Schiffbau-Ausstellung 1908). C. Michenfelder. Describes the models of heavy dock cranes exhibited. Ills. 4500 w. Deutscher Schiffbau—1908. No. 96162 N.

Crane Construction for Various Purposes (Kranbauarten für Sonderzwecke). C. Michenfelder. Illustrates and describes a large number of installations by German firms. Serial. 1st part. 2800 w. Zeitschr d Ver Deutscher Ing—Sept. 12, 1908. No. 96192 D.

Lifting Magnets.

Lifting and Loading Magnets for Steel Works. Brief description of Stuckenholz magnets for lifting and conveying small pieces. Ills. 800 w. Ir & Coal Trds Rev—Oct. 2, 1908. No. 95859 A.

The Economy and Work of Lifting Magnets. E. F. Lake. Considers their many uses and the saving in labor. Ills. 2500 w. Am Mach—Vol. 31. No. 44. No. 96208.

Ore Handling.

A 1908 Iron Ore Handling Plant. Walter G. Stephan. Illustrated description of the new Hulett Machines at Central Furnaces, Cleveland, Ohio, consisting of two 10-ton automatic electric unloaders and one 10-ton ore handling bridge. 2400 w. Ir Age—Oct. 8, 1908. No. 95876.

MISCELLANY.

Aeronautics.

The Laws of Flight. F. W. Lanchester. Results of experiments and mathematical discussion. Paper read before Section of the British Association, Dublin, 1908. Ills. 4000 w. Engng—Sept. 25, 1908. No. 95647 A.

The Multiple Air Propeller. Its Aeronautic Possibilities for Dirigible Airships, Aeroplanes, and Helicopters. Description of two methods of using a number of small propellers of relatively low speed. Ills. 1200 w. Sci Am—Oct. 10, 1908. No. 95696.

Wright Aeroplane—A Noteworthy Invention. L. P. Alford. Illustrated description of the machine and an account of what it has accomplished. 2000 w. Am Mach—Vol. 31. No. 40. No. 95506.

French Purchase of the Wright Aeroplane. Remarks on what Mr. Wilbur Wright has accomplished, and the differences between his machine and French aeroplanes. Engr, Lond—Oct. 16, 1908. No. 96061 A.

Wilbur Wright Takes Passengers Aloft. W. F. Bradley. Brief account of aeroplane flights in France. Ills. 2000 w. Automobile—Oct. 22, 1908. No. 96021.

Experiments with the Langley Aeroplane. Dr. S. P. Langley. An article, written shortly before the writer's death, giving an account of pioneer experiments in aerial navigation. Ills. 5800 w. Pop Sci M—Nov., 1908. No. 96071 C.

See also Propeller Testing, under MEASUREMENTS.

Air Resistance.

Researches on the Resistance of the Air to Thin Plates, Parallel to Each Other and to the Direction of Motion (Versuche zur Ermittlung des Luftwiderstandes der Bewegungsrichtung parallelen Seitenflächen der Körper). Albert Frank. Describes the tests and gives a mathematical discussion of the results. Ills. 6000 w. Zeitschr d Ver Deutscher Ing—Sept. 19, 1908. No. 96195 D.

Fur Cutting Machinery.

Process of Fur Cutting. Gilbert E. Stetcher. Gives a sketch of the development of head gear and the fur cutting industry, illustrating machines used. 1500 w. Ins Engng—Oct., 1908. No. 96070 C.

Ice Harvesting Machines.

Harvesting Ice. Harold B. Wood. Illustrates and describes machines used in harvesting from one to three thousand tons of ice. 2500 w. Cold Storage & Ice—Oct., 1908. Serial. 1st part. No. 96066 C.

Monotype Machines.

Manufacturing the Monotype Keyboard. Illustrates and describes interesting methods and appliances used. 1400 w. Am Mach—Vol. 31. No. 41. No. 95939.

Nasmyth.

Nasmyth's Centenary. Reviews the engineering work of James Nasmyth. 3000 w. Engr, Lond—Sept. 18, 1908. Serial. 1st part. No. 95410 A.

Steel Pen Making.

Modern Methods of Making Steel Pens. Illustrated description of methods used at the C. Howard Hunt plant, at Camden, N. J. 2000 w. Am Mach—Vol. 31. No. 43. No. 96009.

Textile Machinery.

Interesting Textile Machine Work. Illustrates and describes details of novel braiding machines. 1200 w. Am Mach—Vol. 31. No. 41. No. 95943.

Textile Mills.

Power Plants in Textile Mills. Notes from a paper by Lewis Sanders, read before the Nat. Assn. of Cotton Mfrs. 4000 w. Eng Rec—Oct. 17, 1908. No. 95934.

The Falcon Spinning Mill. Illustrated description of a plant at Halliwell near Bolton, England, where electric driving has been installed in a new mill. Ills. 3500 w. Elec Engng, Lond—Sept. 24, 1908. No. 95632 A.

Wire Covering Machines.

Novel Wire Covering Machinery. Illustrated account of machines for covering wire with cotton and polishing and enameling employed at the works of F. Hutchins & Co., Ltd., Harlesden. Ills. 1600 w. Elec Rev, Lond—Oct. 2, 1908. No. 95776 A.

MINING AND METALLURGY

COAL AND COKE.

Austria.

Austria's Supplies of Anthracite (Die Steinkohlenvorräte Oesterreichs). W. Petrascheck. A review of the various districts. Map. Serial. 1st part. 3500 w. Oest Zeitschr f Berg- u Hüttenwesen—Sept. 5, 1908. No. 96144 D.

Coking.

The Coke Yield of Anthracite (Ueber die Ermittlung der Koksausbeute von Steinkohlen). F. W. Hinrichsen and S. Taczat. Results of researches at the Imperial Testing Institute. 3300 w. Glückauf—Sept. 12, 1908. No. 96149 D.

Electric Power.

New Plant at the Penrikyber Navigation Colliery. Illustrated description of a new and extensive plant near Cardiff. The underground workings are being completely electrified. Ills. 4000 w. Ir & Coal Trds Rev—Sept. 24, 1908. No. 95634 A.

England.

The Eastern Extension of the Nottinghamshire and Yorkshire Coalfields. Walcot Gibson. Discussion of the geology of a concealed and virgin coal field where borings and sinkings have been made. Ills. 1200 w. Col Guard—Sept. 25, 1908. No. 95865 A.

Explosions.

Warrior Run Mine Accident. Describes conditions existing in this coal mine and gives verdict of coroner's jury. 1000 w. Mines & Min—Oct., 1908. No. 95629 C.

Illinois.

Majestic Coal & Coke Co.'s Mine at Clinch, Ill. R. S. Moss. Illustrated description of methods of mining and plant. 1400 w. Min Wld—Oct. 3, 1908. No. 95657.

Mine Dust.

The Coal Dust Experiments at Altofts. Illustrated description of additional experiments tending to confirm the theory that by the use of stone dust the effects of coal dust explosions may be confined to a comparatively limited area. 1300 w. Ir & Coal Trds Rev—Oct. 2, 1908. No. 95861 A.

The Problem of Treating Dust in Coal Mines. Frank Haas. Read before the W. Va. Min. Assn. The writer's views differ from many. Also editorial. 5000 w. Eng & Min Jour—Oct. 24, 1908. No. 96032.

Spraying Coal Mines. D. Harrington. Account of pipe line construction for sprinkling system for Sunnyside No. 2 Mine, Carbon Co., Utah, with statement of cost. 3200 w. Mines & Min—Oct., 1908. No. 95625 C.

Mine Fires.

Sulphur Dioxide as an Agent in Fighting Mine Fires. Walter O. Snelling. Considers favorably its effectiveness and safety. 1000 w. Bul Am Inst of Min Engrs—Sept., 1908. No. 95467 C.

Mine Floods.

Report on the Eruption of Water at Brereton Collieries. Information from the report of inspector, Hugh Johnstone, on the causes and circumstances attending the accident on Feb. 15, 1908. Ills. 3000 w. Col Guard—Sept. 18, 1908. No. 95421 A.

Mining.

Recent Developments and Future Problems in Colliery Working and Management. Presidential Address, Richard Landless, Lancashire Branch, National Association of Collier Managers. G. H. Winstanley. 12500 w. Ir & Coal Trds Rev—Sept. 25, 1908. No. 95636 A.

South Staffordshire Method of Mining Coal. Lucius W. Mayer. Description of typical operations in working a thick coal seam in this district. Ills. 3000 w. Eng & Min Jour—Oct. 3, 1908. No. 95793.

Mining Methods at Seaton-Delaval Colliery. Lucius W. Mayer. A thick coal seam with strong cover is mined by the longwall system. Ills. 3000 w. Eng & Min Jour—Oct. 17, 1908. No. 95954.

Operating a Nova Scotia Coal Mine. H. E. Coll. Illustrated description of mines and methods. 2500 w. Eng & Min Jour—Sept. 26, 1908. No. 95447.

We supply copies of these articles. See page 579.

Rescue Appliances.

The Anaconda Protective Hood. Robert N. Bell. Illustrated account of a home-made helmet for fighting underground fires and poisonous gases. Ills. 900 w. Eng & Min Jour—Oct. 10, 1908. No. 95760.

A Rescue Training School and Experimental Gallery for Miners. Description of the new Rescue Training School at Howe Bridge, near Atherton, Lancaster, with illustrations of appliances. 1000 w. Sci Am—Oct. 17, 1908. No. 95894.

Rescue Organization in the Ostrau-Karwin District and the Appliances at the Witkowitz Anthracite Mines at Mähr.-Ostrau (Ueber die Ausgestaltung des Rettungswesen im Ostrau-Karwiner Reviere im allgemeinen und insbesondere über die diesbezüglichen Einrichtungen bei den Witkowitzer Steinkohlengruben in Mähr.-Ostrau). August Fillunger. Ills. Serial. 1st part. 2800 w. Oest Zeitschr f Berg- u Hüttenwesen—Sept. 19, 1908. No. 96145 D.

Ventilation.

Hygrometric Observations in Coal Mines. A. H. Stokes. Description of experiments showing the value of hygrometric observations in connection with ventilation records. 3000 w. Ir & Coal Trds Rev—Oct. 2, 1908. No. 95860 A.

Washing.

Coal Washing at the State Mine Wilhelmina (Kolenzeverij en -wasscherij der Staatsmijn Wilhelmina). L. Davidson. Illustrated description of the plant and methods at this mine in Holland. 3800 w. De Ingenieur—Sept. 19, 1908. No. 96245 D.

COPPER.

Assaying.

Laboratory Routine in Modern Copper Smelters. H. T. Waller. Description of laboratory methods useful in connection with copper blast furnace smelting. 6000 w. Inst of Min & Met, Bul. 49—Oct. 8, 1908. No. 96090 N.

Atacamite Ores.

The Commercial Extraction of Copper from Atacamite Ore. A. J. Evans. Describes deposits in Chile, and gives a résumé of methods tried for treatment. 1500 w. Min Jour—Oct. 10, 1908. No. 95990 A.

British Columbia.

Handling Three Thousand Tons of Ore per Day at the Granby Mines and Smelter, Phoenix and Grand Forks, B. C. A. B. W. Hodges. Illustrated description of the machinery and methods. 2000 w. Jour Can Min Inst—1908. No. 96247 N.

Chili.

See Atacamite Ores, under Copper.

Converters.

Operation of an Anaconda Copper Converter. C. Offerhaus. Explains reactions of the process, details of lining, charging, blowing, pouring and changing the vessels, etc. Ills. 5500 w. Eng & Min Jour—Oct. 17, 1908. No. 95949.

Electro-Metallurgy.

Five-Ton Electrolytic Copper Refining Plant. Chas. C. Christensen. Discussion of consumption of electricity in depositing copper and methods. 1000 w. Min Wld—Oct. 3, 1908. No. 95655.

Idaho.

The Ore Deposits at Mineral, Idaho. H. W. Turner. Discusses nature and occurrence of silver and copper ore deposits and geological functions. Ills. 4000 w. Ec Geol—Aug.-Sept., 1908. No. 95707 D.

Lake Superior.

Lode Copper Mining on Keweenaw Point, Mich. Charles J. Stone. Describes the deposits and their development. 1200 w. Min Wld—Oct. 17, 1908. No. 95928.

Mexico.

Nacozari Mining District, Sonora, Mexico. B. E. Russell. Description of a region which once yielded gold, silver, and lead, but now promises to become a most important copper camp. Ills. 4000 w. Eng & Min Jour—Oct. 3, 1908. No. 95788.

The Moctezuma Copper Deposits in Mexico. Charles A. Dinsmore. History and geology of the Pilares mine, at Nacozari, Sonora, Mexico. Cost and methods of mining. Ills. 3000 w. Min Wld—Sept. 26, 1908. No. 95449.

Smelters.

Smelting Works at Rio Blanco, Peru. Description of a first-class smelting plant recently completed by the Peruvian Mining, Smelting & Refining Co. Ills. 1000 w. Min & Sci Pr—Oct. 3, 1908. No. 95824.

Smelting.

See Assaying, and British Columbia, under Copper.

United States.

Notes on Copper Mining in the American Colonies. Edgar T. Wherry. Historical account of the opening of early copper mines. 2400 w. Jour Fr Inst—Oct., 1908. No. 95695 D.

Utah.

The Boston Consolidated Mine. An illustrated account of an interesting low-grade copper property. 4500 w. Min Jour—Oct. 3, 1908. No. 95902 A.

GOLD AND SILVER.

Assaying.

Methods of Making Crucible Assay Calculations. Robert B. Brinsmade. A summary of crucible assaying of gold-silver ores devised for the use of students. 2500 w. Min Wld—Oct. 3, 1908. No. 95653.

Australia.

The Gold Fields of West Australia. Arthur Selwyn-Brown. An illustrated article reviewing the development, geological features and production. 3000 w. Engineering Magazine—Nov., 1908. No. 96203 B.

Deep Lead Mining in Australia. D. H.

Browne. An account of the gold mining industry and the working of the mines. Ills. 4500 w. Min & Sci Pr—Oct. 24, 1908. No. 96232.

See also same title, under LEAD AND ZINC.

Bromo-Cyaniding.

See Diehl Process, under GOLD AND SILVER.

California.

Unexplored Part of Oregon-California Divide. Dennis H. Stovall. Information concerning a district rich in gold and copper and mine timber. Ills. 1200 w. Min Wld—Oct. 24, 1908. No. 96044.

Cobalt.

The Geology of Cobalt. Abstract of a report of the Bureau of Mines of Ontario prepared by W. G. Miller, which discusses the cobalt-nickel arsenides and silver deposits of Temiskaming. 1800 w. Eng & Min Jour—Oct. 10, 1908. No. 95761.

Cobalt Profits Which Make Time Precious. Alex. Gray. A brief review of mining properties and their output. 3000 w. Min Jour—Oct. 17, 1908. No. 96051 A.

See also Ore Deposits, under MISCELLANY.

Colombia.

Mining in Narino; Republic of Colombia. Henry Edwards. A report of mining properties, particularly of gold deposits, though copper, silver, tin, platinum, and coal have been discovered. 2000 w. Min Jour—Oct. 17, 1908. No. 96052 A.

Quartz Mines in Colombia, South America. F. F. Sharpless. Illustrated description of quartz mining and the principal mines. Opportunities for vein mining as well as for placers. 1500 w. Min & Sci Pr—Sept. 26, 1908. No. 95571.

The Future Gold Output of Colombia. Henry G. Granger. Remarks on the present conditions in Colombia, its resources, especially the gold ores. 4000 w. Bul Am Inst of Min Engrs—Sept., 1908. No. 95465 C.

See also Dredging, under GOLD AND SILVER.

Cyaniding.

Cyaniding Gold Ores. Clyde H. Jay. Gives information that will enable the inexperienced chemist to make all tests. 3000 w. Aust Min Stand—Sept. 9 and 16, 1908. Serial. 2 parts. No. 96225 each B.

Notes on Cyanide Treatment of Gold Ores. G. E. Bray. Gives details of the scope and cost of the cyanide treatment. 5000 w. Queens Gov Min Jour—Sept. 15, 1908. No. 96224 B.

Agitation by Compressed Air. F. C. Brown. Illustrated description of use of agitation in ta'l tanks as practised in New Zealand. 2200 w. Min & Sci Pr—Sept. 26, 1908. No. 95572.

Silver Cyaniding in Mexico. J. B. Empson. Discusses the application of the cyanide process to low grade ores. 1600 w. Eng & Min Jour—Oct. 3, 1908. No. 95791.

Cyanidation of Silver Ores, Pochuca, Mexico. Claude T. Rice. Description of large mills where the ore is completely slimed and where air agitation is used the ore is roughly concentrated. Ills. 5000 w. Eng & Min Jour—Oct. 3, 1908. No. 95786.

The Cyaniding of Silver Ores in Mexico (Le Traitement des Minerais d'Argent par la Cyanuration, au Mexique). Albert Bordeaux. A general review of the whole process. Ills. 5600 w. Génie Civil—Sept. 12, 1908. No. 96125 D.

Jesus Maria and Flores Mills, Guanajuato. Claude T. Rice. Illustrated description of two mills of this district where by cyaniding the silicious gold-silver ores an average extraction of 86% silver and 88% gold has been obtained. 3500 w. Eng & Min Jour—Sept. 26, 1908. No. 95445.

Recent Cyanide Practice in Korea. A. E. Drucker. Describes the candlestick plant of the Oriental Consolidated Mining Co. of northwestern Korea. Ills. 3000 w. Min & Sci Pr—Oct. 3, 1908. No. 95823.

The Estimation of Sulpho and Ferrocyanides, etc., in Cyanide Solutions Containing Copper. Leonard M. Green. Describes reactions, and gives a series of tests dependent on many of them by which the estimations may be made. 3000 w. Inst of Min & Met, Bul. 49—Oct. 8, 1908. No. 96092 N.

See also Malay States, under GOLD AND SILVER.

Diehl Process.

Bromo-Cyaniding of Gold Ores. E. W. Nardin. Description of the Diehl process as carried on at the Hannan's Star plant. 2500 w. Min & Sci Pr—Oct. 24, 1908. No. 96231.

Dredging.

Gold-Dredging on the Choco River, Republic of Colombia, South America. Henry G. Granger. A descriptive record of an important gold-dredging field. Maps. 10500 w. Bul Am Inst of Min Engrs—Sept., 1908. No. 95476 D.

Gold Refining.

Electrolytic Gold Refining. Emil Wohlwill. Gives objections to calculations made by Dr. J. W. Richards. 3000 w. Elec-Chem & Met Ind—Nov., 1908. No. 96095 C.

Hydraulic Mining.

La Grange Hydraulic Mine. Donald F. Campbell. Illustrated detailed account of the profitable mining of low-grade auriferous gravel, in northern California. 1800 w. Min & Sci Pr—Oct. 10, 1908. No 95916.

Idaho.

See same title, under COPPER.

Malay States.

Mining and Milling Practice at the

Raub Mine, Pahang. H. F. Lofts. Describes a gold mine, possibly the oldest in the Malay States, and the cyanide practice. 1800 w. Min Jour—Oct. 10, 1908. No. 95989 A.

Mexico.

Present Condition of Mining in Mexico. Franklin W. Smith. Discusses financial and commercial conditions and attempts at a lower cost of production. 1700 w. Eng & Min Jour—Oct. 3, 1908. No. 95787.

Mining in Mexico, Past and Present. E. A. H. Tays. Describes early methods of mining and reduction and discusses the Mexican miner. Ills. 2400 w. Eng & Min Jour—Oct. 3, 1908. No. 95790.

The Silver Mines of Mexico. Albert F. J. Bordeaux. A survey of the present condition of these mines. 4000 w. Bul Am Inst of Min Engrs—Sept., 1908. No. 95464 C.

Hacienda Buburon, an Old Mexican Silver Mill. Mark R. Lamb. Description of primitive crushing and grinding appliances in the Guanajuato District. Ills. 1200 w. Eng & Min Jour—Oct. 3, 1908. No. 95789.

Guanajuato, the Great Silver Camp of Mexico. Claude T. Rice. Describes the mines of the district, its history, geology and present conditions and operation. Ills. 2500 w. Eng & Min Jour—Oct. 3, 1908. No. 95792.

The Working Mines of Guanajuato. Claude T. Rice. An illustrated account of the principal mines of the district. 1500 w. Eng & Min Jour—Oct. 24, 1908. No. 96031.

Rejuvenation of Guanajuato Camp, Mexico. Thos. C. Welch. Description of ancient and modern methods used in this famous district with particular reference to recent activity. 4000 w. Min Wld—Oct. 3, 1908. No. 95654.

See also Cyaniding, under GOLD AND SILVER; and Mexico, under COPPER.

Nevada.

Decline and Revival of Comstock Mining. Whitman Symmes. A critical discussion of the methods of exploiting this property. Ills. 3500 w. Min & Sci Pr—Oct. 10, 1908. Serial. 1st part. No. 95918.

Present Conditions in Goldfield District, Nevada. G. E. Walcott. Describes leasing system and company work, operation of the various properties and output of the district. Ills. 1300 w. Eng & Min Jour—Oct. 10, 1908. No. 95766.

Placers.

Saving Minerals from Beach Sands. Account of a novel device for recovering minerals from the beach sands of Richmond River, New South Wales. Abstracted from the *Town and Country Journal.* Ills. 900 w. Min Wld—Oct. 10, 1908. No. 95769.

Rand.

The Chinese on the Rand. T. Lane Carter. A brief account of labor-conditions in the Transvaal, describing the experience with the Chinese and the work they have accomplished. 7500 w. Bul Am Inst of Min Engrs—Sept., 1908. No. 95466 C.

See also Gold Milling, and Sampling, under ORE DRESSING AND CONCENTRATION.

IRON AND STEEL.

Blast-Furnace Charging.

Recent Blast-Furnace Charging Inclines (Neuere Hochofen-Schrägaufzüge). Ignaz Sturm. Illustrated description of a new type of automatic charging installation built by J. Pohlig, Cologne. 1600 w. Oest Zeitschr f Berg- u Hüttenwesen—Sept. 26, 1908. No. 96146 D.

Blast-Furnace Fuels.

The Use of Charcoal in Blast Furnace Practice. Describes kilns for charcoal and by-products employed in Sweden, and discusses the charcoal iron industry. Ills. 3500 w. Ir & Coal Trds Rev—Oct. 2, 1908. No. 95862 A.

Blast-Furnace Gas.

See England, under IRON AND STEEL.

Blast-Furnace Practice.

The Relation of Slow Driving to Fuel Economy in Iron Blast-Furnace Practice. John B. Miles. Gives data of blast-furnace records with deductions. 1500 w. Bul Am Inst of Min Engrs—Sept., 1908. No. 95470 C.

An Unusual Blast-Furnace Product; and Nickel in Some Virginia Iron-Ores. Frank Firmstone. Describes the material and the occurrence. 600 w. Bul Am Inst of Min Engrs—Sept., 1908. No. 95472 C.

Fuel Consumption in Blast Furnaces (Ueber den Brennstoffverbrauch beim Hochofenbetriebe). Carl Brisker. Works out the heat balance and shows the possibility of greater economy. 3600 w. Stahl u Eisen—Sept. 9, 1908. No. 96139 D.

See also Iron Ores, under ORE DRESSING AND CONCENTRATION.

Blast Furnaces.

A Description of Messrs. Bell Brothers' Blast-Furnaces from 1844-1908. Greville Jones. A paper read before the Iron & Steel Institute. Ills. 4000 w. Ir & Coal Trds Rev—Oct. 2, 1908. No. 95847 A.

California.

The Occurrence and Genesis of the Magnetite Ores of Shasta Co., Cal. Basil Prescott. Discusses the formation of these minerals. Ills. 4000 w. Ec Geol—Aug.-Sept., 1908. No. 95705 D.

China.

Iron, Steel and Fuel in China. W. D. B. Dodson. An account of the first iron mine and reduction plant in China. 1500 w. Min & Sci Pr—Oct. 10, 1908. No. 95917.

Dry-Air Blast.

A Gayley Dry Blast Installation. Illustrates and describes the refrigerating plant of the dry blast equipment of the Illinois Steel Company's South Works, which contains four refrigerating machines of 300 tons capacity each. Ills. 2200 w. Ir Age—Oct. 8, 1908. No. 95878.

Electro-Metallurgy.

The Development of the Lash Process for Making Soft Steel in the Electric Furnace. A brief illustrated description of the process and the results obtained. 1800 w. Can Min Jour—Oct. 15, 1908. No. 95912.

The Production of Finished Iron Sheets and Tubes in One Operation. Sherard Cowper-Coles. A paper read before the I. and S. Institute which describes the electrolytic production in finished form of iron plates and tubes. Ills. 3500 w. Ir & Coal Trds Rev—Oct. 2, 1908. No. 95854 A.

The Stassano Electric Furnace. Abstract of a paper by M. Stassano in the *Revue de Métallurgie* describing the furnace and the results obtained at Turin where two plants are now operated. Ills. 2500 w. Ir Age—Oct. 8, 1908. No. 95877.

The Electro-Metallurgy of Iron (Sur la Métallurgie Thermo-Electrique du Fer). M. Stassano. Describes the author's furnace, the installations at Turin, and the results obtained. Ills. 9000 w. Rev de Métal—Sept., 1908. No. 96106 E + F.

Recent Advances in Electric Iron and Steel Production (Neueres über die elektrische Eisen- und Stahlerzeugung). Franz Peters. A general review of progress in Europe and America. Ills. 2500 w. Glückauf—Sept. 26, 1908. No. 96151 D.

Progress on the Electric Iron and Steel and Ferro Alloy Industries. John B. C. Kershaw. First part of a series of articles describing the condition of the electric iron and steel industry of the world. 1700 w. Id Trd Rev—Oct. 1, 1908. No. 95584.

See also Foundry Furnaces, under MECHANICAL ENGINEERING, MACHINE WORKS AND FOUNDRIES.

England.

The Iron & Steel Industries of the Cleveland District During the Last Quarter of a Century. W. Hawdon. A paper read before the Iron & Steel Institute. Ills. 3300 w. Ir & Coal Trds Rev—Oct. 2, 1908. No. 95851 A.

Power Supply and Its Effect on the Industries of the Northeast Coast. Charles H. Merz. A paper read before the Iron & Steel Institute which discusses the provision of electricity for industrial use. Ills. 5500 w. Ir & Coal Trds Rev—Oct. 2, 1908. No. 95853 A.

France.

The Iron Ore Fields of the French Lorraine. An illustrated account of the deposits and their development. 1500 w. Ir & Coal Trds Rev—Sept. 18, 1908. No. 95437 A.

Germany.

The Ilsede Hütte Iron-Mines at Peine, Germany. Lucius W. Mayer. Describes mines and methods. Ills. 1600 w. Bul Am Inst of Min Engrs—Sept., 1908. No. 95471 C.

Lake Superior.

See Iron Ore, under ORE DRESSING AND CONCENTRATION.

Metal Mixers.

The Future Development of the Metal-Mixer and the Open-Hearth Process. Arthur E. Pratt. A paper read before the British Iron & Steel Institute which outlines the possibility of extending the use of the metal-mixer and suggests a new steel-making process. 14000 w. Ir & Coal Trds Rev—Oct. 2, 1908. No. 95863 A.

Nevada.

Amarilla Iron and Phosphate Deposits. Oscar H. Hershey. Describes these deposits in Nevada. 1500 w. Min & Sci Pr—Oct. 17, 1908. No. 96022.

Open Hearth.

The Chemical Control of the Basic Open-Hearth Process. Alfred Harrison and Richard Vernon Wheeler. A paper presented to the Iron & Steel Institute which describes a scheme for the complete following of the various reactions. Ills. 3500 w. Ir & Coal Trds Rev—Oct. 2, 1908. No. 95855 A.

See also Metal Mixers, and Steel Works, under IRON AND STEEL.

Pig Iron.

Analyses of British Pig Irons Shown at the Franco-British Exhibition. 6400 w. Ir & Coal Trds Rev—Oct. 2, 1908. No. 95857 A.

Rolling Mills.

Electrical Mill Equipment. Illustrated description of new rolling and cogging mills electrically driven at Dorman, Long & Co.'s Works, Middlesborough. 2200 w. Engr, Lond—Sept. 25, 1908. No. 95670 A.

Some Results of Experience with Electrically-Driven Rolling Mills. C. Koettgen and C. A. Ablett. Read before the I. and S. Inst. Discusses the advantages of electric driving. Ills. Ir & Coal Trds Rev—Oct. 2, 1908. No. 95846 A.

Sheets.

See Electro-Metallurgy, under IRON AND STEEL.

Steel Making.

See Metal Mixers, under IRON AND STEEL.

Steel Works.

Messrs. Bolckow, Vaughan & Co.'s Cleveland Iron and Steel Works. Description of a large British plant. Ills. 3000 w. Engng—Oct. 2, 1908. No. 95710 A.

Britannia Works. Description of the basic open-hearth plant of Messrs. Dorman, Long & Co., at Middlesbrough. Ills. 2000 w. Engng—Sept. 25, 1908. No. 95641 A.

The Clarence Iron and Steel Works, Port Clarence. Describes features of a large plant on Durham side of the Tees. 1400 w. Engng—Sept. 25, 1908. No. 95642 A.

Open-Hearth Steel Works of the French Admiralty at Guerigny. Illustrated description of the plant. 1400 w. Ir & Coal Trds Rev—Sept. 25, 1908. No. 95635 A.

The New Plant of the Cargo Fleet Iron Company, Middlesbrough (Die neuen Werksanlagen der Cargo Fleet Iron Company in Middlesbrough). Emil Jagsch. Illustrated detailed description of the works of this large company. 6500 w. Stahl u Eisen—Sept. 16, 1908. No. 96141 D.

The Frederic-Albert Works at Rheinhausen (L'Usine Frederic-Albert, à Rheinhausen). Illustrated description of this large Krupp plant. Abstract translation from *Stahl und Eisen* for Oct. 9, 1907. 7500 w. Rev de Métal—Sept., 1908. No. 96107 E + F.

The Jubilee of the Jlsede Steel Works (Zum 50 jährigen Jubiläum der Jlseder Hütte). A historical sketch and illustrated description of the present plant near Peine, Germany. 5000 w. Stahl u Eisen—Sept. 16, 1908. No. 96140 D.

Sweden.

The Routivars and Vallatj Iron Ore Deposits (Die Eisenerzvorkommen des Routivara und des Vallatj). Dr. Hecker. Illustrated description of these deposits in northern Sweden. 2500 w. Glückauf—Sept. 19, 1908. No. 96150 D.

LEAD AND ZINC.

Australia.

The Silver-Lead-Zinc Mines at Broken Hill. G. W. Williams. Illustrates and describes the ores, mines and methods. 4000 w. Eng & Min Jour—Oct. 24, 1908. No. 96029.

Lead Smelting.

Erection and Equipment of the Tintic Smelter. Leroy S. Palmer. Illustrated description. Electricity for power and light. 1800 w. Min Wld—Sept. 26, 1908. No. 95448.

Removing Accretions in Crucible of Lead-Furnaces. J. N. Goddard. Information concerning the bomb designed by J. O. Bardell. 700 w. Eng & Min Jour—Oct. 17, 1908. No. 95953.

Bag House of United States Smelter in Utah. Holland E. Benedict. Illustrated description of the construction and arrangement of bag house for filtering the dust laden fumes from the smelter. 1500 w. Min Wld—Oct. 24, 1908. No. 96043.

Missouri.

Power Plant of Joplin Mills. Doss Brittain. Description of various plants in this district. 1000 w. Min Wld—Oct. 3, 1908. No. 95652.

Lead and Zinc Ores in Missouri. J. R. Finlay. Describes the general character of the ores, and the methods and costs of mining. 6500 w. Eng & Min Jour—Sept. 20, 1908. No. 95443.

Zinc Smelting.

A Rotatable Zinc Furnace. George A. Wettenzel. Illustrated description of a furnace which does away with the processes of hand charging and blowing out. 500 w. Elec-Chem & Met Ind—Nov., 1908. No. 96098 C.

MINOR MINERALS.

Cement.

Review of the Cement Industry for 1907. Robert W. Lesley. Review prepared for *The Mineral* Industry for 1907. 8000 w. Cement Age—Oct., 1908. No. 96078 C.

The Mechanical Side of the Cement Industry. A series of short articles describing all the stages through which the material must pass, and the appliances used. Ills. 16000 w. Cement Age—Oct, 1908. No. 96079 C.

Cement Materials of Western Virginia. R. S. Bassler. Describes distribution of cement materials and natural cement and the cement industry in Virginia. Ills. 6500 w. Ec Geol—Aug.-Sept., 1908. No. 95708 D.

Graphite.

The Graphite Mines of Santa Maria. J. C. Mills. Describes occurrence of graphite in Sonora, Mexico, methods of mining and treatment. 1100 w. Mines & Min—Oct., 1908. No. 95624 C.

Mercury.

Mercury Mines at Koniah, Asia Minor. Frederick F. Sharpless. Illustrated description of ancient workings idle for probably 3000 years, now being opened for operation. 500 w. Eng & Min Jour—Sept. 26, 1908. No. 95442.

Oil.

Geology of Illinois Petroleum Fields. H. Foster Bain. Describes occurrence of gas and petroleum and indicates the possibility of additional supplies. Map and Ills. 3500 w. Ec Geol—Aug.-Sept., 1908. No. 95706 D.

Phosphate.

Modern Land-Pebble Phosphate-Mining Plants in Florida. H. D. Mendenhall. Illustrates and describes the mining methods, the occurrence, and details of the plant. 6000 w. Eng News—Oct. 15, 1908. No. 95957.

See also Nevada, under Iron and Steel.

Platinum.

Dredging for Platinum in the Urals, Russia. L. Tovey. Describes the exhaustion of the richer deposits and dredging methods for the gravels too poor to be worked by hand. Ills. 3300 w. Eng & Min Jour—Oct. 10, 1908. No. 95758.

Salt.

Salt Manufacture. George E. Willcox

Describes recent developments in the mechanical methods and appliances of large salt plants. Ills. 3500 w. Jour Am Soc of Mech Engrs.—Oct., 1908. No. 96042 F.

Sand.

The Cape May Sand Company's Plant. Illustrated description of the plant and processes. 1500 w. Ir Age—Oct. 22, 1908. No. 96001.

Sapphires.

Development of Montana Sapphire Industry. Douglas B. Sterrett. Describes the geology and operation of mines. 4000 w. Min Wld—Sept. 26, 1908. No. 95451.

Talc.

Talc and Soapstone in Vermont. G. H. Perkins. Describes the occurrence, quarrying, etc. 1200 w. Eng & Min Jour—Oct. 17, 1908. No. 95950.

Tin.

The World's Tin Supply. T. Good. Discusses present and future supplies. 2000 w. Cassier's Mag—Oct., 1908. No. 95658 B.

Quantitative Separation of Tin from Manganese, Iron and Chromium by Electrolysis. W. T. Williams. Translation of a paper by M. N. Puschin in the *Journal de la Société Physico-Chemique Russe.* 4000 w. Jour Fr Inst—Oct., 1908. No. 95694 D.

MINING.

Accidents.

Mining Accidents in 1907. Extract from Part II of the General Report and Statistics relating to Mines and Quarries in 1907, dealing with accidents in the United Kingdom. Also editorial. 3500 w. Col Guard—Sept. 25, 1908. No. 95864 A.

Caving System.

Surface Effects of the Caving System. Lucien Eaton. Discussion of this system of mining with results of caving in a mine on the Gogebic range. 1300 w. Min & Sci Pr—Sept. 26, 1908. No. 95573.

Drills.

Air-Drills and Their Efficiency. Sam'l K. Patterson. General discussion. 1800 w. Min & Sci Pr—Oct. 3, 1908. No. 95825.

Economics.

The Economy of Winning Ore. W. H. Doherty. Discusses how to increase the efficiency in the getting and transporting of ore from face to mill. Ills. 3500 w. Queens Gov Min Jour—Aug. 15, 1908. No. 95434 B.

Electric Hoisting.

Electric Hoisting Plant at the Hausham Mine of the Upper Bavaria Coal Mining Company at Miesbach (Die elektrisch betriebene Hauptschachtförderanlage auf Grube Hausham der Oberbayerischen Aktiengesellschaft für Kohlenbergbau in Miesbach). Herr Janzen. Illustrated detailed description. 2000 w. Elek Kraft u Bahnen—Sept. 14, 1908. No. 96186 D.

Electric Power.

The Use of Electricity in Mines. Geo. R. Wood. Brief discussion of the problems involved with typical examples. Ills. 1650 w. Ind Wld—Oct. 12, 1908. No. 95889.

Electric Power for Quarrying Marble. C. T. Maynard. An illustrated description of the electric system of the Vermont Marble Co. 2500 w. Power—Oct. 13, 1908. No. 95839.

See also Haulage, under MINING.

Engineering Ethics.

Professional Ethics for the Mining Engineer. John Hays Hammond. An address before the American Institute of Mining Engineers. 3400 w. Eng & Min Jour—Oct. 10, 1908. No. 95763.

Haulage.

Underground Transport of Material. J. Bowie Wilson. Suggestions for mine haulage. 2200 w. Aust Min Stand—Sept. 16, 1908. No. 96227 B.

Electricity in Mines. Illustrates and describes a large main-and-tail haulage gear at Gateshead-on-Tyne, and other electrical plant. 1000 w. Col Guard—Oct. 16, 1908. No. 96053 A.

Rope Haulage at the Carl Mine near Diedenhofen (Die Seilförderung im Carlstolln bei Diedenhofen). Herr Schartzkopff. Describes the plant and haulage arrangements for this iron mine and gives the operating cost. Ills. 2500 w. Stahl u Eisen—Sept. 23, 1908. No. 96143 D.

Head Frames.

Graphical Head-Frame Design (Calcul Graphique d'un Châssis à Molettes). H. Keckstein. Translated from *Kohle und Erz.* Works out a complete practical example. Ills. 3500 w. All Indus—Sept., 1908. No. 96119 D.

Keps.

The Arrangement of Keps for Modern Collieries. J. S. Barnes. Drawings and descriptons of old and new systems. 2500 w. Ir & Coal Trds Rev—Oct. 16, 1908. No. 96064 A.

Mine Telephones.

The Mine Telephone and Its Advantages. Discusses the construction and use of mine telephones. Ills. 1500 w. Eng & Min Jour—Oct. 10, 1908. No. 95765.

Ore Chutes.

The Finger Chute. T. A. Rickard. Illustrated description of a device for expediting the descent of ore into cars. 1200 w. Min & Sci Pr—Oct. 17, 1908. No. 96023.

Prospecting.

River Prospecting for Gold. Marshall Macfarlane. Describes an effective plant and methods of work in French Guinea. Ills. 1600 w. Min Jour—Sept. 19, 1908. No. 95424 A.

Quarrying.

See Electric Power, under MINING.

Shaft Accidents.

The Alpha Shaft Disaster. W. S. Larsh. Describes methods for securing shaft and rescuing entombed miners with plans and diagrams. 2000 w. Mines & Min—Oct., 1908. No. 95626 C.

Surveying.

Surveying at Lytle Colliery. John H. Haertter. Description of an accurate survey of a mine near Minersville, Pa. Ills. 3000 w. Mines & Min—Oct., 1908. No. 95627 C.

Timbering.

Lining-Up Timbers in Inclined Shafts. Benjamin H. Case. Illustrates and describes methods used at Ducktown, Tenn. 1600 w. Eng & Min Jour—Sept. 26, 1908. No. 95444.

Timber Preservation.

Prolonging Life of Mine Timber. John M. Nelson, Jr. Describes experiments with different preservatives and by open- and closed-tank processes, with summary of results. Ills. 5500 w. Mines & Min—Oct., 1908. No. 95631 C.

Tunnelling.

The Karns Tunneling Machine. R. L. Herrick. Illustrated description of the test of a machine designed to drive a tunnel by cutting the rock and without the use of explosives. 1700 w. Mines & Min—Oct., 1908. No. 95628 C.

Advancing the Hot Time Lateral of the Newhouse Tunnel. Henry M. Adkinson. Describes methods used in the rapid driving of a cross-cut 5 x 7½ ft. in size. Also editorial. 4500 w. Eng & Min Jour—Oct. 17, 1908. No. 95951.

Ventilation.

The Ventilation of Mines. Johan Sarvaas. The present number discusses the causes of the vitiation of the air in mines. 2200 w. Aust Min Stand—Sept. 9, 1908. Serial. 1st part. No. 96226 B.

ORE DRESSING AND CONCENTRATION.

Classifiers.

See Jigs, under Ore Dressing and Concentration.

Concentration.

Slipping and Falling of Granular Materials in Water (Glissement et Eboulement des Matériaux en Grains, leur Entrainement par l'Eau). A. Barbonneau. A theoretical mathematical discussion, deducing formulæ and giving constants obtained by experiment. Ills. Serial. 1st part. 4800 w. Génie Civil—Sept. 19, 1908. No. 96126 D.

Filtration.

Continuous Vacuum-Filter Machine. Bertram Hunt. Illustrated description of a continuous filter for slime cyaniding designed by the author. 1300 w. Min & Sci Pr—Sept. 26, 1908. No. 95574.

An Improved Press for Filtering Cyanide Slimes. Ernest J. Sweetland. Description of a new press designed to handle slimes from the cyanide process efficiently and economically. Ills. 1000 w. Eng & Min Jour—Oct. 10, 1908. No. 95768.

Gold Milling.

Rusty Gold, and How It Is Saved. Dennis H. Stovall. Method of saving dark red or "rusty" gold in placer mining. 1000 w. Min Wld—Oct. 3, 1908. No. 95656.

The New Esperanza Mill at El Oro, Mexico. Claude T. Rice. Illustrated description of the remodeled mill and plant to be erected for cyaniding tailings. 1800 w. Eng & Min Jour—Oct. 17, 1908. No. 95952.

An Electrically Driven 300-Stamp Mill on the Rand. Ralph Stokes. Description of a heavy stamp mill with a monthly capacity of 75,000 tons. 3200 w. Min Wld—Oct. 3, 1908. No. 95651.

Some of the Large Stamp Mills of the World. Chas. C. Christensen. Present part describes the Alaska Treadwell and Alaska Mexican Mills. Ills. Serial. 1st part. 1500 w. Eng & Min Jour—Oct. 10, 1908. No. 95767.

Iron Ores.

Concentration of the Mesabi Ore. H. H. Stoek. Describes an experimental concentrating plant of the Oliver Iron Mining Co. designed to treat poorer ores. Ills. 1000 w. Mines & Min—Oct., 1908. No. 95623 C.

The Mechanical Cleaning of Iron Ores. T. C. Hutchinson. A paper presented to the Iron & Steel Institute which states the great advantages and economy of removing impurities mechanically before the ore is charged into the blast furnace. 5000 w. Ir & Coal Trds Rev—Oct. 2, 1908. No. 95845 A.

Jigging.

The Separation of Metallic Ores by Jigging. Arthur Taylor. Describes a modification in the form of apparatus used and the substitution of a vibrator for the plunger, explaining the advantages. Ills. 4000 w. Inst of Min & Met, Bul. 49—Oct. 8, 1908. No. 96089 N.

Investigation on Jigging. Royal Preston Jarvis. Reviews previous investigations, giving a résumé of results; describes tests made with the Jarvis laboratory-jigs, with résumé and conclusions. Ills. 22800 w. Bul Am Inst of Min Engrs—Sept., 1908. No. 95469 D.

Jigs.

The Richards Pulsator Jig and Pulsator Classifier. R. L. Herrick. Describes two machines for hydraulic classification of ores. Ills. 2500 w. Mines & Min—Oct., 1908. No. 95630 C.

Mixing Machinery.

Mixing Machinery. Oskar Nagel. Illustrates and describes types. 1500 w. Elec-Chem & Met Ind—Oct., 1908. No. 95458 C.

Roasting.

Roasting Furnaces. Oskar Nagel. Illustrates and describes types. 1500 w. Elec-Chem & Met Ind—Nov., 1908. No. 96097 C.

Sampling.

Rand Sampling Practice. J. S. Olver. Read before the Inst. of Mine Surveyors (Transvaal). Describes conditions and methods. 1700 w. Min Jour—Sept. 19, 1908. Serial. 1st part. No. 95425 A.

Stamp Mills.

Reinforced Concrete Foundations for Stamp Batteries. S. J. Truscott, and John P. Fuller. Illustrated description of work in Sumatra, where use was made of material at hand. 2500 w. Inst of Min & Met, Bul 49—Oct. 8, 1908. No. 96091 N.

Wilfley Table.

The Wilfley Table. Robert H. Richards. Gives results of tests made of a Wilfley table with a mixture of quartz and chalcopyrite. 2000 w. Bul Am Inst of Min Engrs—Sept., 1908. No. 95468 C.

MISCELLANY.

Great Britain.

Twenty-five Years of Mining. Edward Ashmead. A retrospective review, 1880-1904, of mining companies registered in Great Britain, with notes and comments. 4500 w. Min Jour—Sept. 19, 1908. Serial. 1st part. No. 95426 A.

Ore Deposits.

The Relation of Magmatic Waters to Volcanic Action. Hiram W. Hixon. Discusses the great influence of magmatic waters. Ills. 4000 w. Jour Fr Inst—Oct., 1908. No. 95725 D.

Origin of Cobalt-Silver Ores of Northern Ontario. R. E. Hore. Gives results of a study of these ores in field and laboratory. 3300 w. Jour Can Min Inst—1908. No. 96246 N.

A New Theory of the Genesis of Brown Hematite-Ores; and a New Source of Sulphur Supply. H. M. Chance. Aims to show that the accepted hypothesis explaining the genesis of these ores is untenable, presenting reasons to show that the ores are derived from oxidation of pyrite and pyritic material *in situ*. 7000 w. Bul Am Inst of Min Engrs—Sept., 1908. No. 95474 C.

Petrography.

The Distribution of the Elements in Igneous Rocks. Henry S. Washington. A study of the composition, petrographic provinces of the United States and elsewhere, and facts as yet imperfectly understood. 12000 w. Bul Am Inst of Min Engrs—Sept., 1908. No. 95475 D.

Philippines.

Metallic Mineral Resources of the Philippines. Maurice Goodman. Abstract from *The Mineral Resources of the Philippine Islands*, issued by the Bureau of Science. Manila, 1908. 2000 w. Eng & Min Jour—Oct. 10, 1908. No. 95759.

Portugal.

The Structure or Tectonic Geology of the Arrabida Chain of Mountains, Portugal. Paul Choffat. Descriptive. 2000 w. Min Jour—Sept. 19, 1908. No. 95-422 A.

Refractory Materials.

Use of Basic Refractory Brick in Metallurgy. Francis T. Havard. Considers the sources and cost of magnesite and chromite and the advantages and disadvantages of employing these minerals for furnace linings. 2500 w. Eng & Min Jour—Oct. 24, 1908. No. 96030.

Siberia.

Siberian Mining: Hints to Foreigners. Notes on knowledge essential to foreigners visiting the country and the conditions of mining in Eastern Siberia, laws, taxes, etc. Siberia produces annually some 6 million pounds sterling of gold. 6500 w. Min Jour—Sept. 19, 1908. No. 95-423 A.

Strikes.

Strikes and Lockouts in the Mining and Quarrying Industries in 1907. Extract of a report by A. Wilson Fox of the Labor Department of the British Board of Trade. Also editorial. 2500 w. Col Guard—Oct. 2, 1908. No. 95867 A.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

Publicity for Accidents on the Harriman Lines. Description of method employed to investigate accidents and the issuing of bulletins to the press and public. 3000 w. R R Age Gaz—Oct. 2, 1908. No. 95561.

Dispatching.

Train Despatching by Telephone. G. W. Dailey. Detailed description of the successful use of the telephone in train despatching on the Chicago and Northwestern. 3400 w. R R Age Gaz—Oct. 9, 1908. No. 95755.

Dispatching Trains by Telephone. W. W. Ryder. A paper read before the Association of Railway Telephone Superintendents. Discusses methods of despatching by telephone as used on the C. B. & Q. R. R. 2000 w. Sig Engr—July, 1908. No. 95814.

Signalling.

The Gardiner System of Cab Signalling. Diagrams and description. 2200 w. Elect'n, Lond—Oct. 16, 1908. No. 96047 A.

Signals.

A Talk on Torque. M. Wuerpel, Jr. Theoretical consideration of the forces involved in moving the spectacle and semaphore of a railway signal. Ills. 5000 w. Sig Engr—Oct., 1908. No. 95819.

The "Universal Auto-Combiner." Illustrated detailed description of a power-interlocking apparatus in experimental use in France. 2500 w. R R Age Gaz—Oct. 23, 1908. No. 96027.

All-Electric Interlocking at New Haven. Description of the system recently completed. Ills. 3000 w. R R Age Gaz—Oct. 9, 1908. No. 95756.

The Electro-Pneumatic Signal and Interlocking System at the New Union Station, Washington, D. C. Fred. W. Bender. Detailed description, with plans and diagrams. Ills. 3500 w. Sig Engr—Oct., 1908. No. 95822.

A Remarkable Block Signal System. A. D. Cloud. Describes the normal danger automatic block signal system recently installed on the Metropolitan West Side Elevated Railroad of Chicago. Ills. 1800 w. Sig Engr—Oct., 1908. No. 95821.

Electro-Pneumatic Interlocking on the D. L. & W. R. R. at Hoboken. H. A. Applegate. Detailed description of a large terminal plant with diagrams and plate. Ills. 2000 w. Sig Engr—Sept., 1908. No. 95818.

Electro-Pneumatic Interlocking Plants at the St. George Terminal of the Staten Island Rapid Transit Railroad. Fred. W. Bender. Illustrated description. 1300 w. Sig Engr—Sept., 1908. No. 95816.

Electro-Pneumatic Interlocking Plant on the Chicago and Western Indiana R. R. at 47th St., Chicago. Stanley C. Bryant. Account of the new signalling installation on recently elevated tracks in Chicago. Sig Engr—July, 1908. No. 95813.

Upper Quadrant Signals on the Great Northern Railway Line. Account of automatic and interlocking block signal systems between St. Paul and Minneapolis. Ills. and charts. 1300 w. Sig Engr—June, 1908. No. 95812.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Straight Air Brake Equipment. J. B. Parham. Considers their application to high-speed electric cars, illustrating and describing the motor air compressor. 3500 w. Can Soc of Civ Engrs—Oct. 22, 1908. No. 96073 N.

Cable Railways.

The Heidelberg Mountain Railway (Die Bergbahn Heidelberg). A. Schmidt. Illustrated description of a cable railway from the city to the castle on the mountain, the equipment driving engines, etc. 5500 w. Zeitschr d Ver Deutscher Ing—Sept. 19, 1908. No. 96194 D.

Car Lighting.

A New and Improved Method of Lighting Railway Carriages by Liquefied Oil Gas ("Blaugas"). F. D. Marshall. An illustrated description of the application of "Blaugas" to car lighting with consideration of its cost and illuminating power. 1800 w. Gas Wld—Oct. 3, 1908. No. 95868 A.

Cars.

Hopper Ballast Car for Burma Railways. Illustrated description. 500 w. R R Age Gaz—Oct. 16, 1908. No. 95963.

50-Ton Gondola for the Burlington. Illustrated description. 300 w. R R Age Gaz—Oct. 23, 1908. No. 96026.

Steel Car Construction and Maintenance. G. E. Carson. Describes construction, maintenance, repairs, painting, etc., with comparative cost of repairs of wood and steel cars. 4000 w. Am Engr & R R Jour—Oct., 1908. No. 95541 C.

Electrification.

The Electrification of the Victorian Railways. Abstract of a Report by C. H. Merz to the Victorian Railway Commissioners on the proposed project. Map and plans. 4000 w. Elec Engng, Lond—Sept. 24, 1908. No. 95638 A.

Electrification of the Melbourne Suburban Railways. Account of proposed change from steam to electricity with plans and diagrams showing proposed station and cars. Discusses engineers' report on a system which has 240 miles of track and plans involving an outlay of over $10,000,000. 4000 w. Elec Ry Jour—Oct. 3, 1908. No. 95593.

Proposed Electrification of the Illinois Central. Abstract of the principal portions of the report on Local Transportation at Chicago, which relate to the Illinois Central terminal. 3000 w. R R Age Gaz—Oct. 23, 1908. No. 96025.

Locomotive Boilers.

Washing and Filling Locomotive Boilers with Hot Water. Discusses some of the systems. 1700 w. R R Age Gaz—Oct. 16, 1908. No. 95962.

Care of Boilers at Terminals. J. F. Whiteford. Discusses increase of efficiency through proper handling at the roundhouse. 4000 w. Am Engr & R R Jour—Oct., 1908. No. 95535 C.

Locomotive Operation.

The Dynamics of Locomotive Machinery. Mathematical discussion of behavior of certain parts of locomotive machinery. 2500 w. Am Engr & R R Jour—Oct., 1908. No. 95537 C.

Locomotive Repairs.

Welding Locomotive Frames. A. W. McCaslin. Describes, with diagrams, method used on Pittsburgh & Lake Erie R. R. to repair frames without removing from engine. 800 w. Am Engr & R R Jour—Oct., 1908. No. 95536 C.

See also Welding, under MECHANICAL ENGINEERING, MACHINE WORKS AND FOUNDRIES.

Locomotives.

The Modern Locomotives of the Bengal-Nagpur Railway. Describes different types of locomotives used on this railway. Illus. 3300 w. Mech Eng—Oct. 2, 1908. No. 95704.

Modern British Practice in Tank Locomotives. Illustrates and describes representative types. 2500 w. Mech Wld—Oct. 9, 1908. Serial. 1st part. No. 95977 A.

Mogul Engines for the Iowa Central. Illustrated description of six new Baldwin locomotives designed for freight service. 1500 w. R R Age Gaz—Oct. 2, 1908. No. 95570.

New "Mogul" Type Superheated Locomotives. Italian State Railways. Drawings and description. 700 w. Mech Engr—Sept. 18, 1908. No. 95427 A.

Four-Cylinder Compound Locomotives, Danish State Railways. Illustrated description of an engine constructed on the Vauclain system, and of the "Atlantic" type. 1200 w. Engr, Lond—Sept. 18, 1908. No. 95412 A.

Pacific Locomotives for the Chicago & Alton. Illustrated description of five new locomotives differing from previous standard type in the use of Walschaert's valve gear and wagon top boilers with narrow fireboxes. 2500 w. R R Age Gaz—Oct. 2, 1908. No. 95564.

Pacific Type Locomotive with Narrow Fire Box. Illustrated description of Baldwin locomotives of this type with Walschaert valve gear and wagon top boilers with narrow fire boxes. 2500 w. Am Engr & R R Jour—Oct., 1908. No. 95540 C.

Pacific Type Locomotive for the Western Railway of France (Note sur la Machine "Pacific" de la Compagnie des Chemins de Fer de l'Ouest). Robert Dubois. Describes the conditions governing the choice of this type and the design adopted. Ills. 6000 w. Rev Gen des Chemins de Fer—Sept., 1908. No. 96112 G.

Locomotive Stoking.

The Advantages of the Automatic Stoker as Compared with Hand Firing for Locomotives. G. C. Grantier. Discusses both the advantages and defects. 2500 w. Boiler Maker—Oct., 1908. No. 95478.

Locomotive Tools.

Maintenance of Locomotive Tool Equipment. R. H. Rogers. Describes methods of keeping tool equipment up to the required standard. Comments by A. T. Sexton and C. L. Warner. 6000 w. Am Engr & R R Jour—Oct., 1908. No. 95539 C.

See also Management, under MISCELLANY.

Motor Cars.

A Railway Accumulator Car. Louis Dubois. Illustrated description of a new type of car in use on the Prussian State Rys. 1000 w. Elect'n, Lond—Oct. 16, 1908. No. 96046 A.

Steam Cars and Special Locomotives for Railways of Light Traffic. Abstract of paper read before the International Street Railway Union by Herman R. Von Littrow describing use of steam motor cars and other special equipment in Europe. 1600 w. Eng News—Oct. 8, 1908. No. 95747.

Petrol-Electric Motor-Car Traction on the Arad-Csanad Railway, Hungary (La Traction par Automotrices Pétrolés-Electriques sur les Chemins de Fer d'Arad-Csanad, Hongrie). Describes extensive motor-car traction for passenger trains on this important line, the motive equipment, and the results obtained. Ills. 4000 w. Génie Civ—Sept. 12, 1908. No. 96124 D.

Pneumatic Railways.

A Pneumatic Railway at Chicago, and a Review of Pneumatic Transportation Systems. Describes an experimental line, and review of systems. 2000 w. Eng News—Oct. 22, 1908. No. 96015.

Shops.

The Beech Grove Shops of the Big Four. William Forsyth. Illustrated detailed description of the large locomotive repair shops near Indianapolis, their equipment and methods of driving. 2200 w. Plate. R R Age Gaz—Oct. 30, 1908. No. 96236.

Improvements at the Works of the Kingston Locomotive Company, Kingston, Ontario, Canada. Henry Goldmark. Illustration, plans and description. 4000 w. Can Soc of Civ Engrs—Oct. 29, 1908. No. 96074 N.

Standardization.

See Management, under MISCELLANY.

Steam vs. Electricity.

Electric Traction vs. Steam Railroad Operation. W. H. Evans. Gives a general comparison between the two, and discusses matters of interest. General discussion. 9500 w. Pro Cent Ry Club—Sept., 1908. No. 96085 C.

Train Resistance.

The Predetermination of Train Resistance. Editorial discussion of resistance formulæ and applications. 1400 w. Elec Ry Jour—Oct. 3, 1908. No. 95597.

The Predetermination of Train-Resistance. Charles Ashley Carus-Wilson. Derives formulæ and verifies them by tests, giving practical conclusions. Also general discussion. 35000 w. Inst of Civ Engrs, No. 3686. Dec. 10, 1907. No. 95489 N.

Wheels.

Car Wheel Stresses. George L. Fowler. Reviews the little known on this subject, urging investigations to aid in securing wheels for the requirements of modern service. 2000 w. R R Age Gaz—Oct. 16, 1908. No. 95964.

NEW PROJECTS.

Brazil.

The Madeira & Mamore Railroad. Description of second attempt to build a railroad in Brazil from Portovelho to Garupe. 1500 w. R R Age Gaz—Oct. 2, 1908. No. 95567.

St. Paul.

Progress on the St. Paul's Pacific Extension. Description of work on the line from Butte, Mont., to Seattle, Wash. Ills. 1200 w. R R Age Gaz—Oct. 9, 1908. No. 95753.

PERMANENT WAY AND BUILDINGS.

Construction.

The Building of the New Canadian Transcontinental Railroad. George C. McFarlane. An account of the location, organization methods and progress in constructing the Grand Trunk Pacific. Ills. 4000 w. Engineering Magazine—Nov., 1908. No. 96206 B.

Elevated Railways.

Raising an Elevated Railroad Structure under Traffic. Illustrated account of the raising of the Chicago and Oak Park Elevated R. R. 2400 w. Eng Rec—Oct. 3, 1908. No. 95615.

Chicago Terminal Transfer Track Elevation. Illustrated description of the elevation of two miles of line along 15th Place, Chicago. 2100 w. R R Age Gaz—Oct. 2, 1908. No. 95568.

Freight Sheds.

The Merchandise Terminal of the Atlantic Avenue Improvement, Long Island Railroad. Illustrated description of elevated freight structures. Ills. 2200 w. Eng Rec—Oct. 10, 1908. No. 95736.

Rails.

Some Special Designs of Rails and Tie-Plates. Brief illustrated descriptions of special features in standard designs. 800 w. Eng News—Oct. 15, 1908. No. 95959.

Life of Manganese Steel Rail on Curves—From Service Tests Made on the Elevated Division of the Boston Elevated Railway Company. H. M. Steward. 1500 w. Elec Ry Jour—Oct. 17, 1908. No. 95927.

A Test for Ascertaining the Relative Wearing Properties of Rail Steel. E. H. Saniter. A paper read before the Iron & Steel Institute describing a machine devised to determine the wear on a round test piece revolving at high speed. Ills. 1000 w. Ir & Coal Trds Rev—Oct. 2, 1908. No. 95848 A.

Station Heating.

Hot-Water Heating Arrangements for Passenger Stations. Abstract of a paper by J. P. Canty read before the New England Maintenance of Way Assn.; also discussion. 4200 w. Ry & Engng Rev—Oct. 10, 1908. No. 95811.

Stations.

Note on Diagrams Used on the Belgian State Railway to Facilitate the Determination of the Best Utilization of Platform Lines at Passenger Stations. L. Weissenbruch and J. Verdeyen. 3700 w. Bull Inter Ry Cong—Sept., 1908. No. 95688 G.

Tie Plates.

See Rails, under PERMANENT WAY AND BUILDINGS.

Ties.

Wood or Steel Ties (Holzschwelle oder Eisenschwelle). A. Haarmann. A discussion of their relative economy, claiming the advantage to be on the side of the steel tie. 2200 w. Stahl u Eisen—Sept. 2, 1908. No. 96138 D.

Track Construction.

The Cost of Track Laying. Discusses distribution of costs in new railway construction. 1400 w. Engng-Contr—Oct. 7, 1908. No. 95732.

Results Obtained with Slabs of Elastic Material Used as Bedplates in the Permanent Way. Ernest Müller. Description of the use of felt, leather and woven-fabric slabs. 1900 w. Bull Inter Ry Cong—Sept., 1908. No. 95690 G.

Tunnels.

Roadbed Construction of the New Bergen Hill Tunnel of the Lackawanna Railroad. Brief description of a new type of roadbed and track construction adapted to tunnels and subways. 900 w. Eng Rec—Oct. 17, 1908. No. 95938.

TRAFFIC.

Car Efficiency.

Car Efficiency. Arthur Hale. An account of the work of the committee on car efficiency, followed by discussion. 1500 w. Pro W Ry Club—Sept. 15, 1908. No. 95972 C.

Demurrage.

Freight Car Demurrage. Editorial on the value of demurrage bureaus. 2500 w. R R Age Gaz—Oct. 30, 1908. No. 96235.

Foreign.

Jurisdiction of the Interstate Commerce Commission over Foreign Commerce. Extract from a letter from Franklin K. Lane explaining ruling of the Commission requiring the publication of relative proportion of export and import rates to the Pacific Coast ports. 1500 w. R R Age Gaz—Oct. 2, 1908. No. 95563.

Freight.

The Freight Problem on Manhattan Island. Henry J. Pierce. An address before the N. Y. Traffic Club. 1700 w. R R Age Gaz—Oct. 30, 1908. No. 96238.

Freight Rates.

Regulating Railroad Traffic. E. E. Clark. Address before the Am. Assn. of Freight Traffic Officers. Discusses conditions underlying the fixing of rates. 4000 w. R R Age Gaz—Oct. 2, 1908. No. 95562.

Passenger Rates.

The Legal, Economic and Accounting Principles Involved in the Judicial Determination of Railroad Passenger Rates. Maurice H. Robinson. Reprinted from the *Yale Review.* Serial. 1st part. 2500 w. R R Age Gaz—Oct. 9, 1908. No. 95757.

MISCELLANY.

Accounting.

Railway Accounting in Its Relation to the Twentieth Section of the Act to Regulate Commerce. Henry C. Adams. A consideration of the appropriate form of accounts for transportation agencies. 4500 w. Jour of Acc—Oct., 1908. No. 96075 C.

Objections to the Depreciation Charge. Memorandum of Am. Ry. Assn. special committee containing a summary of views of railroad officers on "depreciation" rules of Interstate Commerce Commission. 2200 w. R R Age Gaz—Oct. 2, 1908. No. 95566.

Arabia.

The Hedjaz Railroad. Illustrated description of the new sacred line between Damascus and Mecca built by the Turkish government. 2500 w. Sci Am Sup—Oct. 17, 1908. No. 95895.

China.

The Chan-Si Railroad, China (Le Chemin de Fer du Chan-Si, Chine). A. Millorat. Illustrated description of the line, structures, equipment, etc. Serial. 1st part. 5000 w. Génie Civil—Aug. 22, 1908. No. 95116 D.

Government Control.

The Relation of Railways to the State. W. M. Acworth. Address delivered to Economic Section of the British Assn. at Dublin. 7500 w. Engng—Oct. 16, 1908. No. 96059 A.

Enforced Railroad Competition. Ray Morris. Abstract of a paper in the Sept. *Atlantic Monthly;* discusses the evils and futility of enforced competition. 7500 w. R R Age Gaz—Oct. 2, 1908. No. 95569.

Great Britain.

The British Railway Position. An editorial letter. 2500 w. Ry & Engng Rev —Sept. 5, 1908. No. 94897.

Observations on British Railway Matters. Angus Sinclair. Reminiscences by an American locomotive engineer who has been a constant observer of British conditions. 1600 w. Ry & Loc Engng—Oct., 1908. No. 95542 C.

History.

Centenary of the First Passenger Train. An account of the trials made by Richard Trevithick. 1500 w. Engr, Lond—Sept. 18, 1908. No. 95416 A.

Management.

Some Good Ideas on Discipline. A report prepared by a committee and adopted by the C. & N. W. Op. Officers Assn. 1500 w. R R Age Gaz—Sept. 25, 1908. No. 95355.

Railway Maintenance-of-Way Organization. H. R. Safford. Abstract of paper in the *Purdue Engng Rev.* Outlines and examines an ideal organization, discussing the duties of officers. 3000 w. Eng News—Sept. 24, 1908. No. 95359.

Better Service at Reduced Cost. Raffe Emerson. A plan for handling locomotive supplies as an actually applied example of the simultaneous attainment of efficiency, standardization, and economy in railway operation and maintenance. Ills. Discussion. 12700 w. Pro N Y R R Club—Sept. 18, 1908. No. 95848.

Natal.

The Natal Government Railways. Description of properties with review of year 1907. 2400 w. Engng—Sept. 25, 1908. No. 95644 A.

Western Pacific.

The Western Pacific. George C. Lawrence. The first of a series of articles dealing with location and traffic, engineering and finances of the road. Ills. 4000 w. R R Age Gaz—Sept. 11, 1908. Serial. 1st part. No. 95000.

STREET AND ELECTRIC RAILWAYS

Accidents.

The Bournemouth Tramway Accident. Board of Trade report on an accident which occurred on May 1, 1908. 6000 w. Elec Eng, Lond—Sept. 5, 1908. No. 95-633 A.

The Railway Accident in Berlin. Gives plan and particulars of the triangular crossing where the accidents on the Overhead and Underground Ry. occurred. 500 w. Engr, Lond—Oct. 16, 1908. No. 96062 A.

Caracas, Venezuela.

The Caracas Tramways. An illustrated description of the electric tramway system. 1500 w. Elec Engr, Lond—Oct. 9, 1908. Serial. 1st part. No. 95982 A.

Car Barns.

Car House Design. Describes recently built car houses which illustrate best American practice. Ills. 6000 w. Elec Ry Jour—Oct. 10, 1908. Special No. No. 95686 C.

Report of the Committee on Operating and Storage Car-House Designs, Am. St & Int. Ry. Assn. Considers the problems to be met. Ills. 5500 w. Elec Ry Jour—Oct. 17, 1908. No. 95923.

The Gay Street Car House of the United Rys. and Electric Company, Baltimore. Illustrated description of a fireproof, reinforced-concrete building. 1100 w. Elec Ry Jour—Oct. 3, 1908. No. 95586.

Concrete Car House and Substation of the Seattle Electric Company. Illustrated description. 1000 w. Elec Ry Jour—Oct. 31, 1908. No. 96230.

Car Maintenance.

Report of the Committee on Economical Maintenance, Am. St. & Int. Ry. Assn. The subject of car equipment maintenance is considered. 3500 w. Elec Ry Jour—Oct. 17, 1908. No. 95924.

Car Reconstruction.

Rebuilding New Jersey Cars for Pay-as-You-Enter Service. Description of conversion of a large number of cars at Newark, N. J. Ills. Elec Ry Jour—Oct. 10, 1908. Special No. No. 95675 C.

Car Repairing.

Special Shop Tools of the Twin City Rapid Transit Co. Illustrated description of special tools used in construction and repair work. 1400 w. Elec Ry Jour—Oct. 3, 1908. No. 95591.

See also Shops, under STREET AND ELECTRIC RAILWAYS; and Cranes, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Cars.

Side Entrance Cars in New Zealand. Account of Multi-side-entrance cars with plans and other illustrations. 400 w. Elec Ry Jour—Oct. 3, 1908. No. 95595.

Construction Details of New Combination Cars Built by the Northern Electric Railway. J. P. Edwards. Illustrated description of double-end combination baggage and express cars. 2000 w. Elec Ry Jour—Oct. 3, 1908. No. 95587.

Conductors.

Report of the Committee on Power Distribution, Am. St. & Int. Ry. Assn. Deals with feeders, working conductors, return and conduit systems. Ills. Includes paper by R. L. Allen. 4500 w. Elec Ry Jour—Oct. 15, 1908. No. 95921.

Economics.

Some Through-Running Problems and Their Solution. H. E. Blain. A paper read before the (British) Municipal Tramways Association; discussion and editorial. 6600 w. Elec Eng, Lond—Sept. 25, 1908. No. 95770 A.

Elevated Railways.

See Subways, under STREET AND ELECTRIC RAILWAYS.

Employees.

Employment of Trainmen. Discussion of the selection, training and discipline of electric railway employees. Methods used on various lines. Illustrations and typical forms. 10000 w. Elec Ry Jour—Oct. 10, 1908. Special No. No. 95680 C.

Treatment of Corporation Employes Incapable of Performing Ordinary Duty. H. Linsley. A paper read before the (British) Municipal Tramways Association; discusses superannuation funds and other methods used on British tramways. 2100 w. Elec Eng, Lond—Sept. 25, 1908. No. 95771 A.

Trainmen's Club Rooms, Benefit Associations, Pension Schemes and Other Welfare Work. Illustrated account of social betterment work on electric railways. 4000 w. Elec Ry Jour—Oct. 10, 1908. Special No. No. 95681 C.

Freight Traffic.

Freight and Express Traffic. Illustrated description of the development of freight and express traffic on electric railways in the United States. 9000 w. Elec Ry Jour—Oct. 10, 1908. Special No. No. 95683 C.

History.

The History of Mechanical Traction on Tramways and Roads. H. Conradi. Ills. 7000 w. Soc of Engrs—Oct. 5, 1908. No. 96093 N.

Interurban.

The Boyertown & Pottstown Railway. Illustrated detailed description of a line connecting two Pennsylvania towns. 2000 w. Elec Ry Jour—Oct. 24, 1908. No. 96024.

Lightning Protection.

Lightning Protection for Electric Railways. E. E. F. Creighton. A brief review of the general conditions of lightning protection. 2000 w. Elec Ry Jour—Oct. 14, 1908. No. 95919.

Locomotives.

The St. Clair Tunnel Single-Phase Locomotives. L. M. Aspinwall and J. Bright. Illustrated description of 66-ton locomotives used for handling freight and passenger trains. 1800 w. Elec Jour—Oct., 1908. No. 95843.

Motor Maintenance.

Report of the Committee on Maintenance and Inspection of Electrical Equipment. Gives the report of the standing committee of the Engineering Association. Ills. 21700 w. Elec Ry Jour—Oct. 14, 1908. No. 95920.

Operation.

The Application of Technical Science to the Construction, Maintenance and Operation of Tramways. R. G. and J. G. Cunliffe. Shows the utility of technical methods in examining their working. Suggestions for profitable research. 2800 w. Elect'n, Lond—Oct. 9, 1908. No. 95986 A.

The Application of Technical Science to the Construction, Maintenance, and Operation of Tramways. R. G. and J. G. Cunliffe. A paper read before the Municipal Tramways Association which discusses various problems in electric railway operation and suggests topics for research. Discussion and editorial. Ills. 6800 w. Elec Eng, Lond—Oct. 2, 1908. No. 95772 A.

Railless.

The Trackless Trolley System. T. Graham Gribble. Describes the principal features of the system, its working, etc. Ills. 4000 w. Tram & Ry Wld—Oct. 8, 1908. No. 95988 B.

Trackless Trolley Tramways. Abstract of a report of a Manchester commission on German systems. Ills. 1600 w. Elec Eng, Lond—Oct. 2, 1908. No. 95773 A.

Shops.

Car Repair Shop Design. General description of typical American car repair shops illustrating best practice. Ills. 6000 w. Elec Ry Jour—Oct. 10, 1908. Special No. No. 95687 C.

Signals.

A New Counting Signal System. Describes an improved automatic signal system. Ills. 1400 w. Elec Ry Jour—Oct. 10, 1908. Special No. No. 95688.

Automatic Block Signals on the Boston & Worcester Street Railway. Account of a new type of signal controlled by an automatic track circuit. Ills. 1200 w. Elec Ry Jour—Oct. 10, 1908. Special No. No. 95679 C.

Single Phase.

The St. Clair Tunnel Electrification. H. L. Kirker. Illustrated description of the installation of single-phase working in order to increase capacity. Also editorial. 4000 w. Elec Jour—Oct., 1908. No. 95842.

Thamshawn-Lokken Single-Phase Railway. Illustrated description of the first railway line in Norway to be converted to single-phase working. Elect'n, Lond—Sept. 25, 1908. No. 95779 A.

Electric Traction by Simple Alternating Current on European Railway. H. Marchand-Thiriar. Account of recent progress in Switzerland, Sweden and Italy and description of various systems. Ills. 27600 w. Bull Inter Ry Cong—Sept., 1908. No. 95689 G.

See Locomotives, under STREET AND ELECTRIC RAILWAYS; and Railway Motors, under ELECTRICAL ENGINEERING, Dynamos and Motors.

Subway Entrances.

Ornamental Treatment of Berlin Subway Entrances. Description of various types of entrances. Ills. 500 w. Elec Ry Jour—Oct. 3, 1908. No. 95590.

Subway Lighting.

The Wiring and Illumination of the Hudson Tunnels. N. A. Cornell. Illustrated description of transformers, switchboards, conduits and fixtures of this large but simple system. 1400 w. Elec Wld—Oct. 10, 1908. No. 95874.

Subways.

The Paris Metropolitan. Describes recent extensions to the subway system. Ills. 2200 w. Elec Rev, N Y—Oct. 10, 1908. No. 95724.

Philadelphia Subway and Elevated R. R. J. A. Stewart. Illustrated description of Market street subway and elevated system. 2500 w. Munic Engng—Oct., 1908. No. 95524 C.

A Proposed Freight Subway Belt Line for Lower New York City. Francis W. Lane. Illustrates and describes the main features of the plan proposed by William J. Wilgus. Also editorial. 4000 w. Eng News—Oct. 15, 1908. No. 95955.

See also Underpinning, under CIVIL ENGINEERING, Construction.

Subway Signalling.

Automatic "Light" Signals in Park Avenue Tunnel. Description of system used since the electrification. Ills. 2000 w. R R Age Gaz—Oct. 9, 1908. No. 95752.

The Signalling System of the Subway and Elevated Division of the Phila. Rapid Transit Co. Detailed description of electro-pneumatic system. Ills. 3300 w. Sig Engr—Oct., 1908. No. 95820.

Automatic Block and Interlocking Signal System as Installed in the Hudson Tunnels. Jas. H. McCormick. Detailed description with diagrams and plans. Ills. 4500 w. Sig Engr—Aug., 1908. No. 95815.

Track Construction.

Standards of Track Construction. Illustrated description of standard practice in American cities. 3500 w. Elec Ry Jour—Oct. 10, 1908. Special No. No. 95684 C.

Proposed New System of Street Railway Construction. C. B. Voynow. The system consists of a flangeless wheel, and a track built of a T-rail with a projecting flange above the tread. Ills. 4500 w. Elec Ry Jour—Oct. 17, 1908. No. 95925.

Train Dispatching.

Train Dispatching Methods and Forms of Train Orders. General discussion of American methods. Illustrations and typical forms. 5000 w. Elec Ry Jour—Oct. 10, 1908. Special No. No. 95682 C.

Dispatchagraph System. Account of a new system where the train dispatcher can set a signal at any desired station and receive a record of the time of interlocking. Ills. 600 w. Elec Ry Jour—Oct. 10, 1908. Special No. No. 95678 C.

Trucks.

Motor and Trailer Trucks for the Denver and Interurban R. R. Co. Description of standard trucks for use on the Denver-Boulder line. Ills. 800 w. Elec Ry Jour—Oct. 3, 1908. No. 95594.

Wire Suspension.

Overhead Line Construction and Maintenance. Illustrated description of standard American practice. 7000 w. Elec Ry Jour—Oct. 10, 1908. Special No. No. 95685 C.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated: W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.

Camptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *w.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electric Railway Review. *w.* Chicago.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *m.* Milan.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *w.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Men. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *b-m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Age Gazette. *w.* New York.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Pàris.
Revue Gén. des Chemins de Fer. *m.*- Paris.
Revue Gén. des Sciences. *w.* Paris.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Signal Engineer. *m.* Chicago.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Street Railway Journal. *w.* New York.
Surveyor *w.* London.
Technology Quarterly. *qr.* Boston, U. S. A.
Technik und Wirtschaft. *m.* Berlin.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagon Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

THE ENGINEERING MAGAZINE

"THE WORLD IS ITS FIELD"

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THE GEORGIAN BAY SHIP CANAL.

By J. G. G. Kerry.

After a long period of neglect the problems of inland navigation and the improvement of inland waterways have risen to a position of first importance in nearly every country in which transportation facilities are a matter of general concern. It is doubtful if any other engineering problem is so universally the subject of investigation on so large a scale. Italy, Austria, Germany and France have under consideration many large projects both for the improvement of existing waterways and for the building of new canals, and in both Great Britain and the United States the problems are deemed worthy of investigation by Governmental Commissions. In the latter country several canal projects have reached the active stage and the improvement of inland navigation is one of the most prominent features of the larger movement for the conservation of all natural resources. In common with all these other nations, Canada has a project for an inland waterway, but with this difference, that the agitation for water transportation facilities, which in other countries represents a movement to revive a waning trade or to escape from the bondage of excessive railway rates, in Canada is but the natural outcome of the enormous expansion of agricultural and industrial activity in the western part of the country, with whose rapidly increasing traffic the existing railways are inadequate to cope. The Georgian Bay Ship Canal project has been under careful investigation by the Canadian Government since 1904 and it is expected that Parliament will authorize its construction, on the lines of the report presented to Parliament last July, during the session about to open. In the following pages Mr. Kerry outlines the history of the Ottawa and French Rivers as a transportation route and describes the general features of the projected waterway. In a concluding section, to follow next month, he will discuss some of the larger problems in more detail and will examine the economic grounds for the construction of the canal.—THE EDITORS.

THE recent growth of population and industrial activity in the Canadian Provinces of Manitoba, Saskatchewan and Alberta has once more drawn the attention of the Canadian public to one of the oldest transportation routes on the continent, that which, following the Ottawa Valley, extends from sea level at Montreal via the Ottawa and French Rivers to the upper lake level at French Harbour in the Georgian Bay. Historical evidence shows that this was, in common with most of our great traffic routes, an established and much used pathway before the advent of European colonization in North America. The Georgian Bay route, as it is commonly called, was used by the first white man to reach the upper lakes, Samuel de Champlain; and it was perhaps fitting that the surveys for a modern waterway along the natural route that he followed should be completed, and their results announced, while the tercentenary of his settlement in Quebec was being celebrated with pomp and circumstance by the representatives of three great nations.

Champlain founded Quebec in 1608 and his followers immediately commenced working their way westward by way of the Ottawa River, choosing this route because that via the St. Lawrence River was barred by the hostile Iroquois from their settlements in what is now the State of New York; this accounts for the early use of the northern route just as at a later date the hostility of the United States to British interests accounted for the building of the Rideau Canal in preference to the opening up of the navigation of the St. Lawrence River. By 1613 Champlain had penetrated inland as far as the present town of Pembroke, and in 1615 he made his memorable journey to the Georgian Bay and thence via the Trent Canal route to Lake Ontario. To-day the canalization of the Trent waters, commenced by the British Government about 1835 and then abandoned on account of political disturbances in Canada, is rapidly approaching completion, and the canalization of the waters of the Ottawa and French Rivers is one of the major projects under consideration by the Canadian Government.

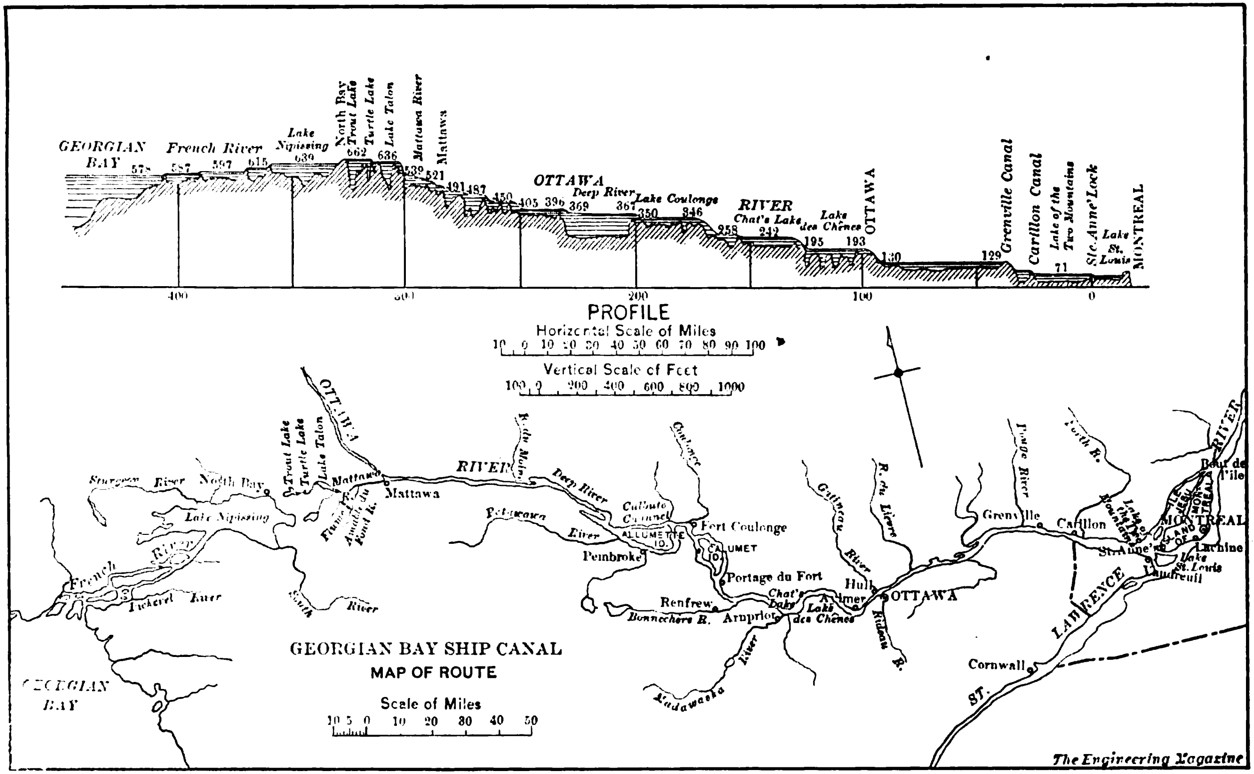
If any question is asked regarding the late date at which the improvement of natural routes of such evident importance is being undertaken, it can be readily answered. Until the present decade Canada has had no need of transportation facilities of the highest order between the upper lakes and the Atlantic; her north and her northwest have lain unoccupied save by the trapper and the fur trader, and practically no all-Canadian traffic has been afloat on her inland seas. At the same time the uncompromising commercial hostility of the United States has prevented its western people from benefiting in any way by these great waterways, the American tariff laws making the handling of American import trade via Montreal a commercial impossibility.

The natural advantages of the Ottawa Valley and Trent Valley routes were recognized at an early date by the Canadian railways and to-day the main line of the Canadian Pacific Railway follows Champlain's route up the Ottawa River, while the Grand Trunk Railway has for many years sent its western grain traffic by the path which that explorer travelled from the Georgian Bay to the eastern end of Lake Ontario. The efficiency of the railway has materially delayed the advent of the canal.

Following Champlain to the west came the Jesuit missionaries, whose "Huron Mission" is perhaps the most picturesque and saddest incident in Canadian history. It is over two hundred and fifty years since that mission was wiped out in the annihilation by the Iroquois of the people to whom it was sent, but the writings of its members as recorded in the "Relations des Jesuits" made the Georgian Bay route familiar to western Europe centuries ago. It is worth noting that recently the main lines of the great lake and rail terminal which the Grand Trunk Railway is building at Tiffin on the Georgian Bay were deviated to avoid the ruins of the old headquarters of that pioneer mission.

By the same route came the Sieur de la Verendrye almost a century later on that expedition which brought him finally, as the discoverer of the far Northwest, to the Rocky Mountains. Later, for a short time after the conclusion of the American War of Independence in 1783, Montreal became the centre of the fur trade and the Ottawa Valley and the French River its highroad. The short and savage struggle for the commercial mastery of the Northwest between the Northwestern Fur Trading Company of Montreal and the Hudson Bay Company brought the route into a prominence which ceased when the conflict ended in the amalgamation of the two companies into that great corporation which for about half a century ruled over well nigh half the continent; from motives of policy that corporation closed up the route via the Ottawa River and sent all its traffic via Hudson's Bay in order that the Northwest might be forgotten and the trade monopoly that had been created by King Charles II perpetuated. The maps of the continent will, however, bear witness forever to the energy of the men of the Northwest Company who named the lands by their own names, and who, as the pioneer Canadian engineers, were first to open Lake Superior to through traffic by their canal construction at Sault Ste. Marie.

After the conclusion of the war of 1812, the great future of the western plains and the importance of the Great Lakes to their commercial development were recognized by both Briton and American. The State of New York, under the inspiration of De Witt Clinton, built the Erie Canal and almost simultaneously the British Government built the canals along the lower Ottawa River and the Rideau and commenced work on the navigation of the Trent River. With the construction of the Rideau Canal began the rise into importance of the city of Ottawa, and in 1837 its merchants sent out the first



PLAN AND PROFILE OF THE PROJECTED ROUTE OF THE GEORGIAN BAY SHIP CANAL.

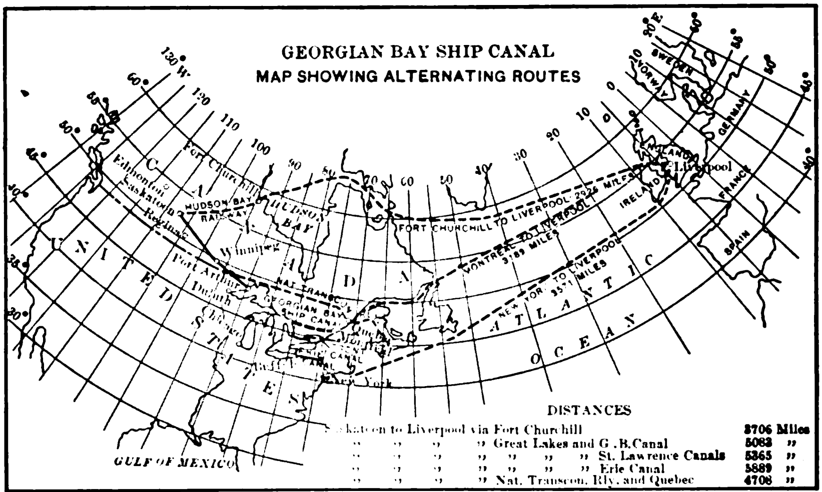
expedition to study the possibilities of the Georgian Bay route for canal construction, the examination being made by Messrs. John McNaughton and Chas. P. Treadwell. Their report was favorable, but public interest at the time was centred on the betterment of the St. Lawrence Route, and the carrying out of the improvement of the latter, on the broad lines suggested by Colonel Philpotts R. E. in his historic report to Lord Durham, occupied the energies of the Canadas, as they were then called, until 1850.

The following decade, 1850-1860, witnessed the first great era of railway building in Canada, but although the ablest and most far-seeing of Canadian engineers had realized at that time, and were openly stating, that the day of the canal as a general system of transportation had passed, the public was agitating for further canal construction. As a result of this agitation Mr. Walter Shanly was commissioned by Parliament to make a report upon the construction of a canal by the Georgian Bay route. The result of his investigation was made public in 1858. There was then no Canadian traffic to be carried on such a waterway, and west of Pembroke there were but few people resident along the route. The absence of any commercial reason for the immediate construction of the canal, other than a hope of diverting American traffic from American routes, perhaps accounts for the fact that the appropriation made did not provide sufficient funds for the completion of the surveys, and Mr. Shanly's report, was, therefore, somewhat of the nature of an interim report. The estimated cost of construction of a ten-foot waterway was given by him at $24,600,000, the general principle of his design being the cutting of canals at all points not already navigable, in preference to the canalization and regulation of the rivers. The problem of the summit level was met by Mr. Shanly with the bold suggestion, worthy of his great reputation as an engineer, that the level of Lake Nipissing should be raised until that ample lake became the summit level, a reasonable proposal in times when there was neither settlement nor improvement on its now busy shores.

Mr. Shanly's work was continued and completed in 1860 by Mr. T. C. Clarke who estimated the cost of construction of a twelve-foot waterway at $12,057,680, the decrease in the estimate being largely due to the adoption of considerably lower unit prices for the necessary excavation. Mr. Clarke favored, where possible, the use of canalized river in preference to canal. The feasibility of the project was now established beyond question; it remained only to demonstrate that there was a commercial need sufficiently great to justify the expenditure called for. No such need existed in 1860 and up to the present day the volume of traffic that will be carried by this waterway has been, and is, a matter of controversy.

From 1860 to 1890 the attention of the Canadian people was fully occupied with projects of national importance, the Confederation of the Dominion, the construction of the Intercolonial and Canadian Pacific Railways and the opening up of the fourteen-foot navigation from the Great Lakes to the Atlantic via the St. Lawrence River being the most prominent undertakings that were completed or well advanced during that period. Agitation in favour of the construction of the Georgian Bay Ship Canal, however, recommenced about 1890, mainly on the part of promoters and contractors with headquarters in the city of Ottawa. Mr. T. C. Clarke, who had for long been one of the principal figures in the American engineering world, was again called upon to report. In 1898 he recommended the adoption of a barge canal with fourteen-foot depth on the lock sills but questioned the practical utility of any such waterway in view of the small amount of Canadian traffic on the Great Lakes. He modified his earlier plans by abandoning the idea of raising the level of Lake Nipissing, thirty miles of the roadbed of the Canadian Pacific Railway and the town site of North Bay lying within the flood-line contour, and he proposed instead the lowering of the small summit lakes, Trout Lake and Turtle Lake, to the level of Lake Nipissing.

The idea of the navigation of the Great Lakes by ocean-going vessels has always been a most attractive one and for over a century it has found many enthusiastic advocates both in Canada and in the United States. It was the basis of Colonel Philpott's report in 1840, the *raison d'être* of the international "Deep Waterways Commission" of 1896 and the underlying principle of the early designs for the Georgian Bay Canal. In more recent proposals, however, it has been recognized that the conditions of navigation upon the ocean are so different from those which obtain on the Great Lakes that the same type of vessel cannot be economically used in both services. The purpose of the Georgian Bay Ship Canal as now projected is to bring the lake carrier to a point where she can trans-ship directly into the ocean liner. As a result of steady agitation a complete survey for such a project was authorized by the Canadian Government in 1904 and an interim report on the survey was laid before the Houses of Parliament in July of last year. It is probable that the final report giving in detail all results of the surveys will be ready for presentation during the coming session of Parliament.



The Engineering Magazine

MAP SHOWING ALTERNATIVE ROUTES BETWEEN WESTERN CANADA AND EUROPE.

It will be well before proceeding further to review, very briefly, the physical characteristics of the route of this proposed waterway. A glance at the accompanying maps and profile will show both its directness and the singular chain of deep lakes and rivers lying along it. The late A. M. Wellington, who was for years one of the most enthusiastic advocates of this route, has described it as "the finest place on the globe for a deep-water canal." Long reaches of navigable water occur, which need no improvement whatever. In fact the existing waterway is a succession of deep, almost currentless pools connected together by short streams broken by rapids and waterfalls. For this reason the water level does not fluctuate with great rapidity, seldom rising more than three inches in twenty-four hours for any considerable number of days in succession.

Geologically and topographically the character of the surrounding country is broadly divided at a point close to the city of Ottawa. To the westward lies a Archæan region composed mostly of diorite, gneiss and granite, abrupt, broken and bare and with well defined and deep valleys; in this section are occasional large patches of level-lying and fertile Cambro-Silurian country. To the eastward is a Cambro-Silurian region bordered close to the north shore of the Ottawa River by Archæan; this region is generally level-lying but it is divided by well-defined outcrops which form the natural dams that hold back the long deep-water reaches of the lower river. Permanent raising of the water levels will not be objectionable in the western section where the channels are narrow and deep, but in the eastern section the river shores are flat, low and well-cultivated and flooding is therefore an economic impossibility.

As in the case of all northern canals, the climatic conditions, which will limit the period of navigation to approximately seven months, are the most serious drawbacks to the efficient working of the route. It is estimated by the engineers that the waterway will be open, on an average, for 210 days in the year, this estimate agreeing closely with the figures for Lake Nipissing given by the Deep Waterways Commission in 1896. It was estimated at that time that Lake Nipissing would be closed by ice from November 29 to May 3, a period of 155 days. That climate will place the Georgian Bay Ship Canal at a disadvantage when compared with the existing St. Lawrence Canals can be readily seen from the following dates of the opening and closing of navigation taken from the Report of the Deep Waterways Commission:

Place.	Average Date of Closing.	Average Date of Opening.
Port Arthur	December 21	May 1
Sault Ste. Marie..........	December 2	April 30
Welland Canal	December 10	April 17
Lake Nipissing	November 19	May 3
Lachine Canal (Montreal).	December 2	April 30

It is hardly possible from these dates to avoid the conclusion that the northern waterway will have a navigation season nearly a fortnight shorter than that which can be obtained for the proposed enlarged canals on the St. Lawrence route.

A mental picture of the route, then, will show between Montreal and Ottawa, or say one-fourth of the length, a broad placid river broken by three groups of rapids and flowing between fertile and well-cultivated shores. This section has been navigable for nearly eighty years and the present enterprise will merely enlarge the scale of the navigation. For 190 miles further to the westward, the route still follows the Ottawa River. This section has been long the highway of the lumberman but has remained little known to general commerce. The broad placid pools and well-settled banks are still found but the river is broken more frequently, more roughly and for longer distances by the rapids, the character of the valley changing swiftly with the change in its geology and islands of great size becoming a feature of the river. Old and well established towns are on the banks but settlement is by no means dense. It is hardly 30 years since the Canadian Pacific Railway reached Mattawa, the western end of the section. The building of the Ship Canal would give to this part of the river opportunities for development which it has never yet had, all through navigation now terminating at Ottawa.

The third section from the Ottawa River to the Georgian Bay runs through a succession of pools with high rocky banks. It is a much broken region with its streams sometimes divided into two or three parallel branches, its areas little settled and less cultivated, and, like most Archæan country, it is not attractive to the agriculturalist. It was unopened to commerce in any effective way until the Canadian Pacific Railway was built through it twenty-five years ago.

The surveys, which have been under the general direction of Mr. E. Lafleur, Chief Engineer of the Department of Public Works, and Mr. A. St. Laurent, Engineer in Charge of the Georgian Bay Canal Survey, have been carried through with great thoroughness, the work done including general surveys, precision levels, borings, soundings, establishment of water levels at the various stages, studies of river regulation, hydrographic surveys of tributary watersheds, studies of power development, of the requirements of modern navigation, of the handling of large freighters, and of the details of lock construction. No plans have as yet been made public and the drawings accompanying this article are prepared from the results of earlier surveys; in major detail the design can be but little altered, the natural features being so well marked and on so grand a scale.

The interim report places the length of the waterway at 440 miles and for over 410 miles it will not be canal but lake or canalized river. The general route has already been sufficiently described. The stretches of canal are found near the summit and near Montreal, but it is questionable whether the latter sections will ever be built or whether the locality does not justify a much bolder scheme of river improvement in spite of the expense entailed. The cut across the divide between the waters of the French and Ottawa Rivers is 3½ miles long, and a stretch of 3 miles of canal is projected in the valley of the Mattawa River where the fall is comparatively rapid. These are the longest sections of actual canal except the section near Montreal. From the foot of the Lake of Two Mountains, out of which the Ottawa flows to its final discharge into the St. Lawrence in four separate branches, two routes are projected, the one following Lake St. Louis and the St. Lawrence River to Montreal, and the other the valley of the Back River or Rivière des Prairies. The Back River is the main stream of the Ottawa and flows at the back of the Island of Montreal, discharging into the St. Lawrence at Bout de l'Ile, a point about 17 miles east of the centre of Montreal harbour, Owing to the expense of right of way and the artificial obstacles that are necessarily found in the environs of a great city, about 5 miles of actual canal have been recommended on the first route and about 11 miles on the second.

In the natural waterways about 332 miles require no improvement whatsoever, for an additional 14 miles a broad waterway can be secured by the cutting off of a few small shoals and there will be about 66 miles of channel or submerged canal to be built. Locks of the ordinary type are to be used, the dimensions of the lock chambers being given as 650 feet by 65 feet by 22 feet on the mitre sills. It is not considered that there will be any lake vessels designed in the immediate future to draw more than 20 feet of water. It is true that the St. Mary River channel is being deepened to 25 feet and that the Canadian lake terminals are being dredged to the same standard, but the extra 5 feet are considered necessary to provide for the free movement of vessels drawing 20 feet and also for those sudden falls in the lake levels which occasionally occur as a result of severe wind storms. 20-foot navigation at all stages is still to be secured in the channels connecting the Great Lakes and only the most important harbours can dock vessels of this draught. It will be noted that the locks are designed to handle self-propelling vessels rather than tows; and in their proportions they are in marked contrast to the St. Lawrence River locks which were designed by the Canal Commission of 1870. The latter are 270 feet by 45 feet in plan and Mr. T. C. Keefer has suggested that they were especially intended to provide for Noah's ark, no other vessel of his knowledge having the same relative dimensions.

Forty-five main dams will be required in all, not including those that may be built for regulating the discharge of tributary streams. Where the river flow is abundant it is proposed to adopt the rock-fill type of dam, but the economic value of power has been advancing so rapidly during the last fifteen years that it is questionable whether the use of so wasteful a device will be permitted. The regulated water levels in the pools will be maintained by the use of stop logs as is customary in Canadian practice. In a few places the Stony patent sluices may be introduced.

Both from the standpoint of navigation and for the development of power the regulation of the discharge of the Ottawa River is most desirable. The units involved in its control are startling. The records show that the minimum discharge near Ottawa in recent years has not been much greater than 10,000 cubic feet per second and that maxima as high as 250,000 cubic feet per second have been reached. It is hoped that the discharge may be so effectively controlled that it will never be less at this point than 90,000 cubic feet per second and never more than 120,000 cubic feet per second. The economic value of this regulation is effectively set forth in the interim report by the remark that the potential low-water horse power on the two main rivers will be increased by it from about 150,000 horse power to nearly 1,000,000 horse power.

It is not easy at this date to grasp the fact that the watershed of the Ottawa River is an almost unknown and uninhabited land. It is mainly in the province of Quebec and far to the north of the river itself which in reality skirts it southern edge; its northern boundary is the height of land between Hudson's Bay and the St. Lawrence River waters. For at least three generations this district has been given over to the lumberman and few and limited in area are the farm clearings in it. Engineering data for the design of the regulating works on the tributaries of the main river are therefore not in existence and exhaustive surveys such as are needed to secure these data cannot now be conducted at reasonable expense except perhaps in the depth of winter. This difficulty will, however, be very greatly reduced when the National Transcontinental Railway, now building, is opened to traffic, as its location crosses the head waters of nearly all the principal tributaries of the Ottawa. It will provide a convenient base for the carrying out of a hydrographic and topographic survey of the upper watershed.

Much attention has already been given to the general hydrography of the river and it is estimated that at a cost of less than $500,000 the well-known lakes Temiscamingue, Keepawa, Quinze, Barrière, Kinejiskaskatic, Turn Back, Askikwaj and Grand Lake Victoria, might be converted into storage reservoirs, and a storage of perhaps 150 billion cubic feet of water obtained. The regulative effect of these great storage basins and the ease with which the discharge of the waters from them can be controlled are too obvious to call for comment. A more picturesque suggestion has been made for the control of the flood discharge, based on the fact that the headwaters of the Ottawa itself lie far to the eastward where the stream flows in a bed of high elevation between the two great ridges which form the height of land between the St. Lawrence River and Hudson's Bay. It is suggested that a large portion of the flood waters should be diverted across the height of land and into the streams discharging into Hudson's Bay. Pending the opening up and further survey of the watershed such a proposal may be regarded as an interesting speculation.

THE DEVELOPMENT OF THE SMALL STEAM TURBINE.

By Chas. A. Howard.

A preceding article by Mr. Howard, in our December issue, contrasted the principal features of design and construction in the leading types of small steam turbine in use in the United States. This concluding paper is concerned with the service applications to which this form of prime mover is best suited.—The Editors.

THE field to which the small steam turbine is adapted is broader in extent than that of any other source of motive power with the exception of the electric motor, which can be used to greater or less advantage under almost any conditions. The great extension in the use of the turbine for commercial purposes in sizes under 300 horse power extends back but a very few years, so that it has scarcely begun to open up its unquestionably broad field. When these small turbines were first extensively placed on the market for machinery driving, their promoters picked for the place to start the equipment of the auxiliaries of steam-power plants with prime movers. During this short time, they have been installed in large numbers for driving exciters, centrifugal boiler-feed pumps, centrifugal hot-well pumps for condensers, fans for forced and induced draft, and also in many cases in small plants for driving the main generators themselves.

For steam-driven exciters, the steam turbine is the ideal type of prime mover, and as every power plant where constancy of service is a desideratum, except possibly where several are tied in together in a large system, should have at least one steam-driven exciter, there is a place in nearly every plant for at least one small steam turbine. The exciter is invariably a small unit and the speed at which it operates best is high, much higher than is economically possible of attainment with small reciprocating engines which are limited even in the smallest sizes to about 350 to 400 revolutions per minute as a maximum. Speed regulation of the turbine within 1½ to 2 per cent is easily attainable and this is as close as is necessary or desirable for the exciter. As there are only two bearings to keep in order and no other sliding or rubbing surfaces in contact, it can be easily seen that both the wear and the attendance necessary are much less than would be the case with a reciprocating engine, a fact which has been brought out and proven in operation.

The use of multi-stage centrifugal pumps for boiler-feeding purposes is only of comparatively recent date, but the great success of all those which have been installed points to a large increase in their use in the immediate future. On account of the high heads against which these pumps are run, their speed is far above the maximum limit of a reciprocating engine, so that it is a question of a steam turbine or an electric motor. If there is use for the exhaust steam the turbine is unquestionably the better proposition; if there is no demand for the exhaust steam it may work out better for the motor, but it should be remembered and considered that these pumps are generally located in the boiler-house basement where the ashes fly thick, and that they will get very little attention and what they do get will be of a very poor quality. In almost every plant, however, there is a demand for the exhaust steam for heating the feed water, and frequently also for heating, drying, and other uses, so that it is usually more economical when centrifugal feed pumps are used to drive them by steam turbines.

In connection with condenser installations there is a very large field for the turbine, especially when the condensers are of large size, and separate wet and dry air pumps are used. Many of the largest and most modern surface-condenser plants are using turbine-driven centrifugal pumps to remove the condensed steam from the hot well and throw it over into the heaters or overboard as conditions demand. Condensers using turbine-driven centrifugal circulating pumps are now being built and show a large saving in the space taken up by the condensing machinery. At the present time, there is no commercially successful dry vacuum pump in use, but everything points to a satisfactory development of this apparatus at an early date. This machine, if successful, will call for a steam turbine for its motive power.

For driving the forced-draft fans in a boiler plant, the turbine offers important advantages. By increasing the speed of rotation the size of the fan is largely reduced. Fans have recently been developed which run at a higher efficiency at a comparatively high speed than the larger fans can do at their slow rotative speed. The maintenance of engines driving forced-draft fans is usually a very expensive item, especially in large plants, and this can be made almost to disappear by the substitution of a turbine.

The successful development of the multi-stage centrifugal pump has opened up a new field for the steam turbine for pumping the water supply of cities, and this shows promise of a very extensive growth. Of course neither the mechanical nor the thermodynamic efficiency of the turbine-driven multi-stage centrifugal pump is to be compared with that of the high-duty pumping engine, but the initial cost of the former for a given capacity, the maintenance expense and the cost of the labor required for operation are very much less, so that in many cases the turbine pump will work out to be more economical. Every installation is a special problem in this regard and if the saving in fixed charges and labor of the turbine pump is greater than the saving in steam of the high-duty pumping engine, then the former will be the unit to install. Under some circumstances the problem will work out one way, under others, in another. One point, however, which is of the utmost importance in making a decision as to the type of pump to be installed is the question of water hammer. This is entirely avoided when centrifugal pumps are used.

In small water works where the choice is between the centrifugal pump and the low-duty, compound, duplex pump, the former can at least hold its own in initial cost and will in all probability be cheaper for a given capacity. The maintenance expense, cost of labor for operation, and the steam consumption are all less in the case of the turbine-driven unit, so that this is almost invariably the best installation for a small water-works system where low-duty pumps are the only alternative, except of course when the centrifugal pumps can be connected to motors driven by electric power purchased at advantageous rates, thus doing away with the boiler plant.

Another very promising field for future development, in which little has as yet been done, is the ventilation of mines. The present practice in this branch of engineering is to install at a mine one or more fans having wheels or runners from six to thirty-five feet in diameter and running at very slow speed, generally driven by either one or two Corliss engines, one on one side of the fan and one on the other. The connecting rod of one of these engines is generally taken down and the engine held in reserve in case any accident happens to its mate. These units are very expensive in first cost, much more so than fans used for other purposes, and their running expenses, while comparatively low, are still considerably in excess of those of a turbine-driven unit. The question of safety, which can be secured only by continuous operation of the fan, is of paramount importance in mine work, so continuity of operation is the first thing to be considered. About the only possible accidents which can happen to a turbine are derangement of the governor and breaking of the shaft, and both of these are equally liable to happen to a reciprocating engine. When one stops to think of the failures which are possible, and which are continually taking place, in engines, there can be little question about the reliability of a properly constructed and properly erected steam turbine. The breaking of a crank, connecting rod, crosshead, eccentric rod or strap, or cylinder head, the twisting off of a valve stem or any one of a score of other breakages of parts will put a reciprocating engine out of commission.

Of course, in mining plants, two engines are generally used on each fan, but two separate, complete, turbine-driven units could be installed at a much lower cost than a large single fan driven by two engines of the type generally employed for this service and would provide duplicate fans as well as duplicate engines. With such an installation, in case anything went wrong with one unit, it would only be necessary to open the throttle and turn steam into the other unit, whereas with the system at present in use, the rod of one engine must be taken down and that of the other set up before the fan can be started again. When it is considered that the fan houses are frequently at some distance from the main works at the head of the shaft, it will be seen that this involves some little time, and some danger to the miners below.

Another line in which some work has been done but which offers extensive opportunities for the turbine in the future is the driving of generators for steam-railroad train lighting. There are three distinct systems of electric train lighting, each having its good points and each its disadvantages. These are, first, the axle system, in which the generator is driven from the axle of the car; second, the storage-battery system, in which the batteries are placed under the cars and are charged periodically from an external source of current; and, third, the system in which a steam-driven generator is placed in the baggage car or on the locomotive.

The axle-driven system might seem at first to be the ideal one, as each car could have its own independent source of supply and would not be dependent on any other car or on the locomotive for light. It is necessary in this system, however, to provide storage batteries under each car to supply the latter with light when it is standing still and for the proper regulation of the voltage on the lights. In addition, there must be an automatic regulator to maintain the proper charging current for the batteries, irrespective of the necessarily variable speed of the generator, switches to prevent the discharge of the batteries through the generator and to keep the polarity of the charging current right, no matter in what direction the generator revolves, and also a compensating regulator to take care of the difference in voltage between the charging current and the discharging current from the batteries to the lamps. It can be seen that this is an exceedingly complicated mechanism, and as railroad operating men generally know little of, and have still less use for, electrical apparatus, it can hardly be said that there is the highest possibility of this system coming into extensive use.

In the storage-battery system, batteries charged after each trip from plants at the terminals are placed under each car. They require from six to eight hours for charging and will give light for only about eight hours. The maintenance cost and weight of the batteries in this system are important, not to mention the fact that the cars are tied up at the charging plant for six or eight hours after each trip.

This leaves as the leading commercial system for future development, and the only one whose use is being extended to any extent today, that in which the current is supplied by a steam-driven generator in the baggage car or on the locomotive. Storage batteries are necessary to carry the lights when the engine leaves the train, but as the interval during which light must be supplied at the time when the engine is detached from the train is very short, these batteries can be very small. The only logical place for the generating unit is on the locomotive and not in the baggage car. When placed in the latter it is separated from the steam supply and has to be connected with it by a steam coupling under high pressure, always a great source of trouble and annoyance. It is frequently desirable with heavy trains to run the baggage cars all together in one section and the passenger cars in another, but if the lighting units are in the baggage cars, one of the latter must be added to the heavy train of coaches and separated from the rest of the baggage. The engineer on the locomotive is the only member of the train crew fitted to look after the lighting unit. It should be placed under his care and not under the care of a man whose chief duty is to handle trunks.

On account of limitations of space, the steam turbine is the only prime mover adapted to driving the dynamo for lighting when the latter is placed on the locomotive. Units of about 25-kilowatts capacity are generally used and these are compact enough to be conveniently placed on top of the boiler, either between the head light and the stack or else further back, sometimes just in front of the cab. In cases where it may seem desirable for exceptional reasons to place the lighting plant in the baggage car, the turbine-driven unit is much the more satisfactory as it can be run by a much less capable man than is necessary to handle a reciprocating engine and in addition it takes up much less space. Electricity for train lighting has come into very extensive use during the past two years and it will be used even more extensively in the future, on account of the great danger of explosion and fire, in case of any otherwise trivial accident, inseparable from the use of gas under a pressure of 175 pounds per square inch.

In marine work but little has been done with small turbines. In fact it is for only a few years that the large turbines have been used to any extent on shipboard. The small machines are applicable to driving centrifugal pumps for feed purposes and circulating pumps for the condensers, just the same as in service on land. They are also well adapted for driving the forced-draft fans as these are in close proximity to the boilers; but electric motors are generally much better for driving the ventilating fans at a distance from the boilers as it is much easier to run conduits for wires than steam and exhaust pipes.

One of the most popular uses of the steam turbine up to the present date is for driving blowers for gas works and foundry cupolas. In gas-works service, it is necessary to stop and start the blowers very frequently and they must be started quickly. The turbine does not have to be warmed up, and if water is carried into it by the steam, it merely slows the machine down a little, whereas with a reciprocating engine, it would knock out the cylinder head. Blowers direct connected to turbines running from 2,500 to 3,500 revolutions per minute can be brought from a standing start up to full speed in from seven to ten seconds. For supplying the blast in forge shops and foundries it is necessary to run the blowers at very high speed to get the necessary pressure and this speed can be conveniently obtained only by direct connection to a turbine. When belts are used, their slipping and stretching and objectionable noise are always sources of annoyance.

For small isolated electric-power plants, the small turbines are pressing the very best reciprocating engines very hard for first place. A large number have been installed for this service and the results in general have been very satisfactory. Of course, mistakes are made occasionally, and some turbines have been installed at a disadvantage, under conditions which would have perhaps been better for an engine, but the few instances in which the results have not been all that was expected should not condemn the turbine as a machine when properly installed and under the right conditions. I have in mind one interesting incident which may give a little food for thought. A plant in a certain office building which furnished the power for lighting, elevators and the various other requirements of the building needed an additional unit. The superintendent, who was too much of a good business man to be a very good engineer, decided that turbines were the latest development in prime movers, so he sent invitations to bid to the various manufacturers of turbines. When the question of steam pressure and back pressure came up, he dug up the old contract on which the boilers were bought and found that the guaranteed steam pressure was 175 pounds per square inch; this he specified as the pressure at the turbine. As to the back pressure, he decided that, since the turbine would exhaust through a pipe which led to a riser to the roof of the building, about 15 stories high, and since the riser opened into the atmosphere, there would be no back pressure and so stated in his specification.

The turbine was erected and ran with a pressure at the throttle of about 150 pounds and a back pressure of 4 pounds per square inch. Naturally under these conditions it did not give very good economy as the nozzles were designed for 175 pounds of steam and no back pressure above the atmosphere. The back pressure especially makes a very great difference in the economy of the turbine. When the superintendent discovered that to run this turbine took several barrels of coal per week more than was necessary with his engine, which was of one of the very best makes and designed for the pressures under which it was running, he declared that the turbine was no good and wanted it thrown out in spite of the protests of the engineer who was running the plant.

In comparing the turbine and the reciprocating engine as to their relative advantages under the most general conditions, the turbine seems to be superior on a majority of points. In individual cases there are always particular conditions which have a greater or less influence on the choice of the type of steam motor to be installed. The most important consideration in this connection is the speed at which the driven shaft must run. When the choice of motor is limited to a steam turbine or a reciprocating engine, speed is very nearly the sole determining factor. It is impracticable to run engines much above 400 revolutions per minute and almost equally impracticable to run turbines at a slower speed, if steam economy is any object at all. This seems very simple, but unfortunately it does not work out quite so easily. Almost invariably the unit, whether it be a generating unit, a pump or a blower, is considered as a whole and the question resolves itself into one which involves the machine to be driven even more than it does the prime mover itself. The natural rotative speed of all machines which depend upon centrifugal force for their operation is high, and the same is true of electric generators. Except for very large volumes and low heads, centrifugal pumps and fans are required to be run at speeds above the limit of the steam engine. Even when the volume and head are of such proportions as will permit direct connection to an engine, the cases are rare in which a much smaller, more compact and less costly high-speed turbine-driven machine cannot be provided that will operate equally as well as, and probably better than, the slower and larger unit.

Steam consumption is a point which is very important in some cases and which need not be considered in others. The latest well-designed turbines of under 300 horse power, which are generally classed as small turbines, have at the speeds for which they are designed nearly as good steam economy as is obtained from the best makes of reciprocating engines under their best conditions; and when all the factors influencing economy are taken into consideration, it is probable that in general the turbine will show to better advantage than the engine. In quoting tests of performance, the steam consumption of reciprocating engines is generally given in pounds of steam per indicated horse power per hour, while it is necessary to measure the steam consumption of turbines in pounds per brake horse power per hour. This little matter makes a difference of from 10 to 25 per cent in favor of the turbine when a comparison is made merely on the horse-power-hour basis. A new engine may be more economical than a new turbine, but in the long run the relative economy of the two is usually changed to a very marked extent after a certain period of operation.

The only wearing surfaces on a turbine are the shaft bearings. As the weights supported are light, the wear is very small and has almost no effect on the steam consumption. In the reciprocating engine, however, even the slightest wear of the valve, valve seat or piston rings will cause leakage which, though not perceptible from the outside, generally increases greatly with the age of the engine.

Of course it must be considered that the condition of an engine will be governed to a great extent by the engineer who has charge of it. In turbine operation, although it is much better for a turbine to be handled by a capable engineer rather than by a poor man, high-class supervision is not nearly so essential as is the case with a reciprocating engine. The principal thing which a man operating a turbine should be taught is to let it alone. There are two shaft bearings which need to be filled with oil every few days and as that is about all the attention a turbine needs, the labor required for operation is much less than is necessary on an engine.

A very important point in cases where the exhaust is returned to the boilers either by running into a surface condenser or by being condensed in a heater is the question of oil in the exhaust steam. The exhaust from a turbine contains no oil whatever, while the oil used for lubricating the pistons in the cylinders of an engine is always present in the exhaust steam in considerable quantities.

The maintenance cost of a turbine will obviously be much less than that of an engine and this has been abundantly proved by experience. As the turbine has only the two shaft bearings where any wear can occur, the repairs must of necessity be less than those required on a reciprocating engine in which it is necessary to keep cylinders bored, valves and seats properly scraped, crossheads in line and the wear taken up on all pins and on the heavy shaft bearings. The first cost of a turbine is sometimes more and sometimes much less than the cost of an engine, according to the size and speed. When the cost of the complete unit for a given service is considered, however, whether it be fan, generator or pump, the total cost will in almost every instance be much lower for the higher-speed turbine-driven installation, which will also occupy very much less space.

It must not be inferred that the advent of the steam turbine will drive the engine out of use. This will probably never take place. The steam engine as built today is probably more intelligently and carefully designed and constructed and better and more widely known than any other machine in use. There are many conditions to which the reciprocating engine will continue to be better adapted than any other type of prime mover. When electricity came into extensive use for lighting, many people thought that the gas companies would have to go out of business, but they are still just as busy as ever. In their future development the engine and the turbine should each seek the field which it can fill best.

METALLURGICAL PRACTICE IN THE GOLD FIELDS OF WEST AUSTRALIA.

By Arthur Selwyn-Brown.

In our issue for last November, Mr. Selwyn-Brown reviewed the geological features, development, and gold production of the principal Australian fields. He completes the study here by a summary of the special milling and metallurgical methods adopted for the treatment of these often difficult ores.—THE EDITORS.

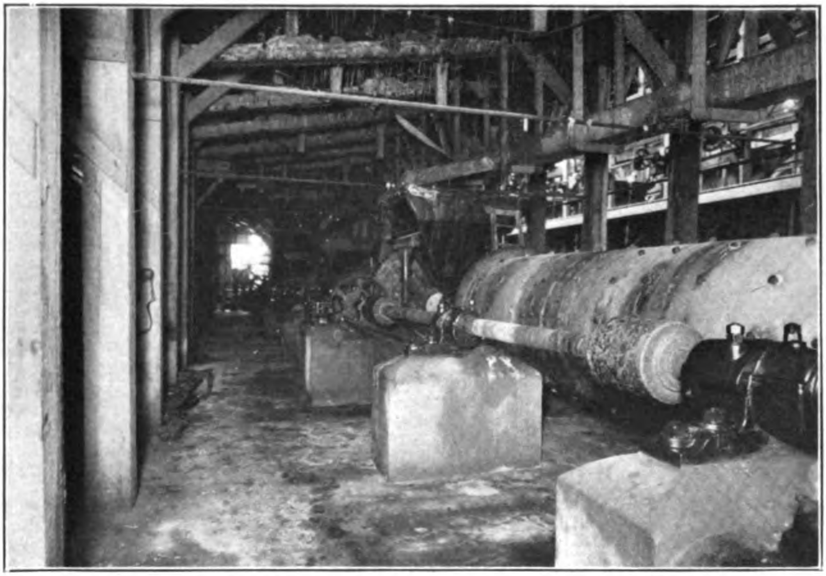
A GREAT impetus was given to gold mining in West Australia, by the discovery of the Coolgardie and Kalgoorlie fields in 1893 and 1894 respectively. At that time metallurgists were developing the cyanide process in the Transvaal and New Zealand, and perfecting the chlorination process in Colorado, New South Wales and Queensland. The mines in West Australia when first opened were very rich and the gold was free and easily saved. Simple crushing and amalgamation processes were, consequently, adopted for treating the ores. The greatest difficulties experienced by the metallurgists arose from the scarcity of water. The mines were situated in arid districts, between 300 and 400 miles westward from the sea and coastal rivers, and the only sources of supply in the mining camps were the mine waters, mineral springs and desert salt-pans. All the ground water was full of alkali and the miners were compelled to distil the alkali water to obtain supplies for drinking and domestic purposes. The scarcity, however, was remedied by the Government early in 1903.

THE WATER SUPPLY OF THE GOLD FIELDS.

The Government clearly recognized the economic value of the gold discoveries and, while the mining boom was on, boldly undertook to supply the principal mining communities with good water. Its scheme was, in addition to being the greatest of its kind, unique in other respects. The estimated requirements of the fields amounted to 5,000,000 gallons of water per day. After numerous surveys had been made, it was determined to run a weir across the Helena River, near Mundaring, and pump the water thus collected, in 2½-foot rivetted steel conduits, a distance of 351½ miles to Bulla Bulling. A concrete weir 760 feet in width and 100 feet in height was constructed across the river. This formed a reservoir with a storage capacity of 4,600,000,000 gallons, and a daily output capacity of 5,000,000 gallons. The main service reservoir from which the towns and mines of the gold fields are supplied is situated at Bulla Bulling, 21 miles eastward from Coolgardie. This reservoir has an elevation of 1,290 feet above the level of the Mundaring reservoir. The water is pumped from Mundaring to the Bulla Bulling reservoir by steam pumps operating in eight sections and from as many intermediate reservoirs or storage tanks. These pumping stations handle daily over 5,000,000 gallons of water, weighing approximately 22,300 tons. From Bulla Bulling the water is distributed to numerous centers by gravity through steel conduits. The scheme, at present, embraces 14 large reservoirs with a combined storage capacity of 31,500,000 gallons, eight main pumping plants and numerous minor service reservoirs and pumping stations in the neighborhood of the towns and mining districts which depend upon the project for their water. The total cost of the scheme was $15,000,000. The income from the sale of water pays interest on the capital invested, and three per cent per annum towards a sinking fund. The supervision of the scheme is exercised by the Department of Mines, and the actual management of the distribution of the water on the various fields is entrusted to various lessees and water trusts. The water supplied is of the finest quality for all purposes and the capacity of the service is adequate. The remarkable results of this great scheme, undertaken in the face of many difficulties for purely economic purposes, has fully justified the boldness of the engineers who planned it, and the government that financed it. Without the adequate water supply which it guarantees it would have been impossible for the gold fields to have been developed to anything like their present extent.

Metallurgical Methods.

By the time the water scheme was completed, the principal mines had been developed to a considerable depth. In many of them, especially at Kalgoorlie, sulphides and tellurides were met with below the water level. This necessitated the modification of the simple amalgamation process and the adoption of improved metallurgical methods. By this time both the chlorination and cyanide processes had been brought to a high degree of efficiency. The chlorination process, as developed at the Mount Morgan Mine, Queensland, offered a solution of the sulphide problems at Kalgoorlie, and it was adopted at several of the mines. The high price of fuel for roasting the ore, however, prevented its general adoption. The cyanide process, in which roasting was not necessary, offered advantages, but neither the South African nor the New Zealand methods of cyaniding were found suitable in West Australia. New methods had to be worked out to adapt cyaniding to the treatment of the local ores. This has been done so successfully that West Australian cyanide practice is now recognized to be in advance of that of nearly ali other mining fields.



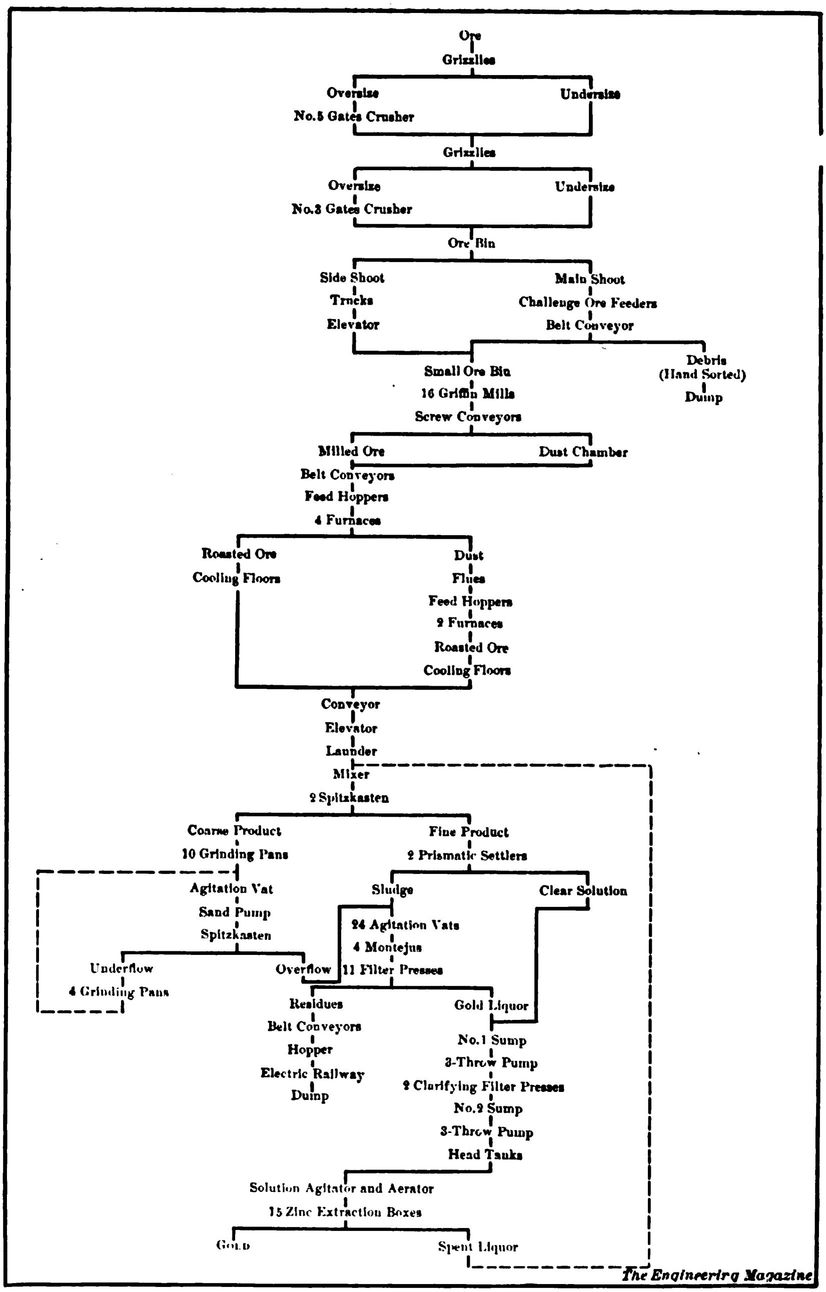
KRUPP FLINT MILLS AT THE GOLDEN HORSESHOE MINE.

Each mill is 16 feet 4 inches long by 4 feet in diameter and is run at 30 revolutions per minute. Each mill is charged with 5 tons of flints, requires 30 horse power to operate it, and grinds 30 tons of sand in 24 hours.

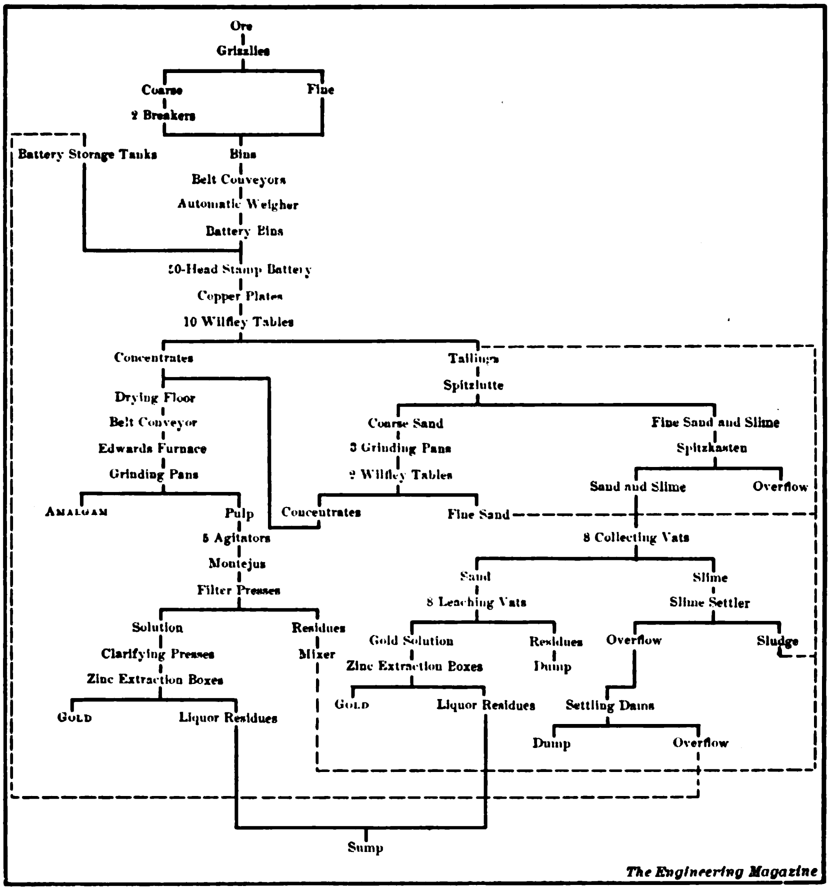
There are two main methods employed in cyaniding gold ores in West Australia. They may be described as, first, the method involving dry crushing, roasting, fine grinding to slime, cyaniding and filter pressing; and, second, the wet crushing, concentrating and cyaniding method. The details of these methods are illustrated on pages 604 and 605, in the flow sheets of two typical mines, the Great Boulder Perseverance, which employs the dry-crushing method, and the Sons of Gwalia, which crushes wet.

Dry Crushing.

The ore to be treated by the dry-crushing method is first crushed in Blake rock breakers, screened and dried in Howell-White revolving furnaces. It is then fed automatically into manganese-steel-lined Krupp or Griffin mills. Ball mills of the Krupp type are considered the most effective crushers. The plant on the Kalgurlie mine



FLOW SHEET OF A TYPICAL DRY-CRUSHING MILL, THE GREAT BOULDER PERSEVERANCE.



FLOW SHEET OF THE SONS OF GWALIA MILL, A TYPICAL WET-CRUSHING INSTALLATION.

is furnished with 9 No. 5 Krupp mills with a combined capacity of 11,000 tons per month. Each mill crushes about 45 tons to a 37-mesh screen size in 24 hours. The compressed steel balls used in the mills weigh 18 pounds each when new. Each mill is charged with balls of a total weight of 2,500 pounds. A new ball is added to each mill daily to compensate for wear and tear. The mills are run at a speed of 25 revolutions per minute and require 25 horse power to drive them. Milling in ball mills costs 75 cents per ton.

The Griffin mills are usually of No. 11 size. The crushing rolls are 15 inches in diameter and are suspended on a 6½-foot shaft, hung on a horizontal driving pulley running on ball bearings. This mill operates on a principle similar to that of the well-known Huntingdon wet-crushing mill, but the Griffin mill has only one rotating crushing roll. The capacity of each mill is about 35 tons per 24 hours. As each machine requires 18 horse power to drive it, the daily output is about 2 tons per horse power. The crushing cost with Griffin mills is slightly higher than that of ball mills. The equipment of various dry-crushing plants is shown in the table below.

TABLE I. ALL-ROASTING PLANT EQUIPMENT.

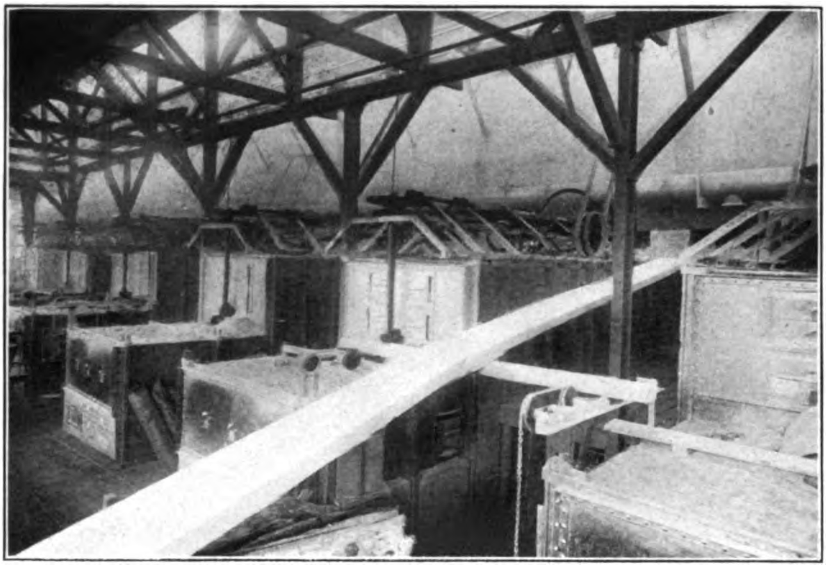
Mine.	Tonnage per Month.	Mills.	Furnaces.	Grinding Pans. Number.	Grinding Pans. Diameter, feet.	Treatment Costs per Ton.
Great Boulder	14,000	2 No. 8 Krupp. / 12 30-inch Griffin	12 Edwards / 8 Merton.	12	5	$2.74
Perseverance	16,000	16 No. 11 Griffin	6 Edwards-Perseverance	14	8	2.76
Kalgurlie	10,000	9 No. 5 Krupp.	15 Edwards.	15	5	2.88
South Kalgurlie	9,000	3 No. 8 Krupp.	8 Merton	5	8	2.80
Associated	9,000	10 No. 5 Krupp.	18 Merton	20	5	2.70
Associated North	4,000	3 No. 5 Krupp.	5 Merton	8	5	2.90

Dry-crushing mills, of course, make a large amount of dust. The mills on the Kalgurlie mine make 150 tons of dust per month, of which the gold content averages 15 pennyweights per ton. The mills are encased in sheet-iron covers which are connected with suction fans. The Kalgurlie mills are connected with three Sturtevant fans which draw the dust from the Krupp ball mills and carry it to a settling chamber, a frame building 72 feet by 14 feet by 23 feet in height. This dust chamber has a sloping or V-shaped floor divided into three compartments to facilitate cleaning. The dust is taken out monthly and the gold is recovered from it by cyaniding.

ROASTING.

Many types of roasting furnaces have been tried in West Australia, but they have all been abandoned in favor of the Merton and Edwards furnaces. These are both Australian inventions, and were developed for roasting ores for the chlorination process. They are now generally adopted throughout Australasia for roasting all classes of ore and their use is rapidly extending in the United States and Mexico.

The Merton roaster is a three-hearth machine-rabbled brick furnace. The hearths are horizontal and alternate ends are left open. The ore is stirred and automatically moved forward from the top to bottom hearth by revolving cast-iron rabbles. The rabbles on the



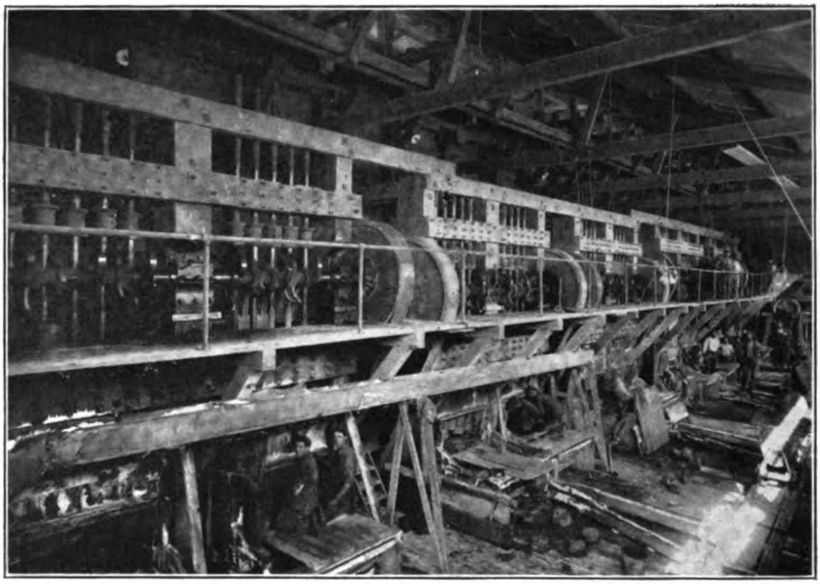
MERTON FURNACES, GREAT BOULDER MINE.
Eight furnaces each with an effective hearth area of 422 square feet. Each furnace roasts 25 tons per 24 hours. Sulphur reduced from 3.5 per cent to 0.05 per cent.

forward portion of the lower hearth, where the finishing or sweet roast is carried out, are water-cooled.

The Edwards roaster is used in two forms. The common type has the furnace fire box at one end. The Perseverance type, as developed at the Perseverance mine, is larger than the ordinary type, and, in addition to the end fire box, has two auxiliary fire boxes placed on each side of the hearth. This roaster is provided with automatic rabblers and a return cooling hearth which extends along the whole of the underside of the main roasting floor, or hearth. Details of the economy of the roasting furnaces are given in Table II.

TABLE II. ORE ROASTERS AT KALGOORLIE.

Mine.	Type.	Area of Hearth, Square Feet.	Average Tonnage per Day.	Percentage of Sulphur in Ore.	Cost of Roasting per Ton.
Kalgurlie	Edwards	665	23	4.2	$0.68
Perseverance	Edwards-Perseverance	1663	93	4.0	0.65
Great Boulder	Edwards	416	25	3.5	0.65
Associated Northern	Merton	630	22	5.0	0.61
South Kalgurlie	Merton	617	36	3.8	0.64
Associated	Merton	446	20	6.1	0.63



BATTERY CLEAN-UP AT THE LAKE VIEW CONSOLS MINE.

There are 75 head of stamps, each weighing 1,200 pounds and having a duty of 5½ tons of ore per day.

Fine Crushing

Fine crushing has been found essential to efficient cyaniding in West Australia. The free gold is often encased in other minerals and is only liberated so as to come in contact with the cyanide solutions when finely comminuted. The presence of calcium sulphate in the ores and mill water causes difficulty in emptying the cyanide vats unless the roasted ore is very finely pulverized. Fine crushing is done in tube mills similar to those long employed in the manufacture of cement, or in pans of the Wheeler type, which have been in favor with Australian mill men since the early gold mining days. The tube mills are from 14 to 18 feet in length and 3½ to 4½ feet in diameter. They are loaded with from 5,000 to 6,000 pounds of flints or other stones, and are driven at a speed of 30 revolutions per minute. Such mills require 20 horse power to operate them. They are lined with chilled iron plates which are often indented in various ways in order to receive a lining of flints set in cement. The crushing stones half fill the mills. The flints are obtained principally from France or the shores of the Baltic Sea and cost about $2 per ton on the gold fields. Each mill consumes about 2½ tons of flints per month, or about 1½ pounds per ton of ore milled. The chilled iron liners last six months.

The Wheeler grinding pans are generally from 5 to 8 feet in diameter and are driven at a speed of 50 to 70 revolutions per minute. The grinding weight of each pan is 2,500 pounds, and each machine requires 6½ horse power to drive it. In order to keep up the crushing efficiency of the pan as the shoes wear down, various methods of counterweighting are resorted to. The commonest method is to affix counterweights on the upper surface of the muller as wearing proceeds. In the Cobbe-Middleton type of pan the muller is fixed and the bottom of the pan is balanced by cross levers acting against the muller. In this way the crushing weight is kept constant during the whole run. The adjustment is automatically made by the levers as required. It is found that the grinding efficiency of pans is proportional to the circulation of the feed, and the circulation varies directly with the interspaces between the shoes. In consequence of this, the speed of the pans is increased as the shoes wear down to assist in keeping the tonnage uniform.

Advocates of pan grinding claim that the successful competition of wet-crushing mills in West Australia with those employing the dry-crushing and roasting methods has been made possible solely by the successful development of the pan. The mechanical details of the pan are still being improved, and it is probable that its efficiency will soon be further increased so that its output will be enlarged sufficiently to permit of a further reduction in grinding costs.

Wet Crushing.

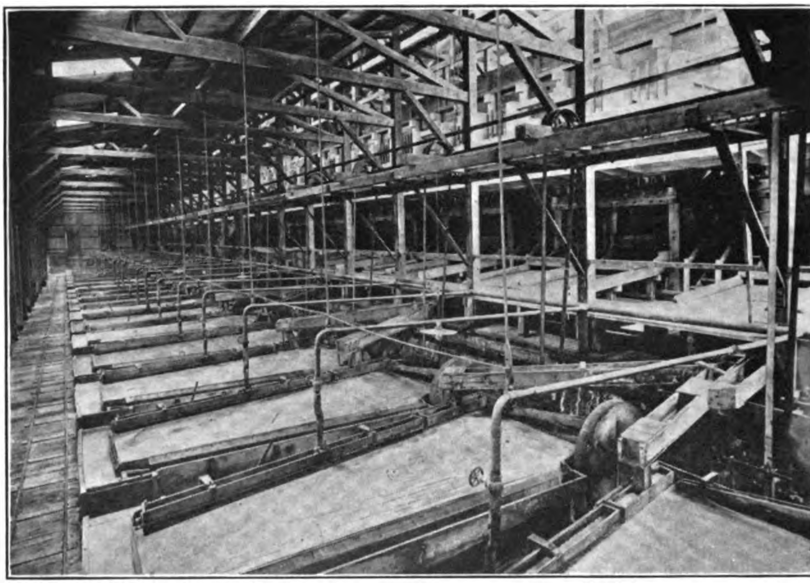
Stamp batteries are chiefly used for wet crushing. The details of such batteries may be summarized as in Table III.

Table III. Stamp-Mill Details.

Mine.	Number of Stamps.	Monthly Tonnage.	Daily Tonnage per Stamp.	Weight of Stamps, Pounds.	Drop in Inches.	Number of Drops per Minute.
Ivanhoe	100	19,000	6.35	1,200	7.5	104
Golden Horseshoe	150	23,000	5.50	1,270	8.0	104
Oroya-Brownhill	50	11,000	7.35	1,100	7.75	108
Lake View Consols....	70	11,000	5.50	1,200	8.0	102

About 20 to 40 per cent of the gold in the ores is saved by battery and copper-plate amalgamation where the latter is practised Some of the batteries, like the Oroya-Brownhill, do not use copper-plate amalgamation.

The crushed ore after passing from the batteries and settling in hydraulic settlers is run over concentrating tables of the Wilfley type. One table is used to every five stamps. The tailings from the tables are pumped to hydraulic classifiers and the coarse sands are run to tube mills and thence to the sump. The fine sands are classified and run over concentrating tables and the fines carried to the sump.



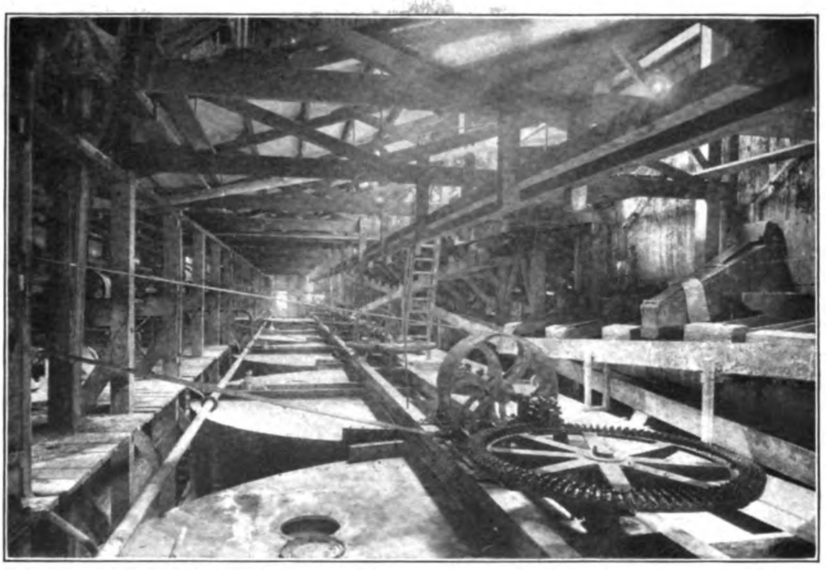
WILFLEY TABLES AT THE IVANHOE MINES, WITH STAMP MILL IN THE BACKGROUND.

Experiments are being made at some of the plants using the "wet-sliming" process to improve the crushing efficiency by stage grinding in pans with final sliming in tube mills. The results obtained at present are conflicting. Some metallurgists prefer to crush in stages in pans while others proclaim the superiority of the tube mills. It would appear that the differences in the results recorded are due more to variations in the nature of the ores crushed than to differences of efficiency in the crushers. The final results of the tests will probably show that the greatest efficiency, in most cases, will be given by happy combinations of batteries, pans and tube mills adapted to the particular requirements of the ores to be treated.

Cyaniding.

The "continuous" process of cyaniding is the one principally practiced in West Australia today. The finely ground ore is kept in contact with the cyanide solution throughout the treatment process. In the wet-crushing plants, the battery water carries from 0.003 to 0.007 per cent of potassium cyanide in solution. The only fresh water used while treating the ore is in washing the filter-press cakes.

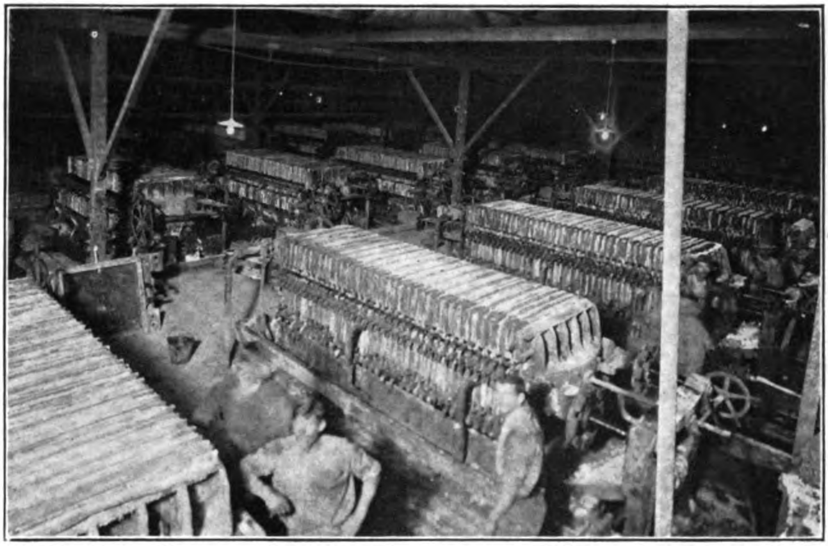
The method of cyaniding at the all-roasting dry-crushing plants is substantially as follows: The ore is dry-crushed in ball or Griffin mills, roasted in Merton or Edwards furnaces, fine crushed in Wheeler pans, agitated with cyanide solution in vats and extracted from the solution in filter presses. The gold is precipitated from the cyanide solutions in zinc boxes on zinc shavings. Zinc dust precipitation, as practised in some of the American mills, has not proved successful in West Australia. The zinc is scrubbed through a 20-mesh screen, calcined, and smelted in Martin tilting furnaces with a flux consisting of 25 per cent fused borax and 10 per cent fine quartz sand. An average assay of the bullion thus produced gives 70 per cent fine gold, 26 per cent silver and 4 per cent base metal. Experiments have shown that the all-roasting plants are cheaper to operate than the wet-crushing plants and they are usually more efficient.



CYANIDE AGITATORS AT THE GOLDEN HORSESHOE MINE.

There are 22 vats, each 22 feet diameter by 8 feet deep, provided with mechanical agitators driven at 6 revolutions per minute. Each vat holds 54 tons of pulp. Agitation is carried on for 20 hours with a 0.06 per cent solution of sodium cyanide.

The wet-crushing process may be illustrated by describing a typical plant. At the Golden Horseshoe mine the ore is crushed in breakers and automatically fed to a 150-stamp mill. The mill pulp is run into a set of 10 hydraulic classifiers. The coarse sands from the classifiers are distributed over 12 Wilfley tables and the fine sands over 11 tables. The slime overflows to settlers. The products of



FILTER PRESSES AT LAKE VIEW CONSOLS MINE.

Each press holds 5 tons of slime. They are filled and washed by 3-throw belt-driven geared plunger pumps.

the Wilfleys are distributed thus: The concentrates go to the roasters, the middlings are re-concentrated and the fine sand and slime are pumped to sand traps. The underflow from these traps is dried, crushed in tube mills and sent to the sumps. The slimes are finally charged into agitation vats holding between 50 and 60 tons and agitated for a period of 18 to 30 hours with a solution of cyanide of potassium of 0.06 per cent strength. The recovery amounts to 88.4 per cent of the assay value of the ore. The total milling and cyaniding cost is $3 per ton.

Bromo-Cyaniding.

In the majority of the mills potassium cyanide is used exclusively. In a few plants bromide of potassium is added to the cyanide of potassium solutions. This practise was introduced by Dr. Diehl to treat the Kalgoorlie tellurides. The dissolving solution, when the Diehl process is used, is made in accordance with the equation

$$2KBr+KBrO_3+3K(CN)+3H_2SO_4=3Br(CN)+3K_2SO_4+3H_2O.$$

The reaction which occurs in the treatment vats is believed to be in conformity with the equation

$$Br(CN)+3K(CN)+2Au=2KAu(CN)_2+KBr.$$

The bromine is obtained from Germany in the form of potassium bromide containing from 40 to 44 per cent of bromide, or potassium bromate with 20 to 22 per cent of bromine. When a vat is charged with slime a bromide solution is made up of 50 pounds of sulphuric acid, 20 pounds of potassium cyanide and 39 pounds of mixed bromine salts. The potassium cyanide used has a strength of 93 per cent and the sulphuric acid 63 per cent. The charge costs about $20 and is sufficient for solution in 200 gallons of water. Some of the ores treated by bromo-cyaniding yield 95 per cent of their gold content. A plant at the Hannan's Star mine, Kalgoorlie, successfully treats an ore averaging only 10 pennyweights of gold per ton. The process is simple, but it requires attention to carry it out successfully. For this reason it has not yet come into extensive use.

Filtration.

The introduction of fine grinding preparatory to cyaniding necessitated improved methods of filtration for separating the auriferous solution from the sand. Very important contributions to the improvement of cyaniding practice have been made in this respect by metallurgists in West Australia. When the cyanide process was first introduced in West Australia the auriferous solution was drawn from the vats by the old decanting methods which are used extensively in South Africa. These were found to be too slow at Kalgoorlie, and experiments were made at the Golden Horseshoe mine with filter presses similar to those used in sugar refineries. Excellent results were obtained and filter pressing immediately displaced decantation in all the local plants.

Filter Presses.

The filter press is designed to separate the finest particles of matter suspended in a solution from the liquid by mechanical means. It consists, in its simplest form, of three rectangular frames clamped tightly together. Two of the frames are provided with corrugated iron plates which completely occupy their centers, like a picture in its frame. The corrugated plates are covered on either side with a punched iron screen, around which a filtering cloth is wrapped. The central frame is open and has no filter cloth around it. If a mixture of slime and water is forced into the center or open frame through a lateral orifice, the liquid will escape through the filter cloth and through the punched iron screens of the adjacent frames. The water will then pass along the surfaces of the corrugated iron sheets to lateral draw-offs connected with a suction pump. Whenever desirable, a current of air or water can be forced through the filter in the reverse direction to the travel of the cyanide solution. Such reverse currents would wash dry or blow off the fine particles of slime adhering to the filter cloths. The filter frames have projecting lugs through which holes are bored for charging the press with pulp, air or wash water, and to carry off the filtered solution. The ordinary press is furnished with from 30 to 60 frames.

The presses are operated as follows: Pulp is forced into each press by pumps or compressed air and spreads over the filter cloths while air and the solution pass through, leaving a cake of slime on the cloth. This operation takes from 10 to 20 minutes. The slime cakes thus formed are washed by forcing wash water through the press at a pressure of about 80 pounds per square inch for 20 minutes. Afterwards a current of air is forced into the frames in the same direction to dry the slime. This air displaces about half the moisture absorbed by the slime. The presses are then opened by relaxing the large screw clamps at the head of each machine. The slime cakes are scraped off the filter cloths into trucks or belt conveyors below the presses. The filter cloths are cleaned, and the machines are again tightly clamped to be ready for fresh charges. The whole cycle of charging, filtering, washing, drying, emptying, cleaning and re-clamping the presses occupies about an hour.

There are 18 filter presses, each having 52 frames, and 900 square feet of filtering surface in daily operation on the Golden Horseshoe mine. Each press has a capacity of 5 tons of raw slime or 6 tons of concentrates per day. Five men charge and discharge 45 presses per 8-hour shift. The solutions from the presses are collected in sumps and subsequently pumped through two clarifying presses before going to the storage vats preparatory to entering the zinc precipitating boxes. Eight presses at the Ivanhoe mine treat 23,000 tons of pulp monthly at a cost of 15 cents per ton. At other mines two men using two presses handle seven charges, or 25 tons of slime in eight hours.

The Moore Filter.

The filter press has been successfully introduced into cyanide plants in the Transvaal, Rhodesia, Mexico and Canada. It is very successful at the Homestake mill in Dakota, but in some of the Western mills trouble is experienced in getting proper skilled labor to operate it. This has resulted in the invention of presses of greater simplicity.

The Moore filter is a development of the filter press. Instead of the filter frames being small in area and fixed in a machine, Moore made them of large dimensions and suspended them in a basket from an overhead traveling crane so that they can be moved to and from a series of vats. A typical Moore filter has 49 filter frames, or leaves, 16 feet long and 5 feet wide, with a combined filtering area of nearly 7,800 square feet, hung in a basket and suspended from an electric crane. Each filter leaf is formed of canvas doubled over a frame of Oregon fir. In the bottom edge of each leaf, a ¾-inch channel iron is screwed to act as a launder for the in-filtered solution. Each leaf contains a 1-inch vertical suction pipe connecting the iron launder with a pump. Each leaf resembles the leaves in a press excepting in the dimensions of the frames and the materials used in their construction. The basket is about 16 feet square, and is hung from the crane by four endless 1-inch pitch chains. It is raised or lowered by a 10 horse-power electric motor. The maximum load of the full basket is 35 tons. The crane travels along a track of 60-pound steel T-rails.

This filter is operated by lowering the basket into a vat full of pulp until the leaves are submerged. The suction pump on top of the basket is started and draws the auriferous liquor through the canvas and discharges it into storage tanks. Suction is continued with intermittent agitation in the vat until a ¾-inch coat of slime forms on the canvas. Then the basket is raised and carried over to a washing vat. After washing the basket is raised and carried to a discharge hopper. The suction is continued until a large amount of moisture is removed from the slime cakes. Air under a pressure of 35 pounds per square inch is finally turned on in place of the suction. This discharges about 85 per cent of the slime into the hopper. The balance is cleaned off by hand. This cycle of operations occupies about 10 hours. Eighteen tons of slime are handled by the filter each 10-hour shift.

THE BUTTERS-CASSEL FILTER.

Cassel inverted the Moore procedure. The Cassel filter, as modified by Butters, is simply a rectangular vat with fixed filter leaves. The leaves are similar to those of the Moore filter in size, but they are made of a frame of iron piping covered with cocoa matting which in its turn is covered with canvas. This makes a strong, straight-filtering mattress. From 50 to 150 leaves are set in a vat. The operation of the filter is similar to that of other suction filters. The liquid is drawn through the leaves by suction pumps and the filter vat is charged and discharged by centrifugal pumps. Cassel filters are handling 4,000 tons of slime monthly at the Lake View Consols mine, Kalgoorlie, and a plant of similar capacity has just been erected on the Gwalia South mine. Filters of this type are displacing the filter press on many West Australian mines. They require less labor to operate them than the presses, are cheap in construction and have large capacity. Large numbers of small steel fixed-leaf filters are being made by machinery houses. They will, doubtless, be employed in many of the new cyanide works where large filtering capacity is not required.

The Ridgway Filter.

A new type of filter, invented by the engineer of the Great Boulder mine, has been successfully developed at Kalgoorlie. It consists of a number of horizontal filter leaves suspended from a vertical spindle in the center of a cylindrical vat. Pipes communicating with each filter frame are attached to the central spindle. The vat is divided into three compartments. One compartment is used for pulp, one for wash water and one for discharging the slime cakes. The filters are revolved around the spindle at a speed which allows each filter frame to remain 13 seconds in the pulp vat, 7 seconds on the elevated bridge while passing from the pulp to wash vats, 30 seconds in the washing vat, 7 seconds while lifting and drying and 3 seconds while the blowing pressure is on over the discharging vat. The complete revolution thus takes about a minute.

There are usually 12 filter frames in each machine with a filtering area of 144 square inches each. The filter deals with 50 tons of dry slime per day. The machine works automatically. A series of 10 treating 500 tons of slime per day at the Great Boulder mine requires the attendance of only one man per shift. The extraction by the Ridgway filter is better than that by any other type and the treatment costs are lower. The efficiency of the filter is greatly promoted by the comparative thinness of the slime cake. It is less than ⅛ inch in thickness as compared with those of several times that thickness in other filters. The thinness of the cake permits cleaner washing and, consequently, a better gold extraction.

Treatment of Concentrates.

The proper treatment of concentrates is becoming an important question with West Australian mining companies. The gold ores on most of the fields become refractory below the water level and concentration has to be resorted to. When only small quantities are produced they can be satisfactorily disposed of to custom smelters. When, however, the output is large, the ores must be dealt with at the mine. The method of treatment employed at a few typical mines will indicate the general lines of treatment in West Australia.

The concentrates at the Oroya-Brownhill mine carry a large amount of mineralized matter and average 35 per cent sulphur, 0.5 to 0.6 per cent tellurium and about 42 per cent of the total gold contents of the ore. They are saved on Wilfley tables and roasted in Merton furnaces. Those furnaces roast 600 tons per month, reducing the sulphur content to 0.2 per cent as sulphide. The roasted material is ground fine in two sets of pans. The first set of pans is fed with mercury three times a day. About 30 per cent of the gold is saved by amalgamation. The second set of pans is used for fine grinding only. They receive the coarse part of the overflow from the first set. The united overflows are sent to vats, and, after being cyanided for 100 hours, are passed through filter presses.

The Redhill concentrates are roasted in Edwards furnaces by heat generated by their own sulphur contents. Assays show their composition to be 36.2 per cent iron, 34.3 per cent sulphur, 0.5 per cent nickel, 4.2 per cent silica, 8.4 per cent alkalies and 14.9 per cent oxygen, with free gold in scaly pieces. There are usually present also from 3 to 4 per cent of soluble sulphates and chlorides. The presence of the latter is due to the salts in the mine water used in milling the ore.

The Bellevue concentrates are also very refractory. They are roasted and ground in pans without mercury. The sulphates in the water cause a large amount of scale to collect in the pans. After a month's run the hard scale assays as high as 250 ounces of gold per ton. The overflow from the pans goes to Wilfley tables. These take out any unroasted concentrates which escape from the furnaces and save scale from the pans. It is found, also, that gypsum crystals are deposited in thick net-like bunches on the riffles attached to the tables, with the axes of the crystals at right angles to the surfaces of attachment. They thus form a series of cross riffles which very effectively save the finest gold particles. This calcium product when collected averages over 5 ounces of gold per ton. The finely ground material from the pans is cyanided and an average gold extraction of 90 per cent is obtained. The scale is sold to the customs smelters.

SYSTEMATIC FOUNDRY OPERATION AND FOUNDRY COSTING.

By C. E. Knoeppel.

V. THE IMPORTANCE OF COMPARATIVE ELEMENTS AND HOW THEY ARE APPORTIONED TO PRODUCTION.

Mr. Knoeppel's series, which began in the October, 1908, number of THE ENGINEERING MAGAZINE, has already dealt with the simple elements of the problem of foundry costing, the importance of correct burden apportionment, and the enumeration and classification of the elements entering into production costs. In the present instalment he discusses the apportionment of the various elements to product. Next month he will show how the principles of cost apportionment enunciated here are applied to various classes of foundries.—THE EDITORS.

STARTING with two definitions, first, that "success is the accomplishment of some particular ambition or undertaking," and second, that "failure is lack of accomplishment," let us endeavor to ascertain, if we can, upon what an accomplishment in foundry work depends—a knowledge which should interest those who are striving for results in the way of greater efficiency.

In the first place, let us keep in view this fact:—*nothing is large or small except by comparison.* When a man speaks of the judgment of another as being "sound," he has compared this man's judgment or his success either with his own or with that of other men of his acquaintance. When a man is called upon to decide regarding a policy, he compares the advisability of carrying it out along certain lines with that of carrying it out along opposite lines. When a man is called upon to decide between the choice of two vocations, he first compares one with the other. A lawyer in summing up compares his arguments with those of his legal opponent, while the jury in turn compare the arguments advanced by the opposing lawyers. Before a man becomes a member of a church, he first compares creeds and beliefs; before a man designs a machine, he compares the different ways he could construct it; before a man builds a house, he compares different styles of architecture—in fact, comparison seems to be a basic element of vastly greater importance than is at first apparent.

It is no doubt evident to all that nothing is done, no move ever made, except through the instrumentality of an *action* of some sort, and that no one acts one way or another without first deciding as to the course to pursue—*conclusion.* Looking at comparison, then, as a basic element, it can be seen that after a comparison has been made but *before* a conclusion can be reached and action taken, it is necessary for something to bring out the good features and eliminate the bad ones—to affirm or to deny—this something being a mental process—Reason. Accomplishment, then, is an effect—the result of an efficient action, based on a logical reasoning applied to a thorough and complete knowledge of comparative elements. If this is true, it follows that if our elements are incomplete or faulty, the reasoning and conclusions are bound to be illogical and the action a failure or at least inefficient—in fact it is this lack of sufficient comparative data that is responsible for so much of the inefficiency that Mr. Harrington Emerson criticizes so ably in the series now running in this magazine.

All this means a great deal to the business world, being of special significance to the foundry industry; for in the conduct of a foundry business, success is dependent upon the course pursued by its management—action—which to result in accomplishment depends upon the reasoning applied to comparative elements—analysis in other words. The lesson is plain. *Facilitate analysis by concentrating every effort toward making comparisons efficient.* Intelligent action—accomplishment—success will follow as a natural result.

The preceding paper gave a suggestive outline of the comparative elements peculiar to the usual foundry enterprise; this paper will take these elements, which serve a two-fold purpose—first, the finding of costs, second, the facilitating of analysis—and reclassify them so that the exposition will not only be more comprehensive and efficient but correctly apportioned to production as well.

The conducting of a foundry business involves two things—the making or production of castings, and the sale or disposition of the castings produced—the shop being responsible for the making or production, and the second element being a purely commercial transaction about which the shop has very little if anything to do, exercising no direct influence over the executive control and administration of the business; consequently in justice to both interests we must consider the following as being the principal divisions of the grand total of the elements entering into cost of production:—

1.—Shop Cost—that is, the cost of making the product.

2.—Commercial Cost—that is, the cost of administering the business and disposing of production.

Shop Cost is found to be made up of two kinds of costs which we will term "Direct Cost," including those items which can be charged direct to specific production, such as iron, moulding, etc., and "Indirect Cost," including those items which cannot be applied direct, such as sand, supplies, supervision, laborers—the elements entering into Direct Cost being classed under the headings or subdivisions of "Direct Materials," such as pig and scrap irons, etc., and "Direct Labor," such as moulding and core making.

The elements which go to make up Indirect Cost are also of two kinds—those which have a tendency to increase or decrease as the volume of product increases or decreases, and those which do not seem to have this tendency; consequently it is necessary to observe this distinction in our calculations, and we will therefore divide "Indirect Cost" into (1), Tonnage Charge, and (2), Foundry Charge, the first being applied to product as an additional charge to the amount which it receives through Direct Material, the second being applied to product on the basis of Direct (or Productive) Labor.

Commercial Cost, defined above as the cost to administer the business and dispose of product, should be divided into "Administrative," including all items of expense which enter into the successful management of the business, such as executive and office salaries, office expense, supplies, etc., and "Selling," including all expenses made necessary because of the marketing of the product of the shops, such as salesmen's salaries and expenses, advertising, etc.

From this it will be seen that we have six subdivisions of costs common to a majority of foundries:—

DIRECT MATERIALS
DIRECT LABOR
TONNAGE CHARGE
FOUNDRY CHARGE
ADMINISTRATIVE
SELLING

These control the numberless details peculiar to them, the subdivisions being in turn controlled by others:—

DIRECT LABOR }
DIRECT MATERIAL } making DIRECT COST.
FOUNDRY CHARGE }
TONNAGE CHARGE } making INDIRECT COST.
ADMINISTRATIVE }
SELLING } making COMMERCIAL COST.

Commercial Cost combined with Shop Cost (Direct and Indirect Cost) make "Total Cost"; so that no matter what the executive wants to scrutinize, whether the amount of sand or chaplets used or the cost to sell the product—the cost to make the castings or the details regarding the shop expenses—he has a means of getting at what he wants to know *automatically*, all being arranged and classified for immediate reference. It is therefore necessary to reclassify the various cost accounts previously shown, according to the six sub-divisions; Charts 1, 2 and 3 show what each sub-division comprises, Chart 4 being an exposition of how they are merged into Total Cost and apportioned to product.

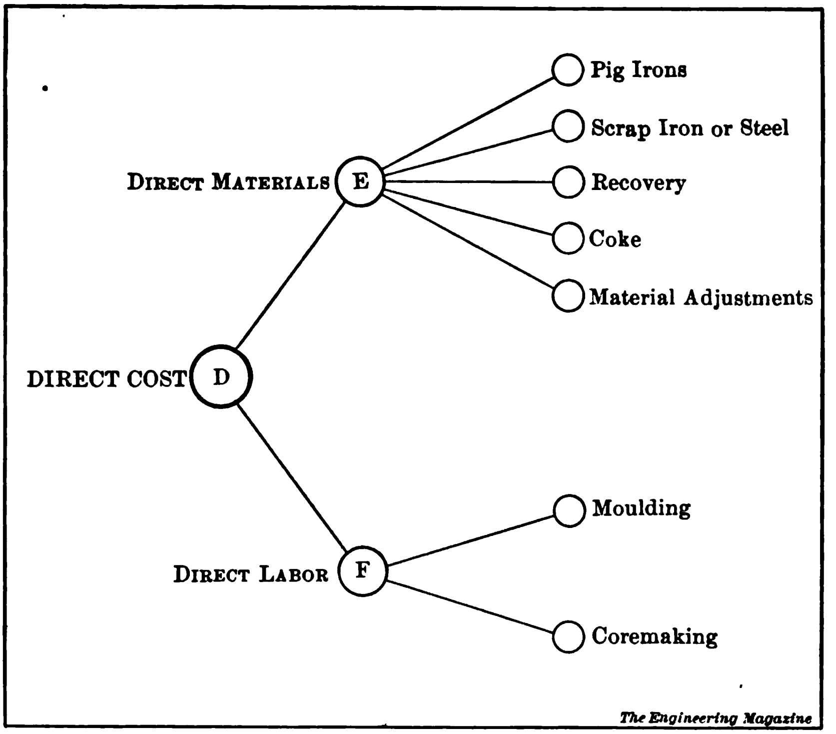


CHART I. THE ELEMENTS ENTERING INTO DIRECT COST.

Regarding the suggested apportionment, it will be seen that Direct Material and Direct Labor, on account of their nature, are *direct* charges to production and are therefore easily disposed of in costing. In Indirect Cost we have an element not capable of being handled so easily, for while there is absolutely no question regarding the advisability of apportioning this element, part to product on the basis of tonnage and part on the basis of Direct Labor, there may be considerable question regarding the advisability of apportioning the various elements which made up this sub-division according to the manner

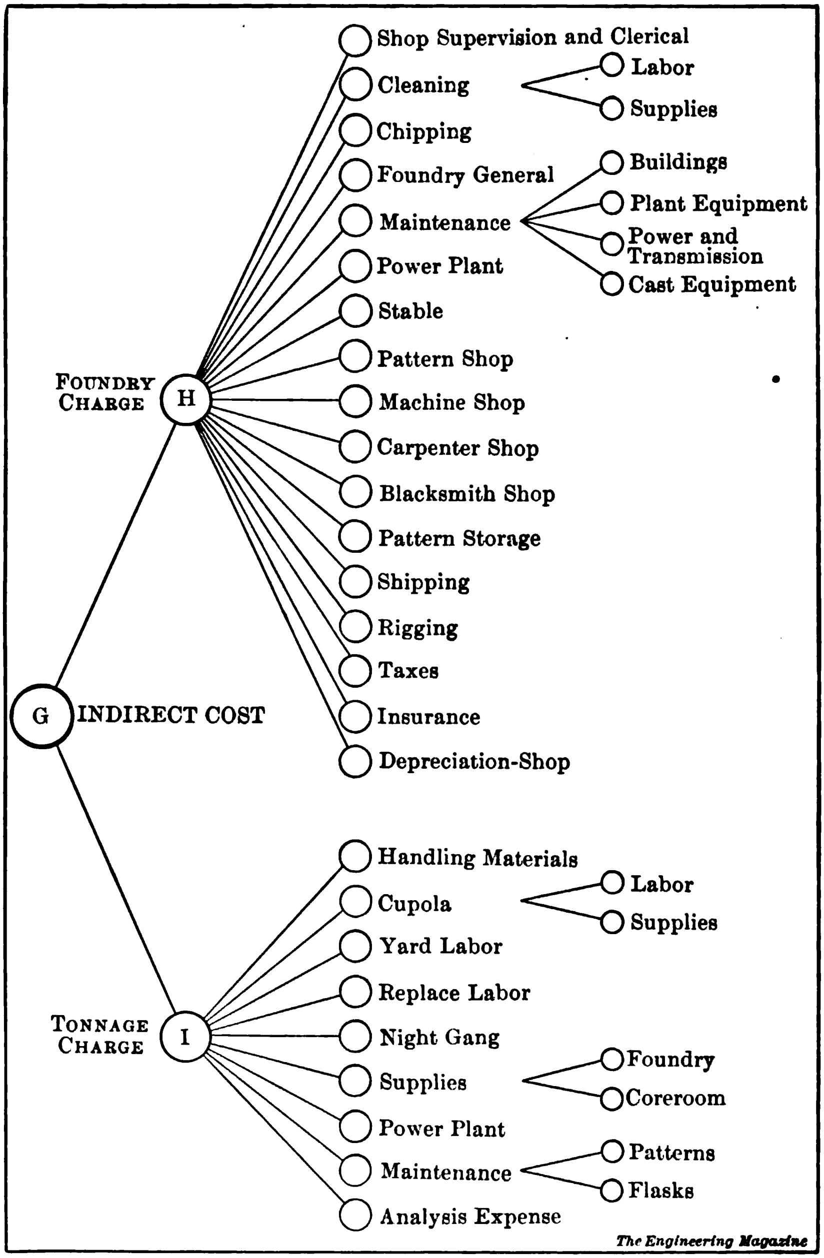


CHART 2. THE ELEMENTS ENTERING INTO INDIRECT COST.

outlined in Chart 2. In determining to which class any item of Indirect Cost belongs, the relation of each one to the tonnage produced must be given consideration. If the tendency is for the cost of an item to increase or decrease as the volume of the product increases or decreases, the item is a charge to production on the basis of *tonnage*. If this is not the case, however, the apportionment must be made on the basis of Direct Labor.

Take for instance the item "Handling Material." Here we have an element that will increase or decrease with the tonnage produced, not proportionately perhaps but to some extent at any rate, while the increased tonnage which necessitated this extra handling cost might have been accompanied by the expenditure of about the same amount of labor, owing perhaps to a different line of work. This reasoning also applies to Yard and Cupola Labor. Regarding Replace Labor, it is evident, though it does not always follow, that the greater the total of production the greater will be the labor expended to replace castings condemned in the foundry; for it is natural to expect that more castings will be lost and replaced when the production is 500,000 pounds monthly than when it is only 200,000. From this it seems proper to include Handling, Yard, Cupola and Replace Labor in the TONNAGE CHARGE section.

A foundry starting with a tonnage of 10 tons daily will find that it will have to add more men to the force who take out the work at night when the tonnage increases to 20 tons per day, so that it is proper to class the item Night Gang as a tonnage expense along with Foundry, Core Room and Cupola Supplies which tend to increase as production increases, while to this same class can be added Maintenance of Flasks and Patterns as these expenditures will be greater with a larger production than when the production is such as does not call into play so many flasks and patterns. As the power used is proportionate to the run of the cupola, the proper amount of the Power Plant charge should be included in the tonnage item along with Analysis Expense, which is included in this section not so much because the expense is likely to increase as the production increases (depending of course on the variety of the work) but because of the fact that analysis is directly related to metal produced. Briefly reviewing, it will be seen upon consideration that the items mentioned may increase in proportion, or faster, or not as fast, as the increase in production; but the tendency is to increase nevertheless, while the increase in the production may be the result of about the same amount of direct labor, although this increase could be accompanied by a greater relative increase or even a decrease in this direct labor, all of which seems to indicate that apportionment of the items mentioned to the production on the basis of tonnage is perfectly logical.

Let us consider for a moment the suggested apportionment to "Direct Labor." If the items have a tendency to increase in cost as the amount of direct labor increases; or if, on the other hand, there is no relation between the two, and no relation between the cost of the items and the tonnage produced, then they are correctly shown in the exposition. Take for instance Shop Supervision and Clerical. It stands to reason that the more producers there are at work the greater will be the need for supervision and clerical work, while with fewer producers less will be required, although the cost per dollar of direct labor will be greatest when a minimum number of producers are at work, because of the fact that supervision and clerical work cannot decrease in proportion to the decrease in the amount of direct labor expended; they decrease as the amount of direct labor increases until a point is reached when more supervision is required; and as consideration will show that the same expenditure of direct labor might result in a large production one week and a small one in the week following, it is evident that the item mentioned is more nearly proportionate to labor expended than to tonnage produced.

The item of Labor and Supplies for the Cleaning Room, as well as Chipping, has been included in the expense apportionable to direct labor, although the labor of cleaning and chipping can be charged direct to production if the foundryman so chooses. It was included as shown for the following reasons. Consider for instance a small complicated casting which might only weigh 500 pounds, taking the entire time of a moulder for a day, as against a large plain casting made in the same time; it is more than likely that the cleaning cost will be about the same in both cases, while on the other hand a small, plain, easy-to-make casting could be cleaned quickly, while a large, complicated, difficult-to-make casting would take considerable time for this operation. It seems after watching the cleaning operation that it bears a close relation to direct labor, comparing the making and cleaning of complicated with complicated work and plain with plain work, although it does not follow from this statement that the relation is always proportionate. On account of this relation, however, and because of the fact that the entire cost of cleaning and chipping could not be applied to product direct without considerable detail work, necessitating the charging of a part of the cost to Direct Labor and the balance to Foundry Charge, it has been included as a labor apportionment item, not only for the sake of simplicity but because in this way the executive is provided with a logical control of this expense. I know of an instance where by keeping separate the entire cost of the cleaning, the executive was enabled to reduce this expense, through comparing it with his other elements as well as with the same item for previous periods, which would not have been possible had part of the cleaning cost been in expense and part divided as DIRECT LABOR, in small amounts, among the various jobs.

As to Foundry General, it may be said that this expenditure is largely dependent upon the number of producers at work, regardless of the tonnage produced, although there might be times when it would be more nearly proportionate to tonnage than to labor—as for instance in cases where, because of change in work, about the same amount of labor might produce a considerably larger tonnage, necessitating additional shop labor. In most cases, however, the tendency is for this cost to increase or decrease with the increase or decrease in direct labor for which reason it has been classed as a FOUNDRY CHARGE expense. Regarding the Maintenance items, it should be evident that keeping the real estate and buildings, the equipment of the plant, etc., in proper condition really has nothing to do with the amount of the tonnage produced by the shops. Repairs might be the lowest when production was the highest, or *vice versa*; in fact, deterioration might be greatest when there was no production at all. As a matter of fact, they might not bear much relation to the amount of direct labor, but as they are not items which increase or decrease with the tonnage produced, we must include them in the FOUNDRY CHARGE section, applying them to production on the basis of labor. As we arranged to charge a certain proportion of the power-plant cost to tonnage, we must include the balance in the FOUNDRY CHARGE section along with the cost of various departments, stable, pattern shop, machine shop, carpenter shop, blacksmith shop, pattern storage, which must be conducted regardless of whether the amount of tonnage produced is 5 tons or 20 tons daily, although these costs would very likely increase with the increase in the force of producers.

Upon first consideration, it might seem as if Shipping belonged to the TONNAGE CHARGE section, because of the fact that the shipping expense is sometimes greater with a large amount of tonnage than with a small amount. A moment's reflection will show, however, that it is possible for a large amount of labor to turn out, instead of large tonnage, a large production in the count of pieces, necessitating considerable shipping expense for gathering, tagging and shipping, so that in the strictest sense this term is proportionate to neither tonnage nor labor, and not being a tonnage charge it must be placed in the labor section. As regards Rigging it follows that the nature of the

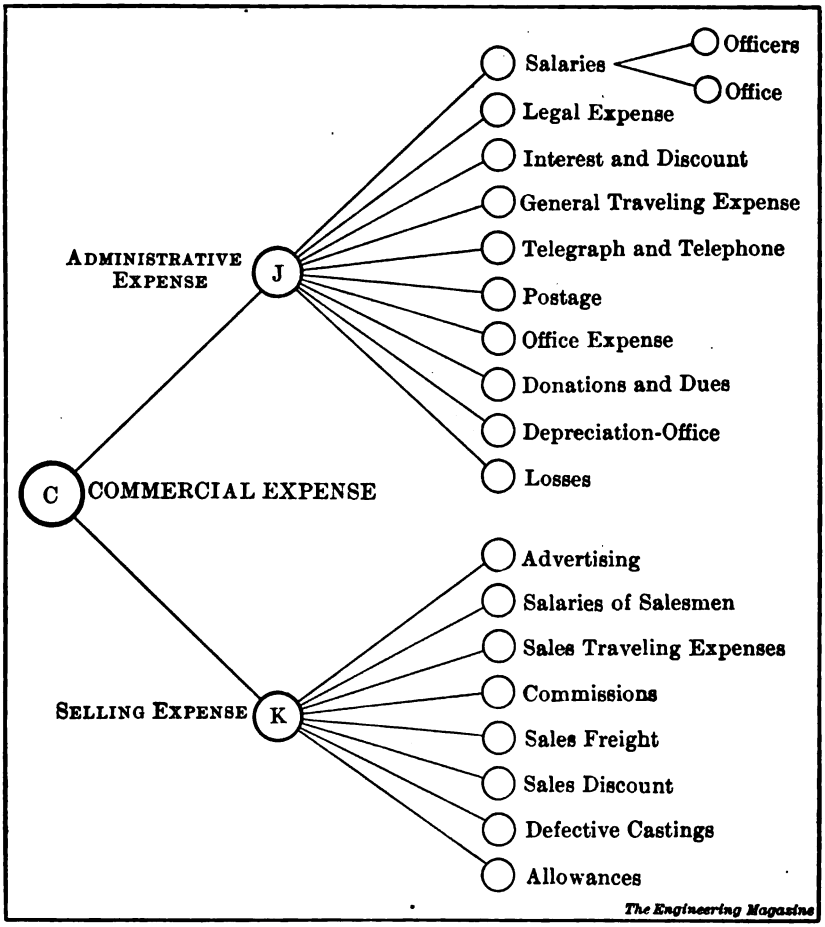


CHART 3. THE ELEMENTS ENTERING INTO COMMERCIAL COST.

work being done, etc., really governs this expenditure, and that it might be greatest with a small tonnage or when the number of producers was not large, or *vice versa,* so that like Shipping, this item really belongs in neither section, for which reason it has been placed in the labor section as a memorandum charge only, in order that Total Cost may show the total expenditure for rigging for comparative and estimating purposes, while the items Taxes, Insurance and Depreciation, bearing as they do no relation to the increase in the tonnage produced, are apportionable, because of this fact, to DIRECT LABOR.

In considering the handling of Commercial Cost, all will agree that some means must be provided for taking care of it—that it is not a cost capable of direct charging, and must therefore be classed with the apportionable items; and that in our search for a basis on which apportionment can be made, we can find only two elements—Production and Sales. On the latter basis, the ratio between the amount of Commercial Cost and the amount of the sales is ascertained and the selling price of the different orders multiplied by the resultant percentage, the product being added to Shop Cost. Another method is to deduct monthly, from the revenue from sales, the Shop Cost of the sales, the difference being gross profit—the amount of net profit being ascertained by deducting the commercial expenses from the gross profits. There is no question that (as before stated) the difference between production and commercial costs is of sufficient importance to warrant us in strictly observing this distinction.

An analysis of the items which go to make up the administrative and selling expenses will show that the expenditures have to do with the past, present, and future—that some are concerned with sales, others with production or production and sales combined, and still others with neither production nor sales. The item "Donations and Dues," for instance, has nothing to do with production or sales, the past or the future. Some of the items in the selling expense division like "Advertising and Salesmen's Salaries" are concerned with getting future production—others with what was done in the past, like "Commissions" and "Allowances." Items like "Telephone and Telegrams," "Postage" and "Office Expenses" are likely to be as much concerned with what is being produced as with the work of making sales or taking care of the sales that have been made. The past cannot absorb that which belongs to the past; we cannot hold the items belonging to the future until they shall be applied; it would be difficult to apportion to sales those items which belong to sales, and to production those which belong to production. It therefore seems, after briefly analyzing the make-up of the commercial expenses, that it would be best to make each month's production stand on its own feet by making it absorb the entire expense for the period, in this way converting all of the expenditures of a period into an asset; for on the assumption that we ship none of the castings we might have made, at the end of the period they would appear in our resources as "Manufactured Castings" at an amount equal to the cost of the material, labor, and expenses. On a basis of commercial expense apportionment to sales, a month's production would be charged to inventory at shop cost, and assuming that there were no sales from which to deduct the commercial expenses, these expenses would have to be considered as a loss. A profit or a loss should show *after* sales are made, not *before*, as the difference between the selling prices of what is sold and the cost of product, which is the result when inventory is charged with commercial as well as shop cost.

A good casting is the result of a moulding process which involves the making and setting of cores—two distinct operations. A completed engine is the result of an assembling process which involves the machining of the parts—two distinct operations. Viewed in the light of the illustrations just cited, production is the result of a manufacturing process which involves a commercial process—the administration of the business and the disposition of what is produced, without which production would be impossible—two distinct operations. Manufacturing expenses bear a direct relation to production—the commercial expenses, an indirect; but *production* nevertheless, is the underlying element with which any enterprise is concerned.

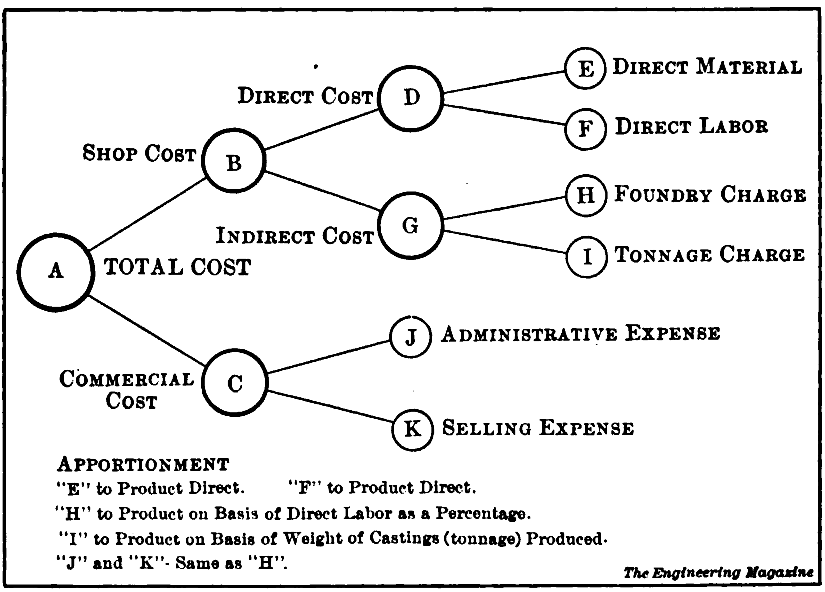
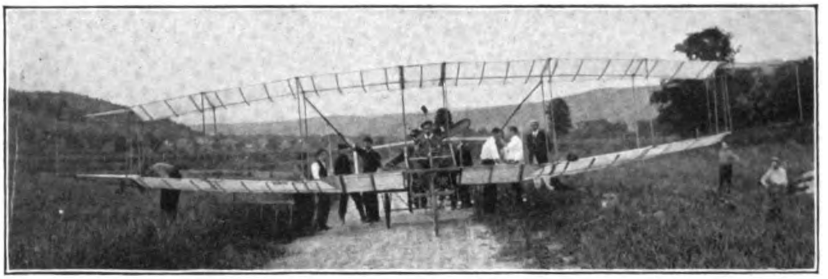


CHART 4. THE MAIN ELEMENTS OF PRODUCTION COSTS AND THEIR APPORTIONMENT TO PRODUCT.

We can apportion "Commercial Cost" to production in three ways—on tonnage, direct labor or shop cost. The method to choose should be one which will be fair to the company, the shop management, and the workmen, and which will also point out to the executive what he should know to supervise and direct intelligently. This can best be accomplished by using direct labor as our basis for pro-rating; but as opinions count for nothing unless backed by some substantial evidence, let us see if there is any logic in this assertion. In the first place, all will agree that direct labor is the true investment in any enterprise, for the reason that the more we expend for labor that actually produces something, the greater should be the amount produced, regardless of how much material was used or the amount of the indirect expenses. It is also evident that the greater the number of producers at work the lower will be the relative overhead expenses or "burden," while these will increase as the number of producers decreases, so that the relation of burden costs to the amount expended for direct labor is too important to be lost sight of—the ratio between the two being an inverse one. If a workman produces a large amount for a low labor cost, his production should absorb a *lower proportion of the burden cost* than the one who produces the same amount at a higher labor cost or a lower production at a high labor cost. If this is logical, then it is right for us to make the product of each workman absorb the burden *in proportion to the amount paid him for direct labor.* In this way each man will stand on his own feet, for the one having the greatest production will absorb the lowest burden cost, and *vice versa.*

The result to the management is this—work costing the most in direct labor will cost the most in burden, which is as it should be for furnishing the best means for accurate price determining as well as a basis for determining the efficiency of the shop management and the workmen. A customer should pay the most money for castings costing in direct labor the most to produce. If a mistake has been made in quoting it will show in the form of a much smaller profit than anticipated, or perhaps in a loss, or in the form of an excessive profit —an over-estimation. If no mistake is made in quoting, however, and the amount of direct labor greatly exceeds what it should have been, it will not only show in the form of an increased direct-labor cost but in the increased amount of burden absorbed, with the result that the total cost will be in excess of the price received, showing a *loss* for the executive to take up with the shop.

Profits or losses will be what was made or lost; prices will be based on true costs; the product of a workman will bear no more or no less of the burden than its direct labor makes it stand; fluctuations will be noticed, as burden costs will rise or fall with the rise or fall in direct labor, so that after due consideration I am of the firm opinion that the points brought out logically point to "Commercial Cost" apportionment to production on the basis of "Direct Labor," as being right and proper.



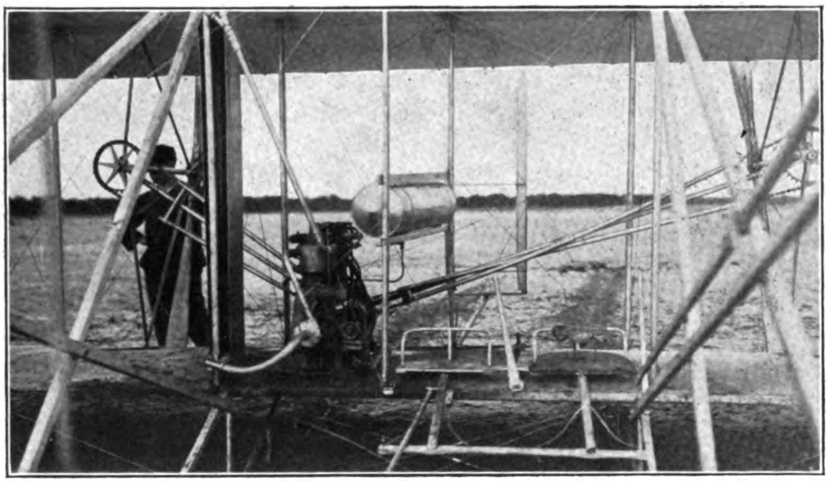
THE "JUNE BUG" READY FOR A FLIGHT.

POWER GENERATION AND TRANSMISSION IN AEROPLANES.

By W. F. Bradley and H. W. Perry.

PRINCIPALLY as the result of the successful work of Wilbur Wright in France, European aeronautical-motor engineers have begun to doubt the wisdom of their special researches in the direction of great power with light weight. Formerly it was generally believed that weight was one of the greatest obstacles to flight, and that the lighter the engine the better. When flights of a few yards were looked upon as marvels, there was doubtless some ground for this belief; but now that half-a-dozen men, on various types of machines, have flown for more than a mile, and the most expert of them have remained aloft for more than an hour, the need for featherweight motors is no longer felt.

Wilbur Wright, undoubtedly the most successful of all aeroplanists, used in his flights in France last Fall, a gasoline motor of greater weight and lower power than the engines of any of his foreign rivals, thus proving conclusively that it is not necessary to possess a special engine in order to fly. Although the Wright power plant cannot be classed as an automobile engine, it is the least removed from motor-car standards of any aeronautical motor in existence. Its four separately cast, water-cooled cylinders have a bore of 4 inches and a stroke of 4½ inches, the normal engine speed being 1,100 revolutions per minute. This gives a normal rating of 30 horse power. All valves are in the cylinder heads, the exhaust valves being operated by overhead rocker arms and the inlets operating automatically. One of the most distinctive features of this engine is that the fuel charge is supplied by direct injection, gravity carrying the gasoline down from the tank to a pump within the crank case which is driven by helicoidal gears off the cam shaft. Lubrication is positive by means of a plunger pump located within the crank case and also driven off the cam shaft. The engine is water cooled by means of forced circulation, the pump being driven from the forward end of the crank shaft. The radiator is an ingenious arrangement of flat aluminium tubes arranged vertically in four series of six each, united at the top by two collectors and at the base by two smaller ones, the tubes themselves being placed on either side of one of the upright supports connecting the two planes of the aeroplane. An Eisemann high-tension magneto, with separate high-tension coil, has been adopted exclusively for ignition. The magneto is driven directly off the cam shaft by exposed gears.

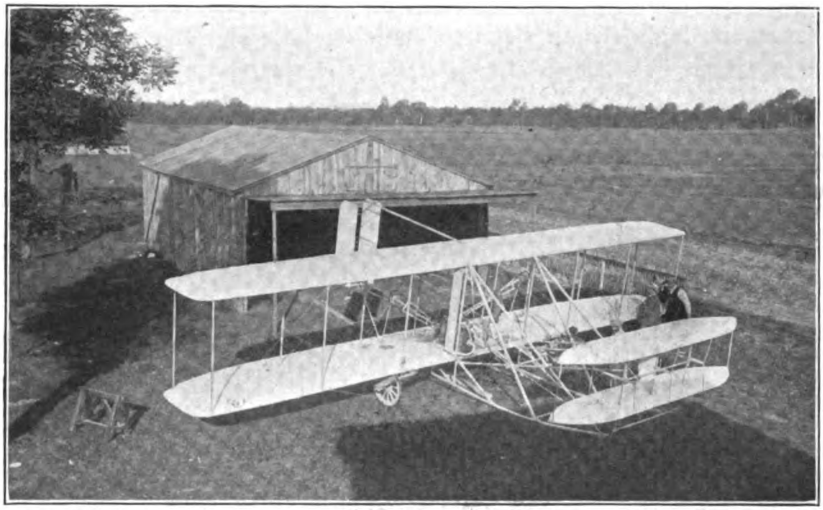


POWER PLANT AND DRIVING MECHANISM OF WILBUR WRIGHT'S AEROPLANE.

Note the two seats for aviator and passenger, the heavy engine, the chain drive to two rear propellers and the vertical flat tube radiator to the left of the engine.

As is generally known, two propellers, to the rear of the main planes and with two blades each, are employed. They are driven by means of chains, and, as the propellers are equidistant from the tips of the planes and the motor is at one side of the center, one chain is necessarily shorter than the other. The longer chain is crossed, in order that the propellers may turn in opposite directions, and both chains run in long, rather closely fitting metal tubes. With the largest size propellers, such as are employed for flights with a passenger aboard, the gear ratio is 10 to 33.

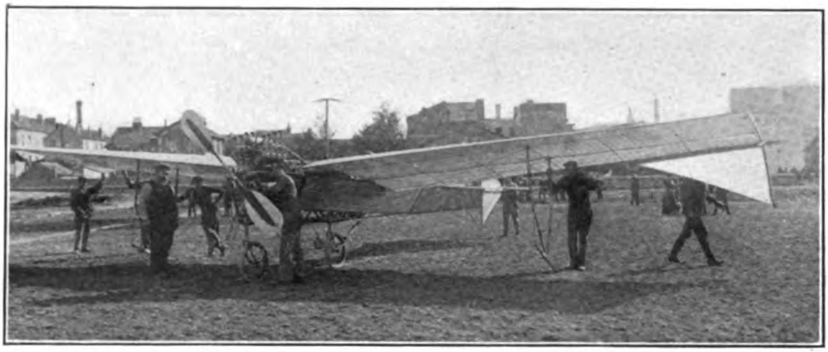
The operation of starting up is performed by two assistants who swing the propellers over by hand, and, once started, the operator has no further need to concern himself with the engine which runs at constant speed. There is a slight ignition advance, but as the maximum advance is always given just before starting the aeroplane the care of the engine ceases then. To stop the engine an ignition cut-out is employed, the connection for which is merely a piece of twine stretched in front of the pilot. On more than one occasion when a passenger has been carried, the string has been touched inadvertently, with the result that the apparatus has come to earth.



FRONT VIEW OF WILBUR WRIGHT'S AEROPLANE AS USED IN FRANCE.

The small planes in front are used for ascending and descending, their angle being altered at will by a left-hand lever. The vertical planes in the rear control the lateral movements and are manipulated by a right-hand lever. Lateral equilibrium is obtained by twisting the rear corners of the "wings" upward or downward out of the normal plane by means of wires connected with the vertical-rudder lever.

In point of flights made, Henry Farman and Léon Delagrange must be classed as the most successful aeroplanists after Wilbur Wright. Both use aeroplanes built by Voisin Frères, fitted with eight-cylinder Antoinette engines. Levavasseur, the designer of the Antoinette, has studied the light-weight engine longer than any other man, and, largely by reason of being first in the field, has had more success than any of his rivals. Lavavasseur works on the principle that the greater the number of cylinders the lower the weight per horse power; no Antoinette engine has less than eight cylinders, and the more powerful have sixteen and twenty-four, the latter models having respectively two and three groups of eight cylinders on a special crank case.



THE ANTOINETTE MONOPLANE FITTED WITH ANTOINETTE MOTOR.

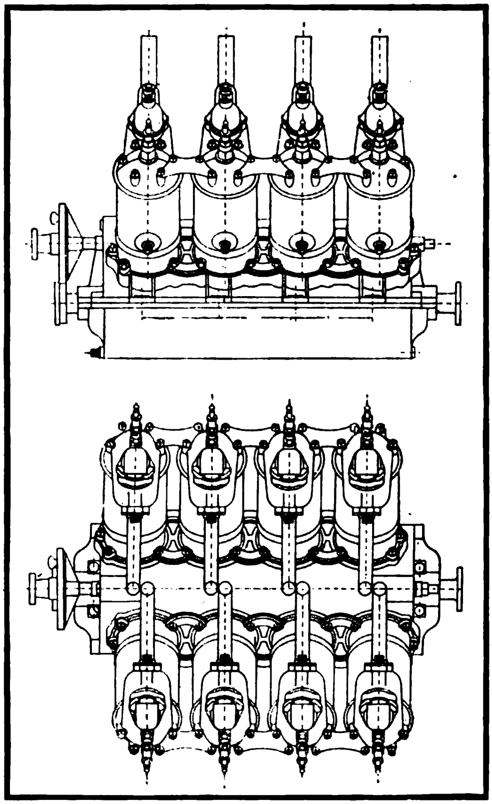
The designer Levasseur is standing in shirt sleeves under the right wing. Note the boat-shaped body with plain tube radiator along the side.

It is the eight-cylinder, 50 horse-power engine, however, that is used on the Farman and Delagrange aeroplanes and also on most of those constructed by the Antoinette company. The separate water-cooled cylinders, of 130 by 130 millimetres bore and stroke, are mounted at an angle of 45 degrees on an aluminium crank case having the form of a rectangular prism. The five-bearing, four-throw crank shaft receives two connecting rods per pin, each pair of pistons, at an angle of 90 degrees, being connected up to the same pin. The cylinders, cast separately and bolted on the crank case, have independent aluminium heads and copper water jackets. The exhaust

HENRY FARMAN AND HIS AEROPLANE AT BRIGHTON BEACH, NEW YORK.

The motor is a V-form, eight-cylinder, 50 horse-power Antoinette. Note the two-bladed propeller mounted on the end of the crank shaft.

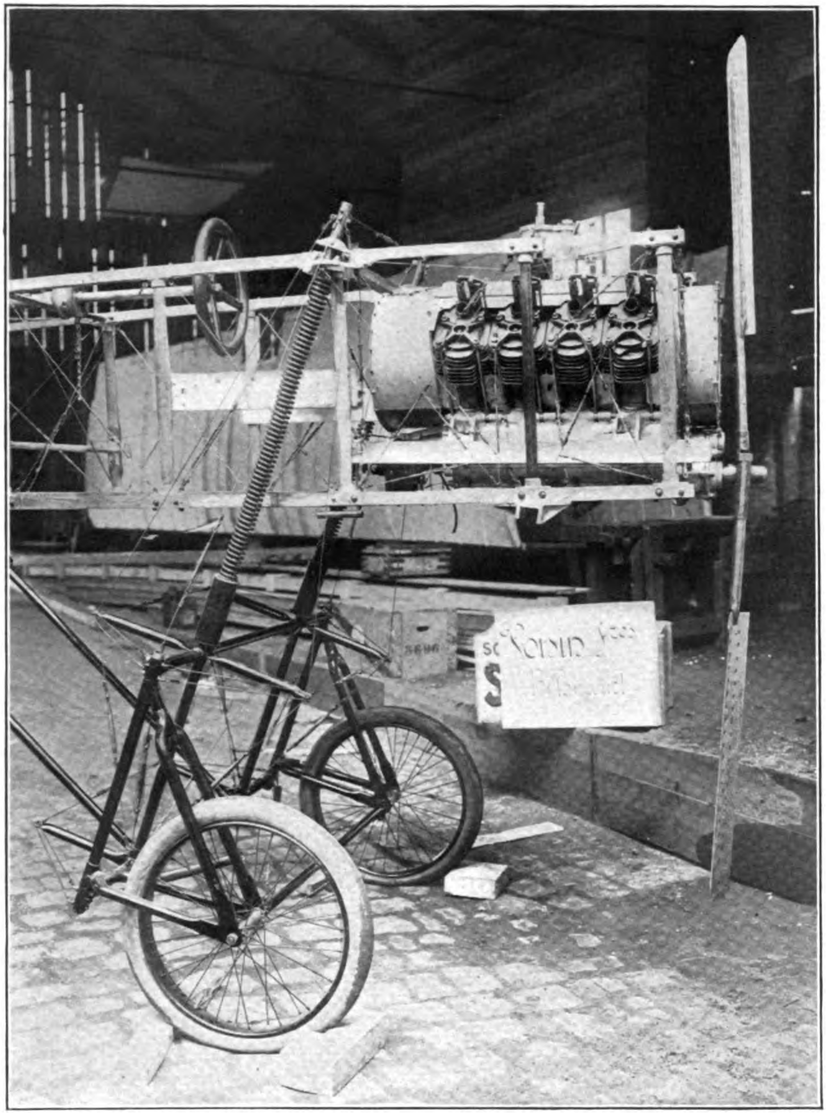
valves, operated by a single cam shaft with integral cams, are within the angle formed by the two cylinders. The inlet valves are automatic, for the Antoinette engine has no carbureter, the gasoline being injected directly into the cylinders by means of a pump and distributor.



ELEVATION AND PLAN OF THE ANTOINETTE V-FORM, EIGHT-CYLINDER, 50 HORSE-POWER MOTOR.

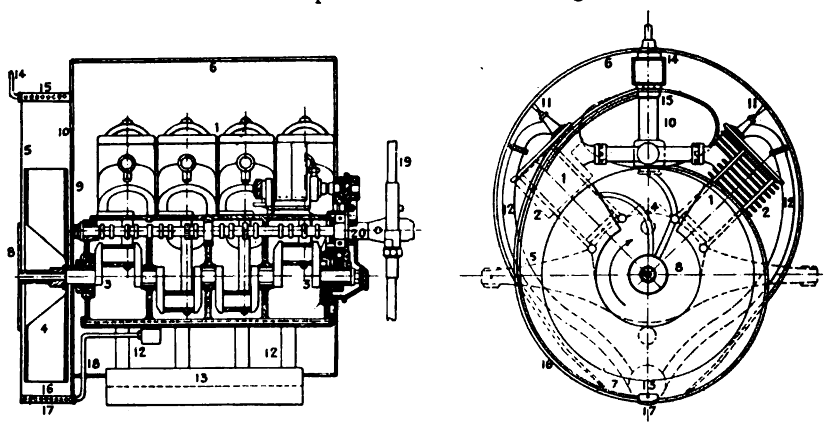
It is worthy of notice that the two most successful aeroplanes—the Wright and the Farman—both have water-cooled engines and direct injection of the charge. In each case the reasons given are a greater efficiency of the water-cooled over the air-cooled engine, and a greater certainty of obtaining regular running by direct injection than by the use of a carbureter. On the Antoinette engine the gasoline pump, driven direct by the engine and provided with a variable stroke in order to regulate the charge, supplies the fuel to eight small distributors, one in each cylinder head, where it is stored during the cycles other than aspiration. Ignition current is obtained generally from a storage battery with high-tension coil and distributor. When desired, however, a magneto is fitted, and in each case provision is made for variation of the firing point.

When first applied to aeroplanes, the Antoinette engines were fitted with a small water tank carrying two or three pints of water in addition to that in the jackets. As longer and longer flights have become possible, greater provision has had to be made for continuous running of the engine. Water circulation is now assured in all the machines by means of a gear-driven pump, and at present on the Delagrange and Farman aeroplanes a special type of plain



EARLY TYPE OF RENAULT V-FORM, EIGHT-CYLINDER MOTOR WITH BLOWERS.
Note spring suspension of the aeroplane frame on bicycle-type wheels, and hand wheel for controlling the movements of the flying machine.

tube radiator is employed. On their latest monoplane machine the Antoinette company has a plain aluminium tube radiator weighing but 26 pounds with its content of six quarts of water, this quantity being sufficient for a 50 horse-power engine. The aeroplane in question has a body in the form of a boat hull and it is on each side of this that the long plain tubes are attached. Regarded from the standpoint of the constructor, the machine is one of the finest pieces of workmanship ever produced, in strong contrast to some of the earlier machines with which attempts were made to navigate the air.



VERTICAL SECTION AND TRANSVERSE DRAWING OF THE LATEST TYPE OF RENAULT 45 HORSE-POWER MOTOR.

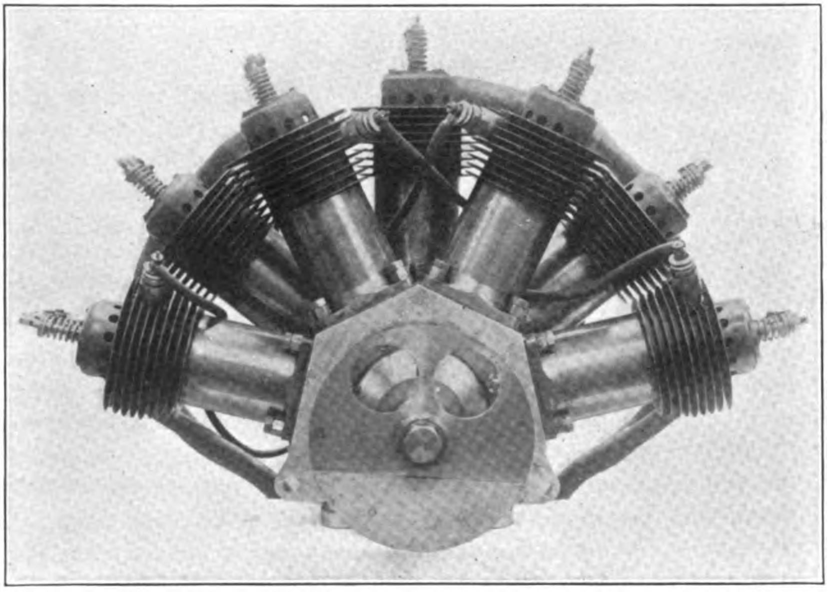
4, fan; 6, sheet metal casing; 7, outlet of forced draught; 8, air intake to blower; 12, exhaust pipes; 13, muffler; 15 and 17, air-cooled oil pipes; 18, lead from lubricator pump; 19, propeller mounted on cam shaft.

Lubrication, an important point in an engine having all its parts machined to the thousandth part of a millimetre, is assured by means of a gear-driven pump which draws the oil from the lower portion of the crank chamber and distributes it through a sprayer in the upper portion. As splash lubrication is also provided, the crank shaft, cam shaft and cylinder walls are always certain of a sufficient supply of oil. The crank case is divided into four compartments in order to assure a splash feed whatever the angle of the engine.

On the Farman and Delagrange aeroplanes, as indeed on all the French machines, the propeller is mounted directly on the crank shaft, turning of course at the same speed as the engine. This is contrary to Wright's practice, on whose machine the propellers, instead of having a speed of 1,000 to 1,200 revolutions per minute, do not turn at more than 400 revolutions per minute.

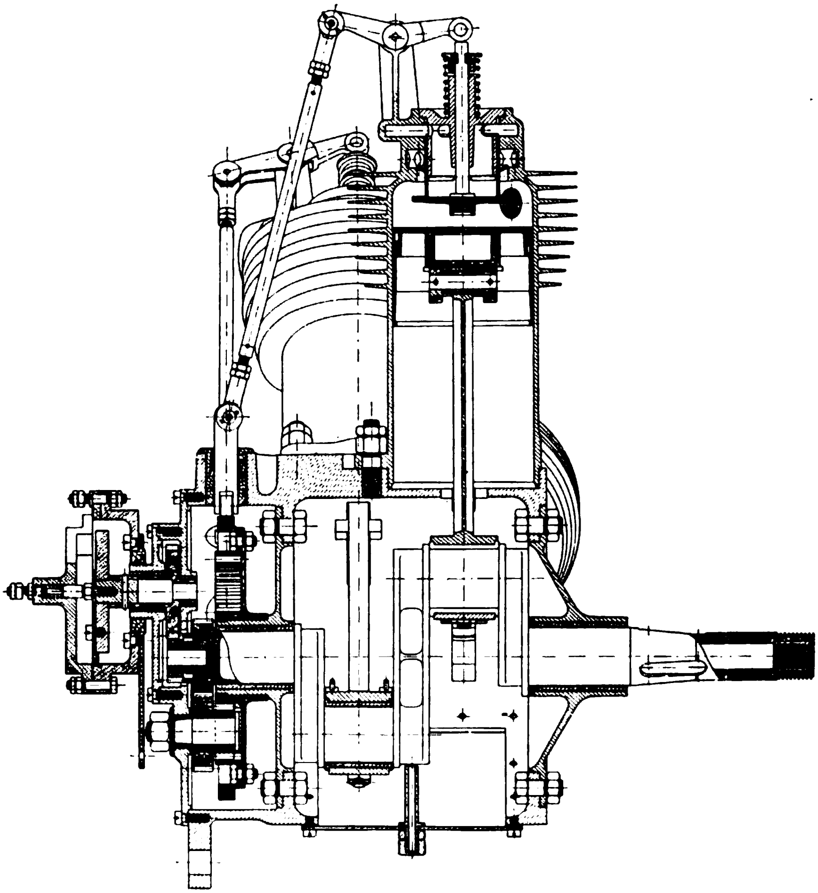
An Antoinette engine of 130 millimetres bore and stroke weighs 220 pounds empty; to this should be added, however, from 30 to 45 pounds for such accessories as gasoline, oil and water pumps, storage battery, spark plugs, piping, etc. A sixteen-cylinder engine of 80 millimetres bore and stroke weighs 165 pounds, but to this should also be added about 45 pounds for accessories.

Renault is the first among the large European firms of automobile constructors to pay especial attention to the light-weight explosion motor for aeroplanes. The Renault aero engine, which is rated at 45 horse power, has eight air-cooled cylinders arranged in V form, each having a bore of 90 millimetres and a stroke of 120. The crank shaft has four throws and five bearings with two connecting rods to each pin, in this respect being similar to that of the Antoinette. The sixteen valves, which are within the angle formed by the two sets of cylinders, are all mechanically operated from a single cam shaft, the exhausts, which are above the inlets, being operated by overhead rocker arms. The carbureter is similar in principle to the one used on the touring cars, the Renault engineers being of opinion that although there is a slight gain in weight by using direct injection, the fuel consumption is so greatly increased that the advantage is nullified. Ignition, too, follows motor-car practice, a high-tension Bosch magneto, carried in a reversed position under the forward extension of the crank shaft, being adopted in preference to storage batteries or dry cells.



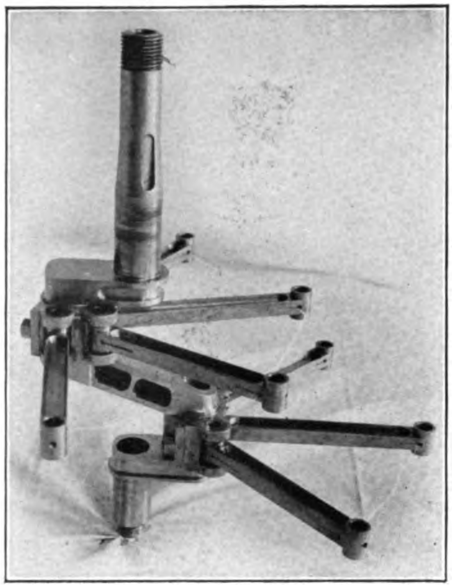
ROBERT ESNAULT-PELTERIE (R. E. P.) SEVEN-CYLINDER ENGINE WITH VALVE-OPERATING MECHANISM REMOVED.

At 1,500 revolutions, the power developed is 45 horse power, and by increasing the speed to 1,600 revolutions 48 horse power can be obtained. A distinctive characteristic of this engine is that the propeller, instead of being mounted on the crank shaft, as is usually the case with European aero motors, is fitted on the rear of the cam shaft, thus revolving at half the engine speed. Cooling of the cylinders is aided by means of a centrifugal fan mounted directly on the forward end of the crank shaft and a double sheet-metal casing surrounding both the engine and the fan. On the first models produced two fans were fitted, one at either end of the engine; this arrangement, however, was found to be inefficient, and a single fan was



CROSS SECTION OF THE R. E. P. ENGINE THROUGH ONE OF THE CYLINDERS.
Note two-throw crank shaft.

adopted with the casing of such a nature that the draft was directed around all the fins of the cylinders, around the exhaust pipes, and finally discharged at the engine base on the exhaust box carried longitudinally under the motor. Advantage is taken of the forced draft to cool not only the cylinders but also the lubricating oil. On leaving the base of the crank chamber, which forms an oil reservoir,

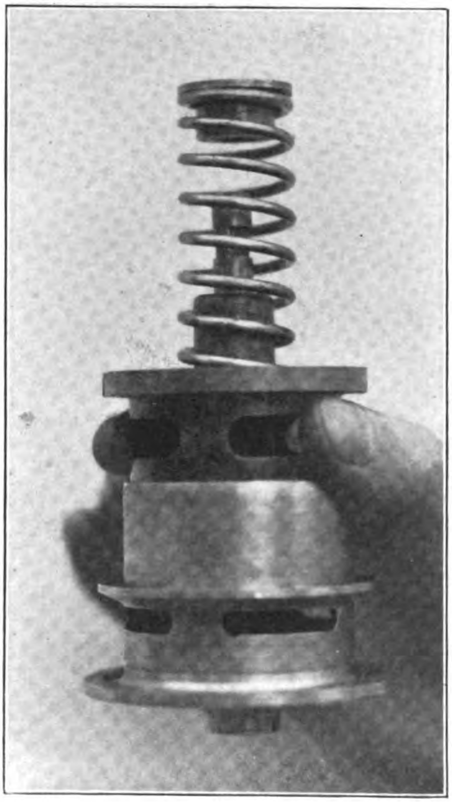


CRANK SHAFT AND CONNECTING ROD OF THE R. E. P. SEVEN-CYLINDER MOTOR.

the lubricant passes through tubes in the base and head of the casing of the ventilator before arriving at the tank from which it is fed by sight feeds to the engine bearings. Circulation is of course assured by a gear-driven pump. With full equipment, but with gasoline and oil tanks empty, the Renault engine weighs 312 pounds.

Excluding the many engines which have been designed, built and run for a certain length of time on the testing block only, Robert Esnault-Pelterie has the honor of producing the most original and at the same time the lightest engine ever used for aerial work. The Esnault-Pelterie is not a light engine by reason of careful selection and skilful working of metals, but because of its peculiar design. Either five or seven cylinders are employed, although the latter number is much more common than the smaller number. The seven cylinders, each with radiating fins, are staggered around the upper half of a circular crank case, three being in one plane and four in another. The two-throw crank shaft, one of the most original features of the engine, receives three connecting rods to one pin and four to the other; in reality, there are only two direct connections to the crank shaft, the connecting-rod bearings having in one case two supplemental radiating arms and in the other three, to each of which is attached a piston. The steel pistons, machined out of the solid, have a very much thinner wall than is usually considered possible for an internal-combustion motor, because the connecting rod is not attached to the wall but to a special double bearing screwed into the piston head.

The valves and valve-operating mechanism are no less original than any other part of the engine. Thus, the charge is aspired and the waste gases cleared through the same valve in the cylinder head, operated by overhead rocker arms. The valve consists of a vertical cylinder, a central stem and a flange fitting on the valve seat as in the



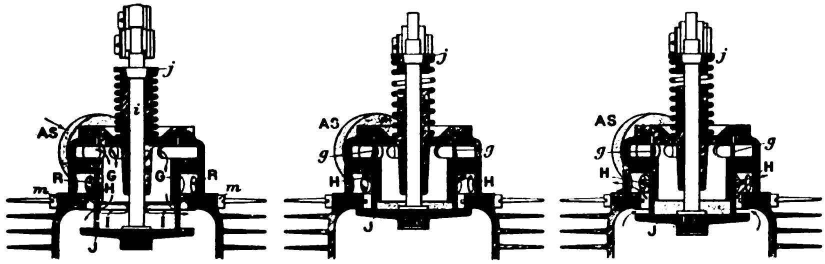
COMBINED MECHANICALLY OPERATED INLET AND EXHAUST VALVE OF THE R. E. P. MOTOR.

ordinary type of poppet valve. Above the valve proper is a circular collar or sleeve which, according to its position in the cylinder, opens or closes a series of ports. There are three principal positions of the valve, corresponding to three bosses on the cam shaft. If the valve stem is on the highest boss of the cam, the poppet valve is lifted from its seat, gas passes through the cylindrical casing and enters the cylinder through the open ports; the collar is in such a position that communication with the exhaust pipes is cut off. When the valve stem drops down to its lowest position, the valve closes in the same way as an ordinary poppet valve, closing all connection with both the inlet and the exhaust. At the intermediate position, the valve is slightly raised from its seat, allowing the escape of the spent gases, while the collar closes connection with the intake pipe. A single circular cam operates all valves. In reality it is a two-face cam, for, owing to the necessity for staggering the cylinders in order to occupy only the upper half of the crank case, one set of cams must be a little to the rear of the others. This large single cam, with its two faces, one carrying six, and the other eight, bosses, is mounted on the axis of the crank shaft and is revolved at one-sixth of the engine speed by means of suitable gearing.

There are two carbureters, one supplying three, and the other four, cylinders. The ignition, which is obtained by means of storage batteries and a trembler coil, presents nothing of especial novelty. Lubrication is by splash only, but because of the varied positions of the cylinders, the central one being vertical and the outside ones inclined more than 45 degrees, baffle plates are fitted at the bases of the cylinders of such form and size as to limit the supply of oil to those cylinders which, by reason of their position, would be likely to take up an excess.

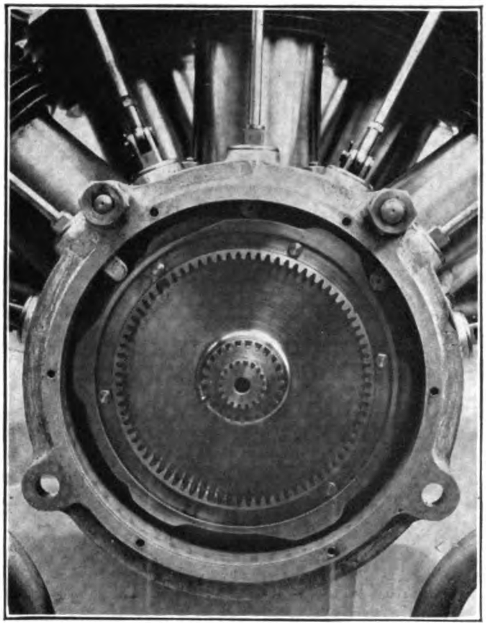
The seven-cylinder engine complete weighs 114 pounds, which is an extraordinarily low weight for a machine developing 35 horse power. The crank shaft, although provided with a particularly wide bearing at its outer end—the end to which the propeller is attached—weighs only 5½ pounds; the crank case complete with bolts weighs 11½ pounds; each of the pistons complete with two rings weighs 1 3-10 pounds. The principal use of the Esnault-Pelterie engine has been on an aeroplane designed by its inventor which is commonly known as the R. E. P. There is no transmission, for the four-bladed propeller is mounted direct on the crank shaft and revolves without any intermediate gearing at the engine speed.

It would be possible to extend the list of aeronautical engines almost indefinitely, for the number of aeroplanes and special aero engines constructed in Europe appears to be almost unlimited. Those that have actually been used for aerial navigation, however, are exceedingly few, and those that are capable of being used, in their present condition, still fewer. Some interesting experiments in rotary motors have been made by both Farcot and Burlat, who place four and eight cylinders at equal distances around a circular crank case, the pistons being connected up to a one-throw crank shaft. The difficulty here is largely one of lubrication. The most valuable of the Farcot series are a two- and an eight-cylinder engine with an original type of combined inlet and exhaust valve having a certain resemblance to the one invented by Robert Esnault-Pelterie.



SECTIONAL DRAWINGS ILLUSTRATING ACTION OF R. E. P. COMBINATION VALVE.
AS, inlet; R, holes for open exhaust; G, sleeve; H, small collar; I, ports in sleeve; J, flat valve; *g g*, walls of sleeve closing inlet holes.

Aside from the Wright brothers' aeroplanes, the only heavier-than-air machines that have made fully authenticated successful flights in America up to this time of writing are the three biplane fliers built and flown by the Aerial Experiment Association at Ham-

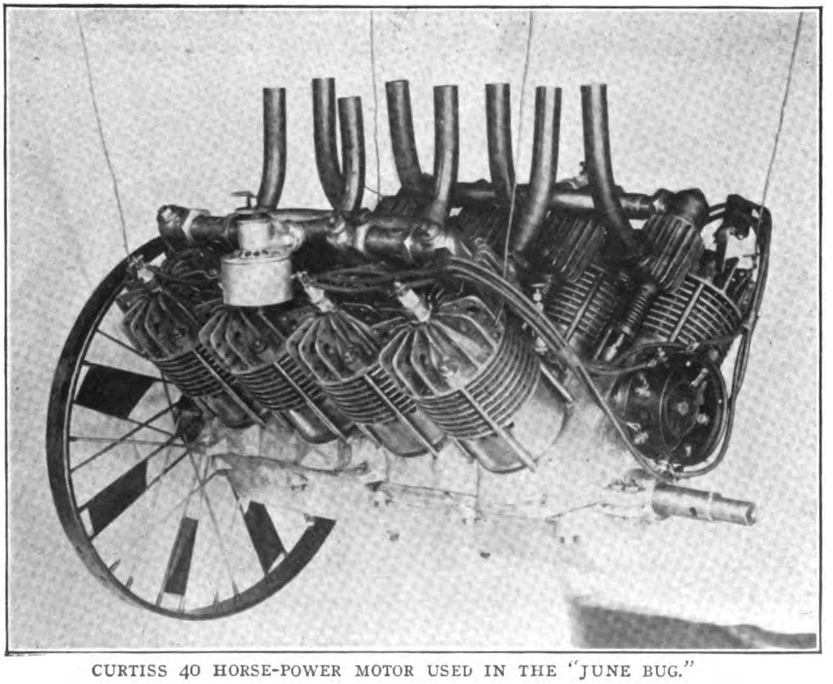


R. E. P. MOTOR WITH FRONT OF CRANK CASE REMOVED, SHOWING SINGLE CAM FOR ALL VALVES.

mondsport, N. Y. These are known as the "Red Wing," the "White Wing" and the "June Bug," or as "Aerodromes" Nos. 1, 2 and 3. The engine used in all three of these machines is the Curtiss air-cooled gasoline motor. It will suffice to illustrate and describe the motor used in the "June Bug," the third machine of the series and the one that on July 4 last won the International silver trophy offered by the *Scientific American* through the Aero Club of America for the first heavier-than-air machine to fly a distance of one kilometre measured in a straight line in the presence of official timers. The engine weighs 150 pounds and is rated at 40 horse power. It has eight cylinders arranged in two rows at an angle of 90 degrees, as in the Antoinette, and offset or staggered. This arrangement is compact and gives great power per pound of weight. The cylinders have a bore of 3⅝ inches and the pistons a stroke of 3¼ inches. The normal speed is 1,800 revolutions a minute. The cylinders are cast separately and have finned heads and auxiliary exhaust ports on the lower side beneath the last radiating flanges. Inlet and exhaust valves are all located on the upper and inner sides of the heads, and the push rods are so disposed that all valves can be operated by a single cam shaft located inside the crank case in the same vertical plane as the crank shaft. On one end of the cam shaft is mounted the ignition current distributor, with its cables leading through supports to the spark plugs inserted through the centers of the heads. The exhaust valves open into upward curved pipes that exhaust directly into the air.

The illustration shows two carbureters, each feeding a single bank of cylinders, but as used on the "June Bug" there was one carbureter for each cylinder. The carbureters are especially designed for lightness and for use on aeronautical engines. They weigh only 15 ounces each, have a central fuel feed, and an adjustable automatic air supply, so that they give automatically a uniform mixture at varying speeds and are not affected by changes in position. A light balance wheel having steel spokes and rim and fitted with vanes to act as a fan in aiding cooling, is keyed to one end of the crank shaft; the double-bladed propeller is attached to the other.

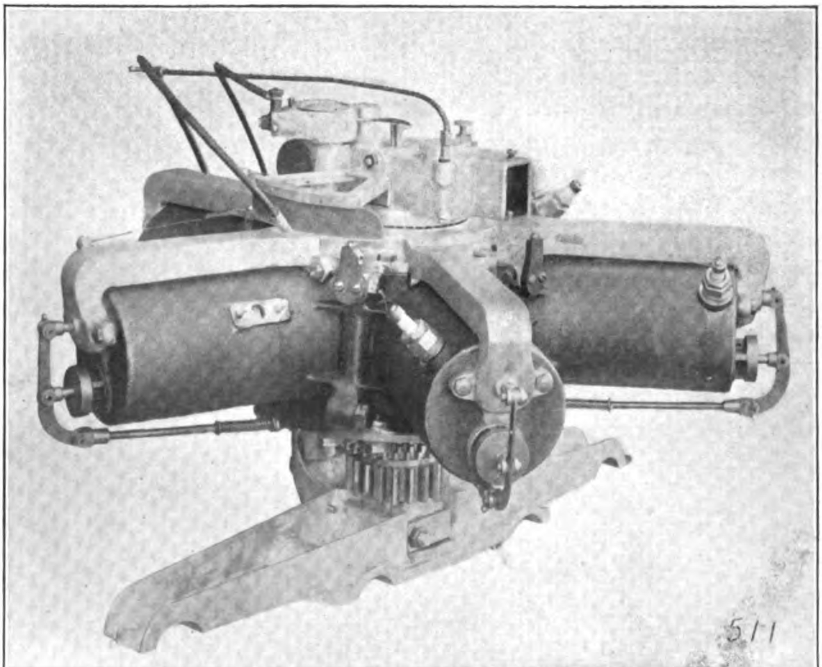
A Curtiss engine is used also on the Baldwin dirigible balloon which successfully passed the government tests at Fort Myer in September and was accepted by the United States Army for use by the Signal Corps. In this case, however, the engine has but four cylinders and is of the vertical type. It has a weight of 110 pounds and is rated at 25 horse power. The dimensions are: height, 18 inches; length, 20 inches; width between base supports, 7 inches. The cylinders have a bore of 3⅝ inches and a stroke of 4 inches. The engine is designed to run at a normal speed of 1,800 revolutions per minute. The crank shaft, which is 1¼ inches in diameter, is fitted with a light balance wheel and with a small sprocket to carry the chain that drives the long propeller shaft in the framework suspended from the gas bag. The rear extension of the crank shaft



CURTISS 40 HORSE-POWER MOTOR USED IN THE "JUNE BUG."

is fitted with a spur gear that drives the cam shaft, to which the distributor is attached and which in turn drives the shaft of the magneto. This magneto weighs 9 pounds, somewhat less than batteries and coil.

Airship engines of one and two cylinders are also built at Hammondsport on the same lines as motorcycle engines. They are furnished in 3 and 7 horse-power sizes, while the four-cylinder motors are made in both air-cooled and water-cooled models of 15, 20, 25 and 50 horse power, and the eight-cylinder V engines in air-cooled type only, of 30 and 40 horse power.



ADAMS-FARWELL REVOLVING, FIVE-CYLINDER, 36 HORSE-POWER AERONAUTICAL ENGINE.

It is indicative of the activity in aeronautical lines in America that more than fifty such engines were built last year by a single company, and that in Dubuque, Iowa, a company that has been building automobiles for a number of years, has this year brought out a light engine of 36 horse power for aeronautical use. This belongs to the revolving-cylinder type, having five cylinders disposed radially with connecting rods acting on a one-throw stationary crank shaft. This Adams-Farwell engine weighs only 97¼ pounds, or 2.7 pounds per horse power. About 85 per cent of the whole weight revolves in a horizontal plane, giving a gyroscopic effect. The engine is air cooled and the valve mechanism very simple.

MEANS AND METHODS OF HEATING THE FEED WATER OF STEAM BOILERS.

By Reginald Pelham Bolton.

II. FEED HEATING BY THE USE OF LIVE STEAM.

In the first article of his series, presented last month, Mr. Bolton examined the general question of the gain or loss by feed heating and the special case of feed heating by means of waste furnace gases. In the present section he discusses the economy of heating by live steam. A concluding instalment next month will deal in a similar manner with the economy of exhaust-steam heating.—The Editors.

IN the first part of this discussion it was shown that the heating of feed water to high temperature may find a possible value in certain boilers, by the promotion of their internal circulation. More often it finds a justification in the removal, by the higher temperature, of scale-making or acid elements; deposits of the former retard the heat transfer through the plates, while the presence of the latter may cause physical injury to the interior part of the structure.

If this high temperature cannot be produced by waste material, but must be effected by the heat already produced in the live steam, the process is accompanied by some loss of that heat, in the portion dissipated in radiation from pipes and heaters and also in any waste elements in the feed water which are heated only to be thrown away. The well-known forms of "live-steam purifiers," are really open heaters on the contact system, being practically extensions of the steam space, placed high enough above the water level in the boiler to afford a sufficient head or height of the feed-water level maintained in the purifier to overcome friction in the feed piping and in the check and feed valves. The cost of the additional heat thus imparted to the feed water is that of the heat lost in radiation and in raising the temperature of the waste materials, to which must be added the cost of any additional pumping of the feed. (Chart I.)

The same class of work is accomplished in the marine "evaporator," which is really a live-steam heater of the surface or closed type. In this apparatus, to make up deficiencies in the return system from a condensing engine, sea water is boiled to steam, and the deposited salts are blown down to waste in the form of concentrated brine. The process is a necessary one in steam vessels in order to avoid the carriage of large quantities of fresh water.

The system of evaporating this feed water can be made very economical if proper disposition be made of the heat contained in the steam. As shown in Chart II, the steam may be raised to a pressure corresponding to that in the low-pressure receiver of the engine. It may be utilized for work in that cylinder, cutting down the cost by the work thus secured, but its cost in boiler heat may be lessened to a much greater extent by its introduction direct into the feed system, in a contact heater. In a series of evaporators, the steam can be used in double or triple effect. The result of this method was tested by Lieut. Newton Mansfield, on the U. S. S. Dixie,* the evaporated steam being passed from one evaporator to two others, from which it was trapped to a distiller and there cooled. Running single effect, 1 pound of water was obtained for 0.266 pound of coal, or, at say 7 to 1 evaporation in the boiler, 1 pound of steam at boiler pressure for 1.86 pounds of coal. Running double effect, this was reduced to 0.99 pound.

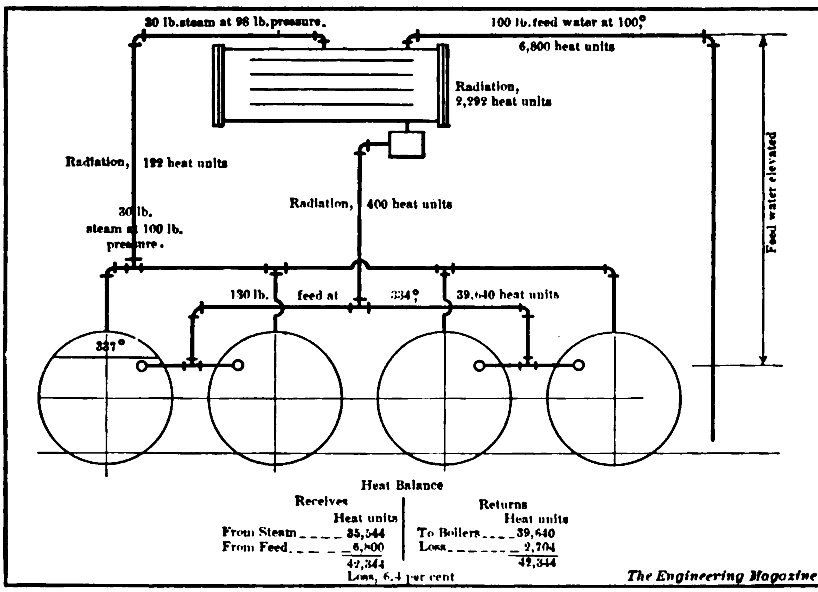


CHART I. HEAT BALANCE OF THE LIVE-STEAM PURIFIER.

Another method with a single evaporator, is to borrow steam for the process from the high-pressure receiver on the main engine, and to discharge the evaporated steam into the low-pressure receiver, thus losing only the useful work of the initial supply in the intermediate cylinders. The most economical method, however, is to de-

* Jour. Am. Soc. Naval Engineers, Vol. XII, Part 2.

liver the evaporated product direct to the contact heater, as shown on Chart II. The net cost per pound then amounts to 867 heat units when the steam is taken to the low-pressure cylinder, 159 heat units when it is condensed direct into the feed.

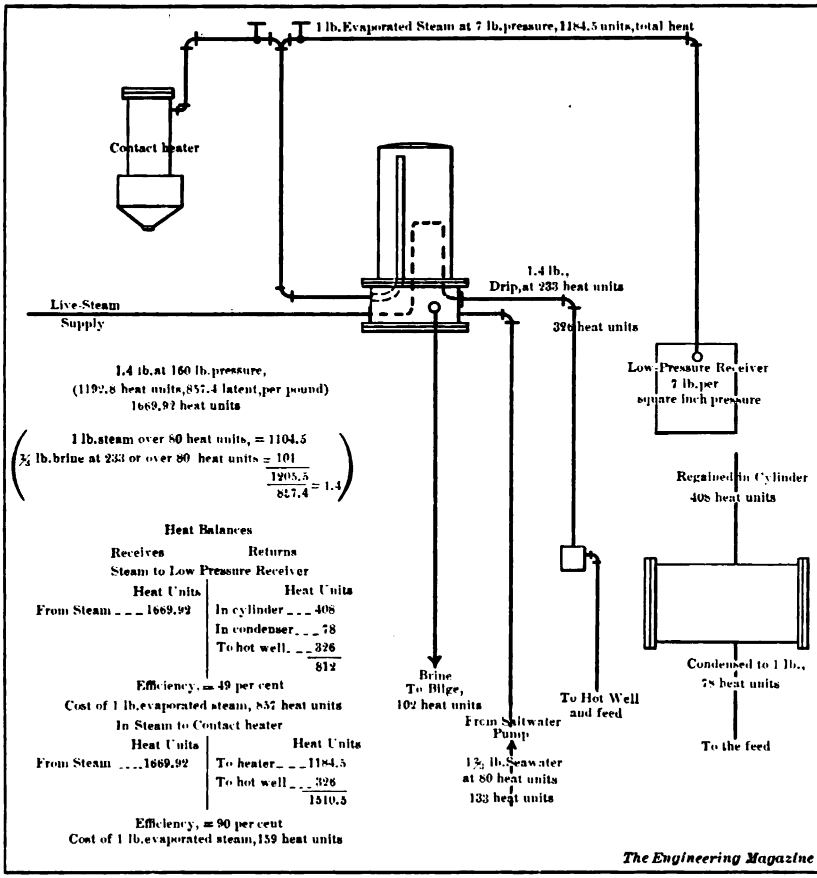


CHART II. HEAT BALANCE OF THE LIVE-STEAM EVAPORATOR.

The Engineer, London, in a recent article* on the subject of the possible advantages derivable from feed-water heating by means of live steam, bases some argument as to its value upon the assertion that there are "dozens, if not hundreds, of live-steam feed-water heaters in regular use in steamships," the use of which is assumed to demonstrate that their owners or operating engineers must find them to produce an economy. This argument is placed against the record of the recent careful test, by Messrs. Goodman and Maclachlan, of the

* Quoted at length in THE ENGINEERING MAGAZINE for May, 1908, page 259.

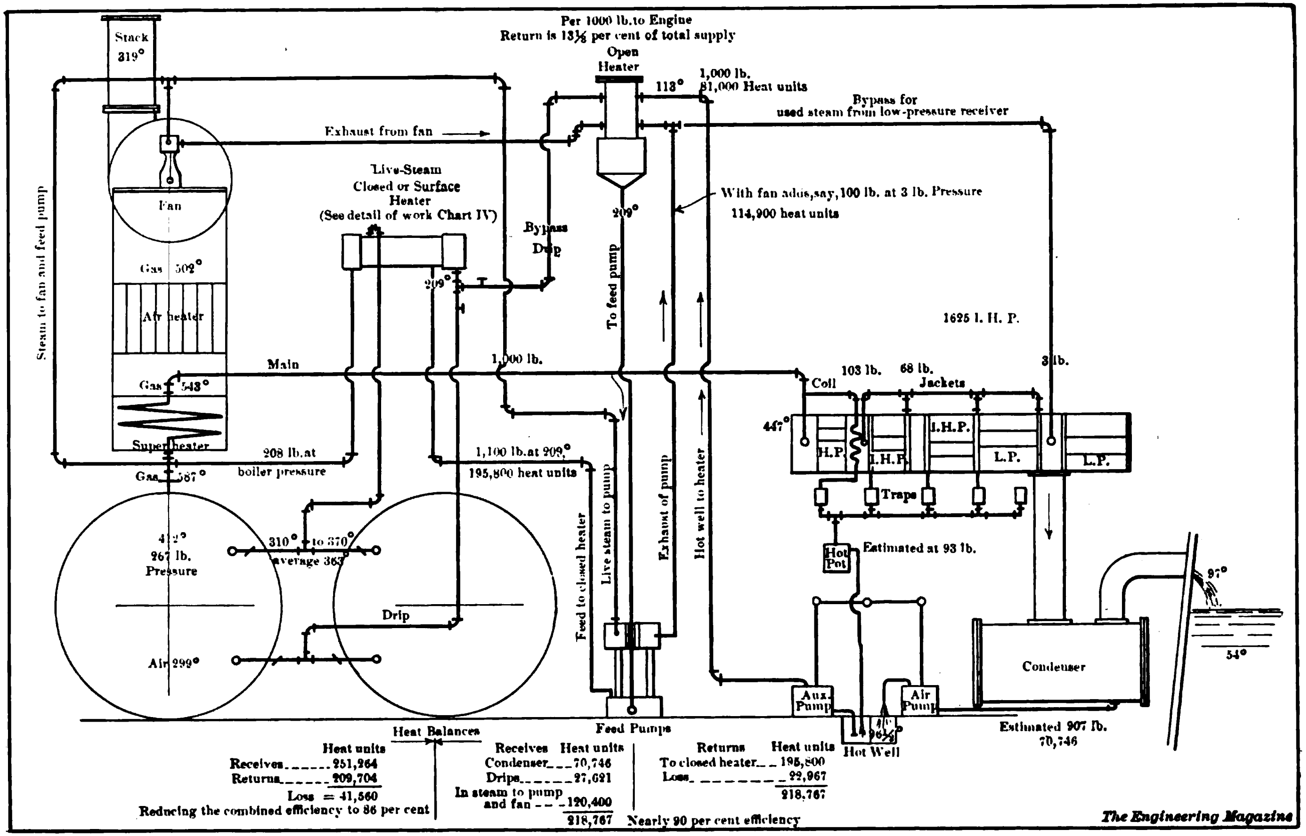


CHART III. HEAT BALANCE AND ARRANGEMENT OF AUXILIARIES AND FEED-HEATING APPARATUS ON THE SS. "INCHDUNE."

use of a live-steam heater with a land boiler, in which it was demonstrated that there was no advantage, nor was there any particular loss in that instance, in the use of a live-steam heater. This rather negative result seems to indicate, however, that the particular boiler did derive from the introduction of feed water at steam temperature an advantage in internal circulation which just balanced the loss of heat by the process of ad-heating the feed water.

This result was predicted long ago by James Weir, in his work on "Terrestrial Energy," as follows:—

> "The heat that is carried into the boiler by the feed represents an excess that has come out of the boiler and passed through the engine. Exhaust steam and waste heat must be used to effect economy.
>
> "By using steam direct the result will be neither loss nor gain, but the effective amount of steam the boiler will produce without priming, will be diminished in proportion to the quantity taken from it to the feed."

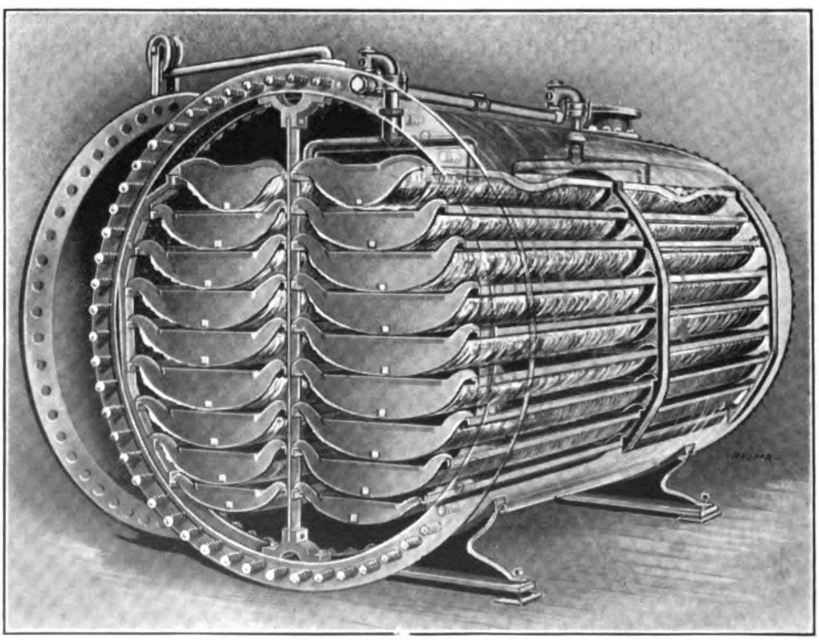
The assertion that there is any large number of live-steam feed-water heaters in use in steamships is open to doubt, and, as far as any advantage can be shown by those that are in operation, it would probably be found, upon close examination of the conditions, that the economy which is attributed to their use is to be found in the operation of the combined details of furnace, boiler, draft, machinery, and methods of absorption of waste heat into the feed water.

The most successful marine installations in which closed or surface live-steam heaters are used, are those in the vessels of the Inch Line, the economical performances of which are remarkable.* These vessels have a combination of appliances and systems, which, when taken together, have resulted in the production of an indicated horse power in the main engines for less than 1 pound of fuel. For the purpose of illustrating the small part which is played in the combination by the live-steam heater, I have prepared the accompanying diagram (Chart III) of the combined appliances. These appliances, used in conjunction with an unusually high pressure, induced draft and effective heating of the furnace air-supply, include a superheater, steam jackets, a reheater in the intermediate receiver, five-cylinder quadruple-expansion engines, jacket traps discharging to feed return, an open or contact heater utilizing the exhausts of some auxiliaries, other auxiliaries driven by the main engines, and, in connection with all of these, a live-steam heater.

The foregoing elements make an interesting and economical combination. The furnace air is pre-heated to 299 degrees F., and the temperature of the gases of combustion, which is 587 degrees, is

* *Engineering*, London, January 18, 1901.

reduced 44 degrees by the superheater and 41 degrees by the air-tubes, so that the gases emerge from the stack at only 319 degrees. A moderate amount of superheat, 57.45 degrees, is attained, of which 22.5 degrees is lost in radiation on the way to the high-pressure steam chest, due, it is stated, to insufficient insulation. The first receiver is fitted with a coil to which superheated steam is admitted, so as to re-heat the exhaust from the high-pressure cylinder, and this supply is then utilized in the jackets of the intermediate-pressure and low-pressure cylinders, which are all closely covered, not only on the sides, but also on the heads. The drips from these points are then trapped, and the superheated water is discharged to a receiver or hot pot, whence it is introduced into the feed water in the hot well. The air pump and the circulating and hot-well pumps are driven by the main engines, but the boiler feed pump and the fan engines exhaust into a contact or open heater, where the temperature of the feed water is raised by the exhaust steam from these auxiliaries from 113 degrees, at which it enters the contact heater, to a tempera-



HOPPES LIVE-STEAM FEED-WATER PURIFIER.

Placed above the boilers, and filled with live steam at boiler pressure by a steam pipe at the top. The water is pumped in at the top and flows to the boilers through a "gravity pipe." On its way down it overflows the pans, following the under side and depositing the precipitated solids. A removable front head gives easy access for removing and cleaning the pans. Hoppes Manufacturing Company, Springfield, Ohio.

ture of 209 degrees, at which it enters the live-steam heater. So far, the process of recovering waste heat, and of ad-heating the feed water thereby, is one of accumulating recovery of otherwise lost material, and the efficiency of the system, even if charged with the steam required for the operation of the hot-well pump, is very high.

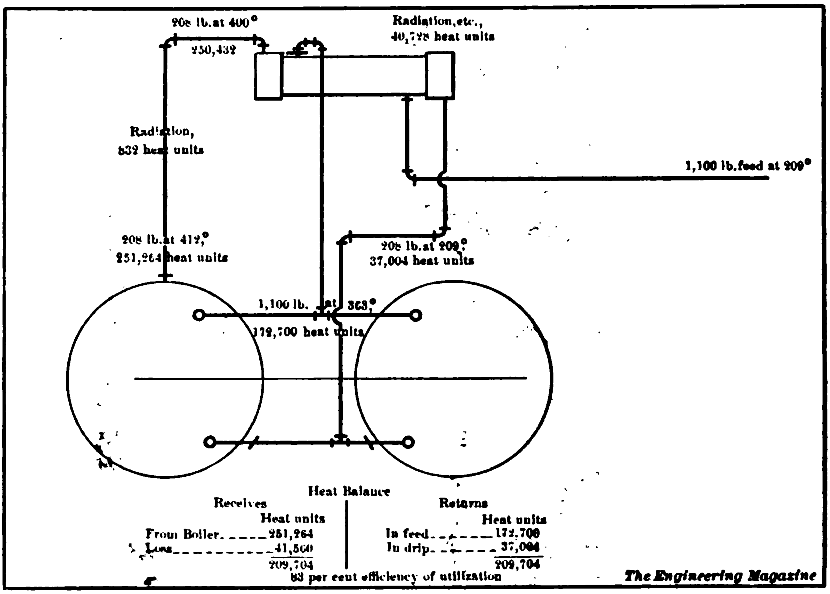
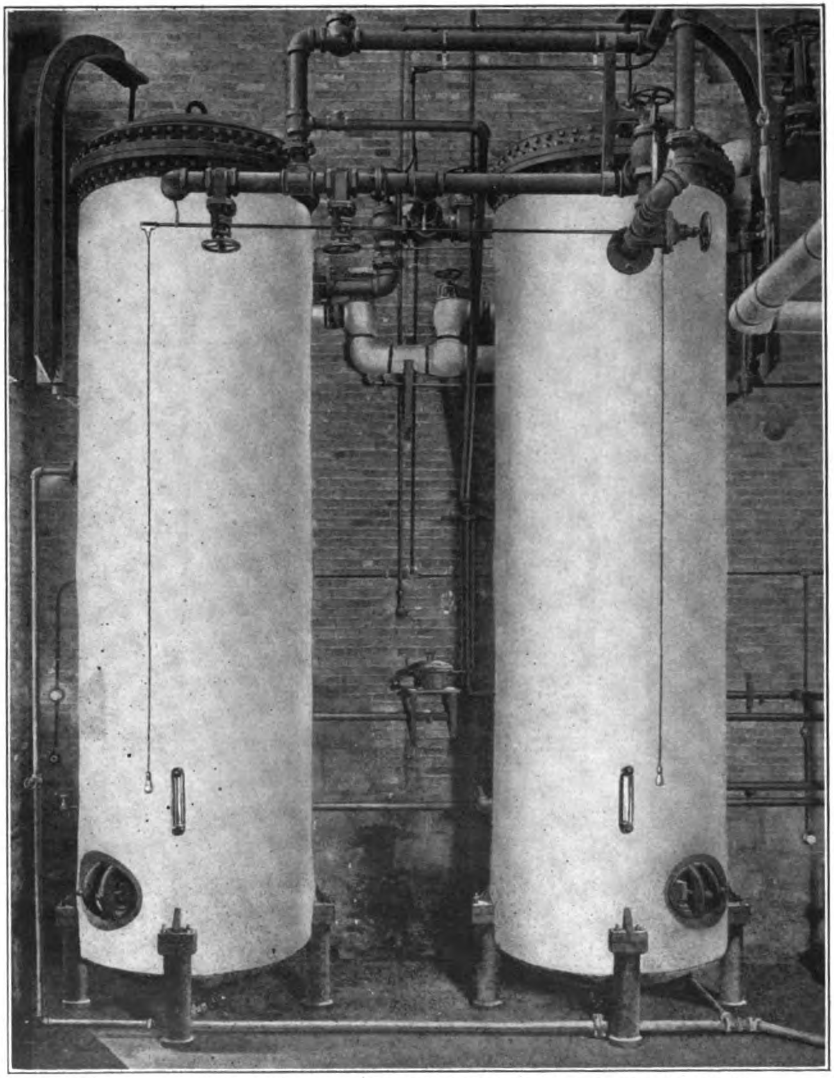


CHART IV. HEAT BALANCE OF THE LIVE-STEAM CLOSED HEATER AS INSTALLED ON THE SS. "INCHDUNE."

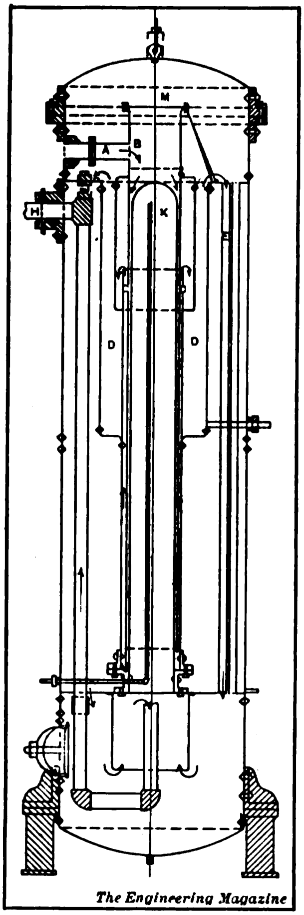
The live-steam heater, arranged as shown in Chart IV, was designed to receive either boiler steam or superheated steam and to return the condensation direct to the two boilers. The return made in this manner is productive of the least possible loss, but it was abandoned, on account, it is stated, of its uncertainty. In the system then adopted, the discharge was trapped and led up to the contact heater, involving the ad-heating by more live steam of the condensed water due to the work of heating in the live-steam heater, a process of accumulation which evidently found a balance at some figure between 310 degrees and 370 degrees of final feed temperature. The temperature of steam supply to the heater is stated to have been 400 degrees, so that the steam was no doubt taken from the boiler, and not from the superheater. Under these circumstances, the feed, entering at 209 degrees, was delivered to the boiler at from 310 degrees to 370 degrees. The lower temperature is stated to have been due to the inefficiency of the traps, and the higher we may assume to have been the best attained when all conditions were favorable. The



AN INSTALLATION OF TWO 1,500 HORSE-POWER LIVE-STEAM PURIFIERS.

The Eclipse Feed Water Heater and Purifier Co., Oshkosh, Wis.

efficiency of the combined appliances for heat recovery as far as, and up to, the inlet of the live-steam heater, is nearly 90 per cent, but the efficiency of the live-steam heater under the best conditions reduces the combined efficiency to 86 per cent. This reduction represents a direct loss of 41.5 heat units per pound of steam delivered to the main engines, which is no doubt lost sight of in the general good effect.



DIAGRAMMATIC VIEW OF THE "ECLIPSE" PURIFIER.*

In the face of this concrete example, in the steam plant of a vessel of the highest efficiency, it is not possible to maintain that the live-steam heater is a source of economy in itself. It may well be, however, that in this instance, as in others, the high pressure and temperature of the steam supply rendered it very desirable that the feed should by some means be introduced at a relatively high temperature, to avoid racking strains on the boiler of the particular type employed, which was operating at a high furnace temperature. The reduction of the cost of maintenance, and the avoidance of unnecessary leakages, may well pay for the cost of the live steam in the feed-heating process, but it should not be assumed that the same effects would be found in connection with a boiler of a different type and working under less strenuous conditions. The general conclusion on the subject of the use of live steam in this connection would, therefore, appear to be, that it is a source of inevitable direct loss, but that this loss may be outweighed, in the types of boilers which are internally fired, by the effects of better circulation promoted by the ad-heated feed water. The application of live-steam heaters should be made only to ad-heat feed water in which all possible sources of waste or used heat have already been utilized, and from which all air and gases have been removed. The process may be applied with advantage to the separation of deleterious materials from feed water, when these are to be eliminated only by the high temperature involved. The live-steam heater should be so arranged as to return its condensation as directly as possible to the boiler.

* The water entering the chamber B through the pipe A is forced between the chambers B and K—a live-steam chamber—in a very thin sheet into the chamber C which is surrounded by live steam. It then enters the settling chamber D which is fitted with a blow-off for discharging sediment. Thence it rises to chamber M where cooling by the cold water in B causes the deposition of scale-forming materials. The water is then forced through small tubes E, surrounded by live steam, into a final settling chamber from which it is drawn to the boilers through the pipe H. The final temperature is about 300 degrees F.

MICROSCOPIC METALLOGRAPHY AND ITS EMPLOYMENT IN FRENCH INDUSTRIES.

By Jacques Boyer.

Modern engineering and mechanical construction demands other and better knowledge of materials than the old chemical and physical tests could afford, and of all the new modes of examination metallography has proved most efficient and most useful. It has received much attention on the Continent, largely because of the earlier demand there created by the development of the exacting demands for extraordinarily high service in motor-car and ordnance work. Prof. Boyer's article details the practice followed in some of the most celebrated French establishments, by authorities whose names have become celebrated throughout the whole world of engineering.—The Editors.

METALLOGRAPHY is finding constantly enlarging utilization in the industries. As is well-known, it is a method of testing which proceeds by examining microscopically a highly-polished metal surface that has been submitted to the action of a reagent. By this the diverse constituents are differentiated, some being attacked, while others are not. Thanks to the perfections introduced into the necessary technical operations, the method has come into current use in France, being employed, for example, in the Creusot Works, establishments of the Société de Constructions Mécaniques at Denian (Nord), of the Compagnie des Fonderies, Forges et Aciéries de Saint-Etienne (Loire), of the Société Métallurgique de la Bonville (Eure), in the great de Dion-Bouton shops at Puteaux, near Paris, and in many other establishments working in iron, steel, bronze, brass, and other alloys of copper. Furthermore, micrographic observations of this kind are nowadays executed very rapidly, as it is possible to polish, etch, and photograph a sample in about twenty minutes.

Let us take up the various steps of a metallographic examination and see what information of industrial value may be derived.

First, the sample must be cut. Certain precautions are necessary to prevent alteration of the substance during this operation, which is performed with a saw in the case of most metals and alloys. In particular, heating of the piece is avoided by running the saw at slow speed and flooding it with soap and water and oil. Ordinary annealed steels, bronzes, brasses and many common alloys are thus sectioned. Some others, however, must be cut with very thin carborundum

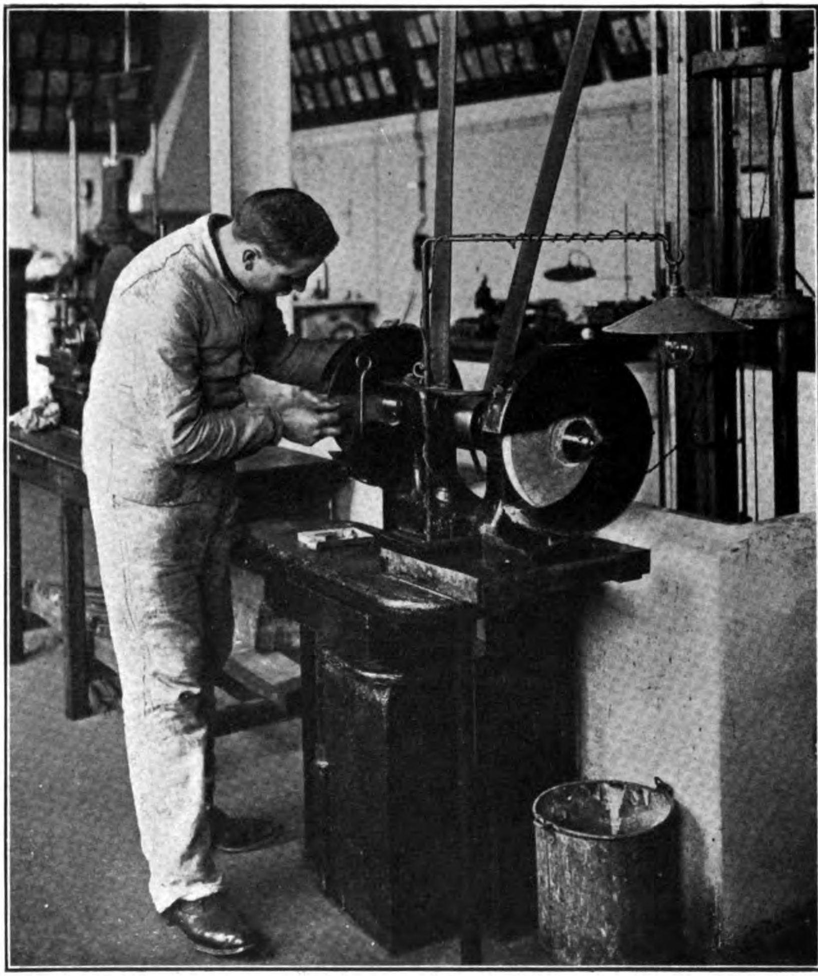
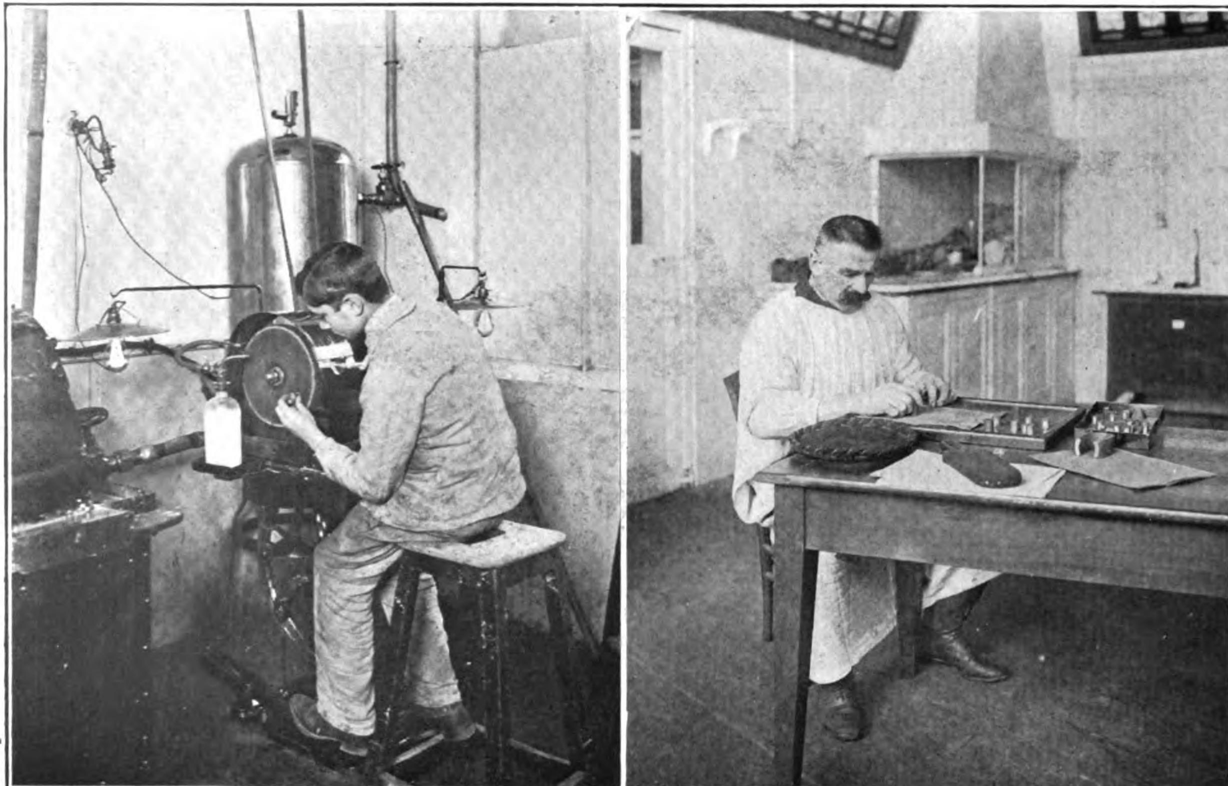


FIG. 1. ROUGHING DOWN THE SPECIMEN.

grindstones. The next step is polishing, which includes roughing down, grinding with emery, and finishing.

Roughing down, which has for its object the dressing of the face to be observed, is generally done on an emery or carborundum stone, revolving at variable speed according to the metal which is under examination—800 to 1,000 revolutions a minute for soft steels, unhardened bronze and brass—in other words, for all alloys which are in such a state that slight heating is not objectionable. In other cases, especially for tempered steels, the speed of the wheel is lowered and it is kept thoroughly wet. The grindstones are mounted on a



FIGS. 2 AND 3. ON THE LEFT, A CORNER OF THE SPECIMEN-FINISHING ROOM AT THE DE DION-BOUTON WORKS, PUTEAUX. **ON THE RIGHT, RUBBING ROUGHED DOWN SPECIMENS ON EMERY PAPER TO GET RID OF THE HARDENED SKIN.**

In Figure 2 the vaporizer containing the alumina in suspension in water may be seen behind the wheel.

frame and operated by foot power or mechanically, as shown in the illustration on page 655 (Figure 1). In order to avoid a deep hardening effect, the metal must not be pressed too hard against the face of the stone, and according to M. Henry Le Chatelier, in order to avoid the slightest inaccuracy of result, the skin which is formed should be removed; this is done by rubbing the roughed-down samples by hand or coarse emery. (Figure 3). Last comes finishing (Figure 2) which depends for its success almost entirely upon the care given to the preparation of the materials used in this final polishing operation. As it is necessary to use powders with grains of very uniform size, and as these are not found in commerce, they must be specially prepared. Ammonia-alum is pulverized and calcined. The alumina thus obtained is ground in a mortar to break up the lumps which have formed. It is then washed several times with an 0.001 to 1 solution of nitric acid, next with distilled water, and finally with water to which one or two cubic centimetres of ammonia per litre have been added. In this way the various salts, especially carbonate and sulphate of lime, which might be precipitated with the alumina, are removed, and if a slight excess of nitric acid remains it is neutralized. This being done, the alumina suspended in water is put into a receptacle of one or two litres capacity; it is allowed to rest a certain time and the large grains which are precipitated are rejected, the supernatant liquor being siphoned off. This is allowed to rest successively for two hours, four hours, etc., and at the end of each period the liquor is siphoned off, while the corresponding precipitates are carefully preserved separate, each one being finer than the preceding, as the number of decantations increases.

Le Chatelier has designed an apparatus for more rapid preparation, which is worthy of notice. Commercial two-minute emery is sifted through 150 mesh and then through 200 mesh, and that portion is collected which passes the first screen and remains upon the second. For the finer polishing powder or putty the finest grade of commercial emery (60 to 120) is washed by an ascending current of water with a speed of about one millimetre per second, and the portions which are carried off by the current are collected for use. The designer has invented also a special apparatus suited to the practical conduct of this process.

The polishing materials being secured, let us pass to their mode of utilization in the finishing process. This is simply a polishing with alumina, conducted upon rapidly-revolving discs. Those used in ordinary shop laboratories are made of thoroughly seasoned wood, covered with a flat disc of zinc, over which thick cloth is stretched. The polishing is begun with two-hour alumina, followed by four-hour, and if necessary with still finer grades. In this work, as one of the illustrations shows (Figure 2), the alumina is suspended in water in a spraying apparatus, and an excellent distribution of the polishing powder is thus secured.

In the de Dion-Bouton establishment one room is given up exclusively to the finishing operation; the roughing down and the rubbing with emery paper are performed in another laboratory so as to avoid the danger of carrying grains of emery over on to the polishing cloth mills. Under each one of these (four in number, working with different finenesses of alumina) is a good-sized water reservoir for the collection of the powder which is produced. Furthermore, the floor of the room is oiled, the walls specially coated, and the only one who enters the room is the workman who does the polishing. A compressor serving all the shops supplies the air necessary for operating the sprays.

Thanks to this installation, samples of steel are polished in ten minutes, and copper alloys in twenty minutes for the harder, and about thirty minutes for the softer, types. Occasionally, however, more difficult cases of polishing arise. Wires of small-cross section are inserted in a clamp of fair size and the whole thing polished together, or they are enclosed in some alloy melting at a low temperature and the entire face is polished. A metal shaving is examined in the same manner. It is placed flat in an alloy which is softened by gentle heating.

The polishing completed, the sample is next attacked by appropriate reagents which differ widely both as to composition and concentration according to the substance to be studied. After this, it is submitted to the microscopic examination. We need not discuss the older, well-known forms of apparatus—Cornu, Charpy, Nachet and Zeiss—but we shall consider only the Le Chatelier microscope which has found so wide practical application in metallography.

Reversing the ordinary arrangement, the objective is directed upward, which permits the examination of large objects and especially makes a single plane surface suffice for the examination of an ordinary sample. This is placed directly upon a support, replacing the stage of the microscope. The disposition dispenses at once both with the regulation necessary in the ordinary form of microscope to bring the surface to be examined exactly normal to the axis, and also with the still greater task of preparing a sample with two plane and parallel faces. An important economy of time is thus secured.

The eye-piece, O (Figure 4), is placed horizontally on one side and receives the image through a total-reflection prism placed below the objective and above the screw P by which it is adjusted. The examination is thus carried on easily while the operator is seated before a table. Focusing is effected by means of the screw-threaded plate V which surrounds the objective and carries the support E. Its face must be absolutely perpendicular to the axis of the objective. The support is carried upon three points, carefully adjusted to exact height so as to insure the true position of the sample. For work demanding the highest precision a special stage is devised by which a series of successive photographic negatives may be obtained from the same sample. This stage (Figure 5) replaces the screw-threaded plate V. It is composed of three carriages of which two, b and c, move at right angles to each other. Their travel is about 20 millimetres and is measurable by a vernier scale; a third movement of revolution controlled by the knob a is also measured on a vernier. It permits the sample to be revolved about its own axis.

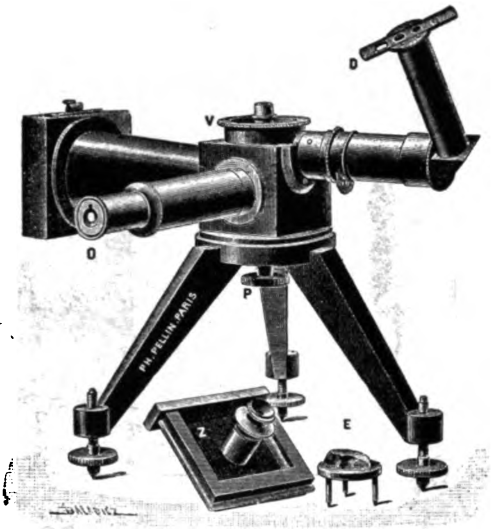


FIG. 4. THE LATEST FORM OF THE LE CHATELIER MICROSCOPE.

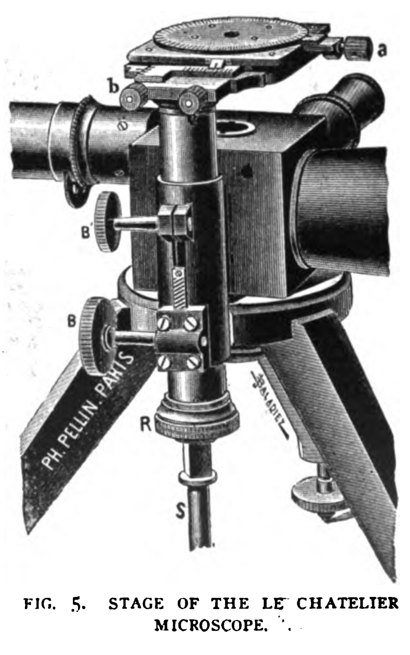


FIG. 5. STAGE OF THE LE CHATELIER MICROSCOPE.

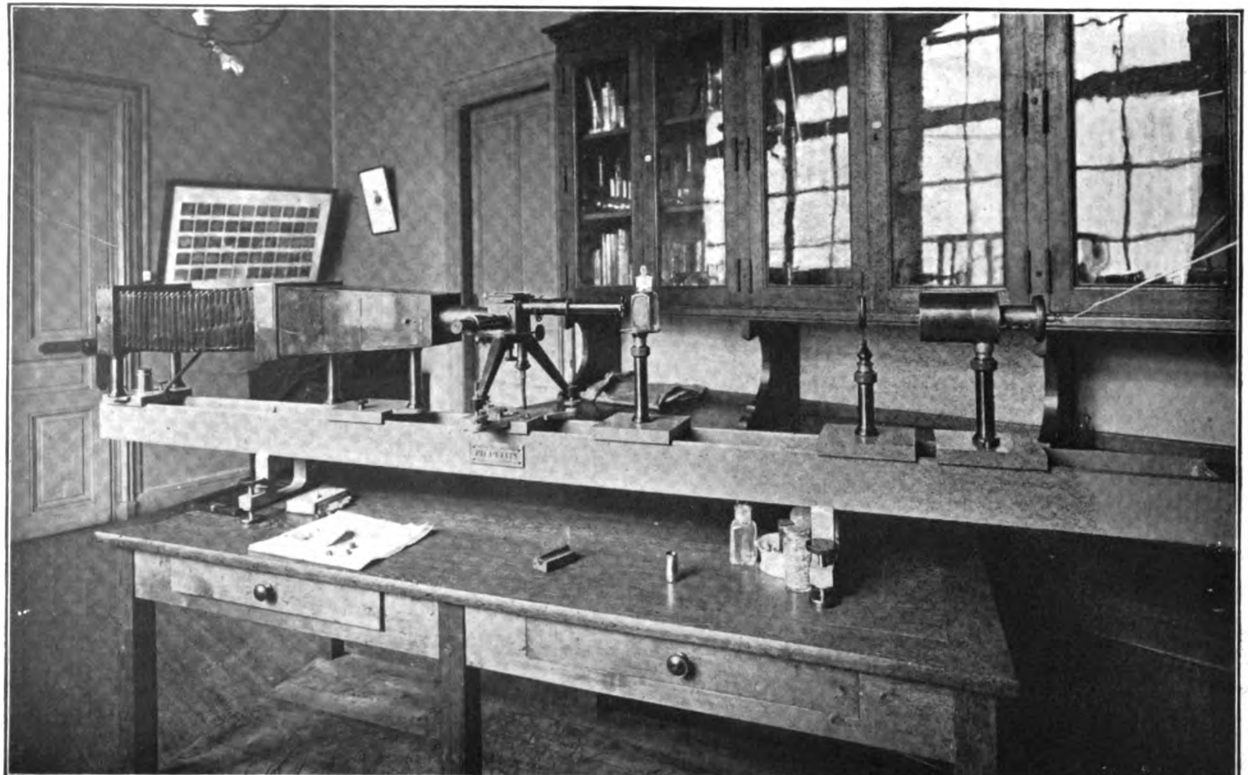


FIG. 7. THE LE CHATELIER MICROSCOPE AND ITS ACCESSORIES MOUNTED ON A METAL BED.
Photographed by M. Boyer in Le Chatelier's laboratory at the Sorbonne, by special permission.

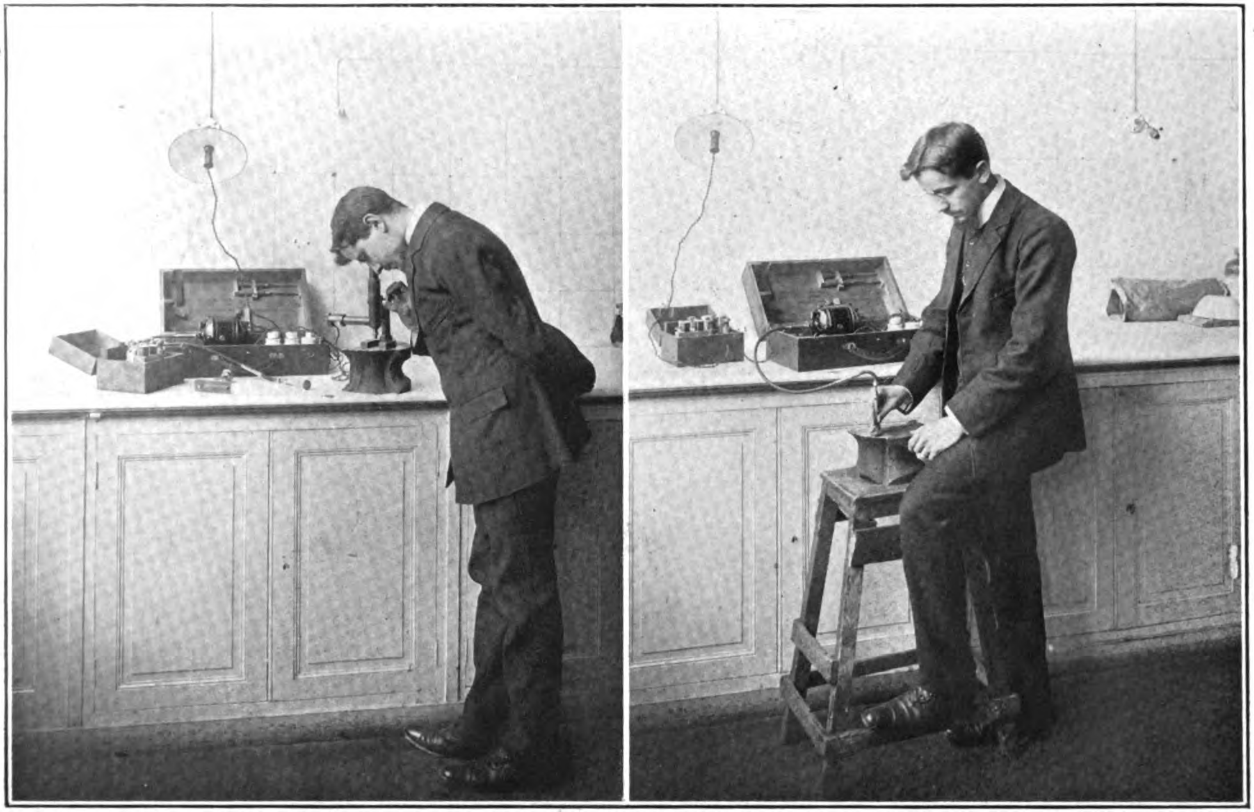
Focusing is accomplished by the three movements; a rack and pinion B serves for the rapid adjustment; a fine micrometer movement R accomplishes the exact focusing; finally, a flexible shaft S attached to the fine adjustment serves for focusing from a distance when the operator is using the camera.

In microscopic work on metals, however, lighting is the most delicate matter to regulate. Generally, this regulation is secured by trial, using a large number of movable pieces. M. Le Chatelier has sought to reduce this experimental effort to a minimum and to give to each element an exactly determinable effect. These elements are two—variable opening and variable position of a single diaphragm D which is so placed that:—

FIG. 6. A SMALL SHOP INSTALLATION OF THE LE CHATELIER MICROSCOPE APPARATUS.

1.—The opening of the diaphragm controls the angle of the luminous beam which falls upon each point of the sample. This angle must vary with the nature and quality of the objective, as in the case of photography. The larger the angle the more the influence of spherical aberration is felt; on the other hand, the smaller the angle the more will diffraction fringes tend to develop. The greatest clearness is obtained by a certain mean, which must be regulated in each case by experiment.

2.—The position of the diaphragm controls the average inclination at which the beam falls upon the sample. For clearness alone this



FIGS. 8 AND 9. ON THE LEFT, METALLOGRAPHIC EXAMINATION WITH THE LÉON GUILLET OUTFIT. ON THE RIGHT, POLISHING A LARGE SPECIMEN WITH THE SMALL EMERY WHEEL OF THE LÉON GUILLET OUTFIT.

direction should approach normal, but it is necessary to depart from this in order to reduce the amount of the light reflected by lenses to the eye of the observer. At a proper inclination the major part of the light thus diffused may be stopped by the collecting prism itself.

The diaphragm D (Figure 4) is placed at the front of the lighting system composed of a lens and the collecting prism. It throws its image upon the rear face of this latter. Beyond this, a second diaphragm cuts off the rays other than those which fall upon the test specimen under examination.

Accurate reproduction of the micrographic image, however, requires that it be preserved photographically. The Le Chatelier apparatus has been studied particularly with this object in view, and presents advantages over the Nachet and Martens apparatus, having now become almost the only form employed by French metallurgists. The latest type of this microscope, which M. Le Chatelier himself courteously permitted me to photograph in his laboratory at the Sorbonne (Figure 7) is mounted on a metal bench so as to secure great stability. The ensemble consists of a Nernst lamp, a bulb or flask for absorbing certain rays, a lens, and the microscope proper. An incandescent lamp suffices as a source of light for general observation, but for photography it is better to use a two-filament Nernst lamp, which permits relatively short exposure.

Unfortunately, this apparatus lends itself but ill to the examination of large finished parts and still less to machinery fully mounted. M. Léon Guillet, the distinguished professor of metallurgy at the Conservatoire des Arts et Métiers, Paris, has therefore designed a metallographic outfit particularly for inspectors, for expert examinations, for tests in place—for example, the inspection of ingots, the rapid verification of large metal mirrors, of automobile chassis, of machine frames, or for studies such as that of the breakage of a line shaft or of the proportion of copper in brass parts, etc. As shown in the illustrations (Figures 8 and 9) this apparatus consists of:—first, a continuous-current motor revolving at high speed, and a flexible shaft upon which the polishing mill is carried; second, files, emery paper of proper fineness, a box of reagents, hand-operated sprays for alumina, and two object glasses; third, the microscope, which is vertical and arranged so that it may be fixed very easily upon any object either by a screw clamp or by leather bands. The lighting for this microscope is obtained by a system similar to that used in the Le Chatelier apparatus, but the lamp is carried upon the apparatus itself. To this outfit is added a microscope stage with two movements, which may be fixed upon the lower support when laboratory observations are to be made.

Thanks to the perfection obtainable in all the instruments of observation, metallographic manipulations can now be conducted with great ease in French industrial establishments.

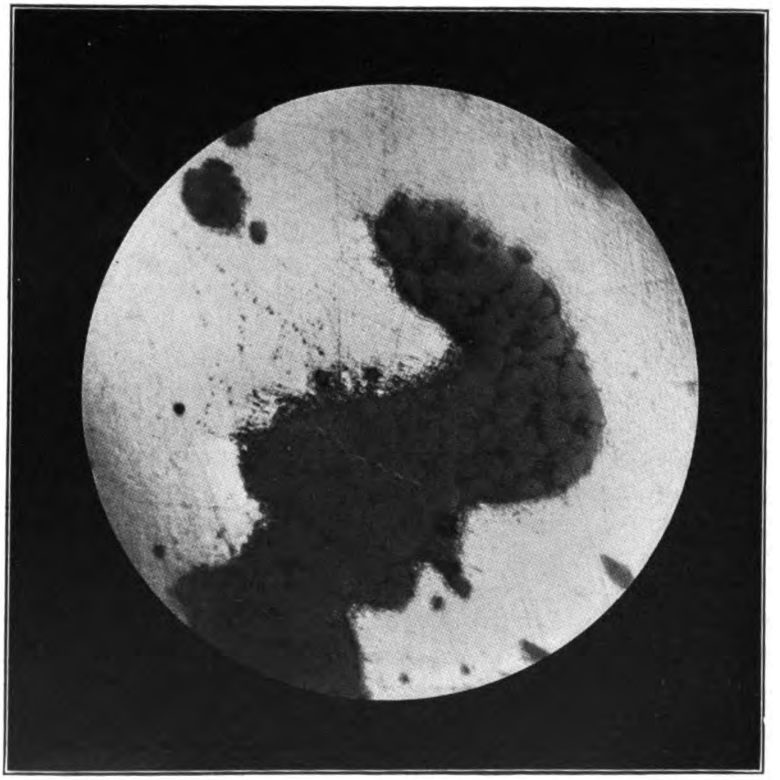


FIG. 10. SLAG IN IRON IN AN UNETCHED SPECIMEN.

General Applications.—This method of examination may sometimes be substituted for chemical analysis, and it often discloses, even before attack, little cavities invisible to the naked eye, but destructive to the quality of the product. (Figure 10). It determines the heat treatment to which the metal has been subject and that which it should undergo to secure the maximum efficiency. Before, or at times after, the attack, the sample will discover the presence of constituents different from those met with in similar products of good quality. From this an abnormal composition may be inferred, which may be further investigated, perhaps directly by metallography, or in other cases by chemical analysis. We find a very striking example of this sort in the disclosure of the presence of oxide of copper in samples of copper.

The examination of the distribution of constituents and their relative importance gives most valuable indications which are furnished by no other method. Later, a large number of applications based upon this fact will be cited. In this connection attention will be drawn to the influence of rapidity of cooling upon the constitution of anti-friction metals, (Figure 11), certain bronzes and alloys containing lead, etc.

Finally, the metal will often show very distinct deformations, indicating the sort of mechanical treatment to which the mass has been subjected.

Let us now review rapidly the information which metallography may furnish concerning the principal metals of industry. So far as concerns the composition of cast iron, it defines:

1.—The approximate percentage of combined carbon; this is in the form of free cementite and of pearlite (ferrite-cementite eutectoid); attack by an alcoholic solution of picric acid will cause the pearlite to appear, while an attack by picrate of soda in soda solution will bring out the cementite in brown.

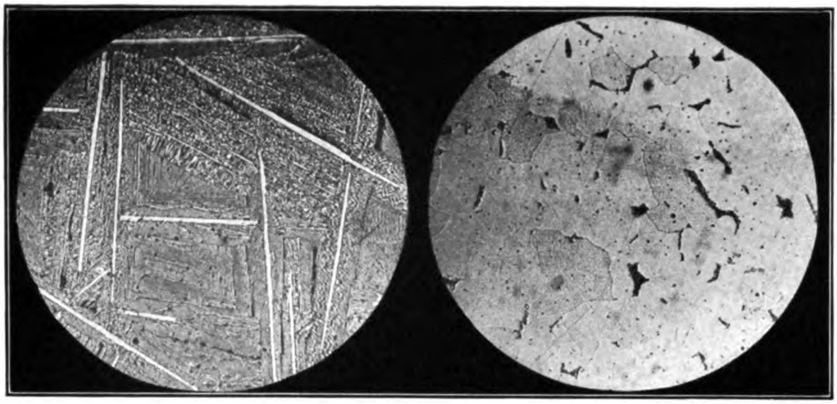
FIG. 11. ANTI-FRICTION METAL.
Magnified 48 diameters.

2.—The approximate percentage of graphite; graphite is visible after polishing and before any attack; the graphite and the annealing carbon are easily distinguished. (Figure 12).

3.—The approximate percentage of phosphorus. An acid solution leaves the phosphoric parts intact. M. Le Chatelier has remarked: "The classification of grey cast irons according to their phosphorus contents is extremely easy and rapid." In white cast iron (Figure 13) the distinction between the phosphoric parts and the cementite may still be made, although with a little more difficulty, by an energetic attack with nitric acid, which colors the cementite slightly, leaving the phosphoric parts uncolored.

FIG. 12. CAST IRON SHOWING CARBON AFTER ANNEALING.
Magnified 50 diameters.

4.—The approximate percentage of sulphur. This substance is in a state of yellow globules of sulphide of iron or of bluish crystals of sulphide of manganese. However, micrography does not permit estimation of silicon and manganese. Beyond this, metallography permits not only determination of the quality of malleable cast iron, so far as concerns the depth of decarburation and the temperature at which the operation was conducted, but it furnishes also exact knowledge concerning the heat treatment undergone. Thanks to it we may estimate with sufficient exactness the annealing carbon. This is



FIGS. 13 AND 14. ON THE LEFT, WHITE CAST IRON, SHOWING CONTRAST BETWEEN CEMENTITE AND PHOSPHORIC PARTS. ON THE RIGHT, A 0.05 PER CENT. CARBON STEEL ETCHED WITH PICRIC ACID.

Magnified 133 diameters.

present in round black globules which cannot be confounded with the lamellar graphite. The annealing of castings is a frequent operation, designed to produce softening; nothing is easier than to determine in any piece—the roll of a rolling mill for instance—the depth to which the temper extends, often an item of capital importance.

The services which this new method of procedure may render in the chemical or thermic treatment of common steels are of great importance and could not be secured by any other mode of examination. (Figure 14). For steels to be case-hardened, micrography, among other things, permits us to determine in advance and also upon finished pieces whether the steel employed is suitably low in carbon; to determine after case-hardening and before tempering the exact depth of the cementation layer; to ascertain before tempering the quality of this surface, which should contain about 0.85 per cent. of carbon, but should show no needles of cementite; and to define with ease the quality of the final product after tempering. The surface should then show a composition of very fine martensite and should not enclose needles of cementite or troostite (Figure 15). For tempered steels metallography gives the composition of the piece in its various parts, shows the depth to which the temper has gone (the martensitic layer), indicates whether or not the tempering heat was right (martensite should be imperceptible in hard steels). For annealed steels the micro-structure indicates if the annealing was well done (the temperature sufficient, but not too high); if the cooling was conducted under proper conditions (sorbite or troostite are produced by rapid cooling, pearlite by slow cooling). When annealing has for its purpose the removal of the effects of cold rolling or hammering, every trace of orientation in the structure should disappear. If it has for its purpose the removal of temper, martensite should be converted into pearlite.

In any case—and this is a capital point, which cannot be too strongly urged—when micrographic estimation of carbon in any iron or steel product is undertaken the metal should be annealed; otherwise we are likely to find troostite and above all sorbite if the steel has been rapidly cooled (as in rolled and hammered forms), and we might thus be led to estimations which are much too high.

Few French industries have been more aided by metallography than that of steel casting. Practically, carbon may be estimated within 0.05 per cent. micrographically. Attack by picric acid suffices to bring out the pearlite; by comparison with a fixed scale the percentage of carbon may be found (Figure 14). So far as concerns other information, silicon, manganese and phosphorus are dissolved in the ferrite; sulphur may sometimes be distinguished in the form of widely-dispersed yellow globules; among extraordinary constituents, oxides, sulphides and slag may be distinguished. So far as concerns the distribution of constituents, the pearlite should be noted with the greatest care; this is the principal point. In raw steel castings pearlite is always found in large and irregular masses; it is otherwise after heat treatment.

So far as porosity is concerned, careful examination in advance of any attack must be made for blow-holes, which in this material are of great importance. The best results will be obtained from heat treatment when the pearlite is as uniformly distributed as possible. We shall then be certain to have got rid of brittleness—if this is not due to incorrect composition, especially to too high a percentage of phosphorus.

In the examination of steels which have undergone mechanical treatment, as, for example, rolled, forged and drawn shapes, whether the inquiry be as to composition, the presence of abnormal constituents, or soundness, the same results may be obtained as in the case of cast steel; but here, so far as mechanical and heat treatments are concerned, we may deduce new conclusions:

1.—As to the temperature at which the metal was forged; exaggerated size of the grains of ferrite in mild steels, or a coarse arrangement of the pearlite and ferrite in semi-hard steels, will show if the metal was worked at too high a temperature, or if it is brittle. It is easy to restore it to a better condition—annealing at a temperature slightly above its highest transformation point will suffice; the overheated metal is regenerated. In the rare case of a metal being "burned" it is of course known that no treatment short of a new fusion will restore the quality. The condition may be recognized by the cavities which appear here and there in the place of pearlite, and by the large quantities of oxide present.

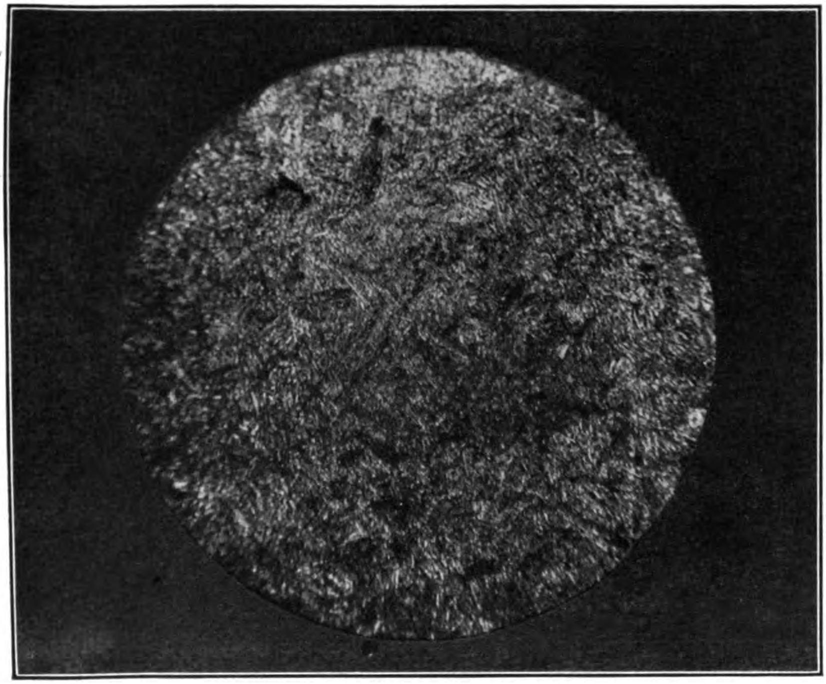


FIG. 15. FINE-GRAINED MARTENSITE ETCHED WITH PICRIC ACID.
Magnified 200 diameters.

2.—As to the finishing temperature of rolling; the great influence of this coefficient is well-known and has led to the design of some notable special machinery for rolling rails, especially in America. According to the investigations of various savants, particularly Stead, it seems especially advantageous to secure a troostitic structure characteristic of steels slowly tempered. M. Guillet, after observation of a number of rails thus treated, believes rather that it is sorbite which is present. To obtain it, the rolling must be finished very little above the critical point, or, better still, within the critical interval. Micrographic examination permits us to discern very easily the structure which has been obtained, and consequently to regulate the process of manufacture so as to secure the desired end (Figure 16).

3.—As to the results of cold working, followed by heat treatments, micrography renders the utmost service. By it we are enabled to see the deformations to which the surface and deeper layers have been subjected. It exhibits the effects of rolling or fine drawing. It permits us to ascertain if the metal has been well annealed, if it has been overheated, etc.

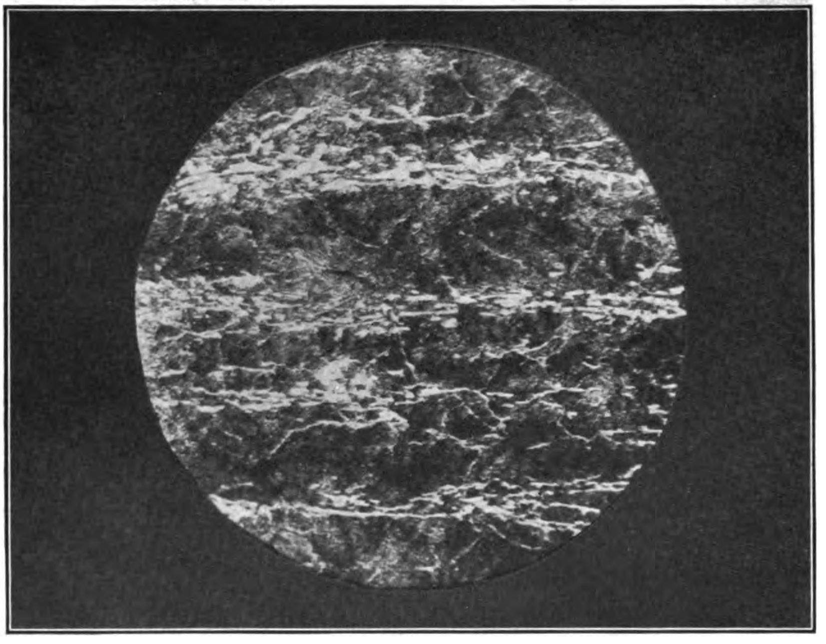
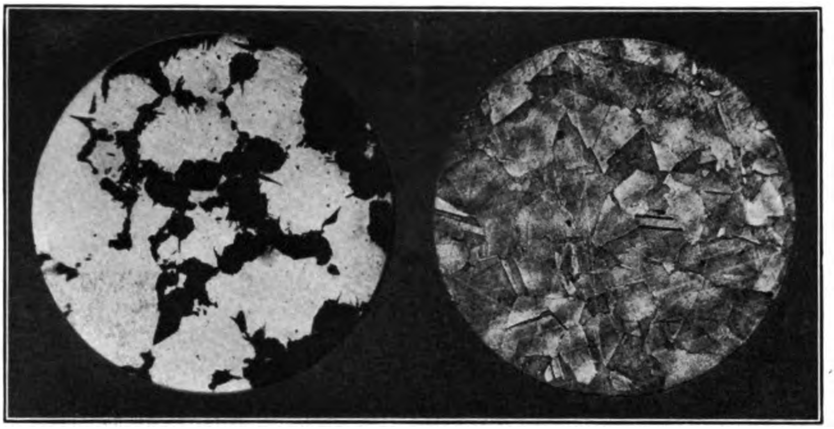


FIG. 16. A 2.20 PER CENT CARBON STEEL CUT IN THE DIRECTION OF ROLLING. Magnified 200 diameters.

4.—Lastly, in the final product, the distribution of the constituents is often of considerable importance. For example, a steel plate showing pearlite in parallel bands will usually exhibit a high degree of brittleness. Microscopic metallography further finds useful application in the definition of special steels. The steels of commerce commonly met with, as is known, are structurally composed of pearlite with ferrite or cementite; of pearlite with a carbide other than cementite; of martensite or troostite; of troostite or sorbite with a carbide, or of γ iron. (Figures 17 and 18). It is easy to determine with which one of these steels we are dealing, and we may thus form practical conclusions because the properties of the several groups differ. It is to be noted that manufacturers have the extremely bad habit of designating a special steel by the percentage of some alloyed



FIGS. 17 AND 18. ON THE LEFT, TROOSTITE CRYSTALS (BLACK) IN A GROUND MASS OF MARTENSITE (WHITE). ON THE RIGHT, γ-IRON NICKEL STEEL.

Magnified 129 diameters.

constituent. They speak, for example, of a 2 per cent. nickel steel; now this does not describe anything; and if it is satisfactory to the producer it involves the consumer in the risk of mistake, but in such a case the microscope permits us to determine exactly the carbon contents, and, beyond this, the form of the pearlite and the size of the grain of the ferrite will furnish exact information. Thus, in nickel steels well annealed, we shall always find pearlite very finely grained; in chrome and silicon steels the grain of the ferrite is extremely fine.

When we have to deal with a steel which is close to the limit between pearlitic and martensitic it is impossible to obtain precise results; in fact the carbon contents deduced from the pearlite observed under the microscope do not in general represent the total. A certain proportion is in solution. Nevertheless, we may determine whether or not the steel is safe, for if it is not entirely homogeneous there will be extremely hard spots difficult to work or perhaps almost impossible to machine. Furthermore, as concerns homogeneity of these steels close to the limit, the microscope frequently permits us to define regions which belong wholly within a certain zone. Another example is still more interesting; when nickel steels for case hardening first appeared, of which the commonest type contains 0.12 per cent. of carbon, with 2 per cent. of nickel, shops in which these steels were worked found parts very clearly outlined in which tools would cut with extraordinary facility. Microscopic examination showed plainly the presence of nodules very high in nickel.

In the matter of heat treatment, to cite only the very important case of tool steel, microscopic examination permits us to determine the best temperature for tempering. Also it makes possible the comparison between two treatments of the same steel; in the treatment of double-carbide steels it permits us to see if all the carbon has entirely disappeared, and it fixes, also, the hardening temperature and the time of heating before tempering, which, as is well known, is of much importance.

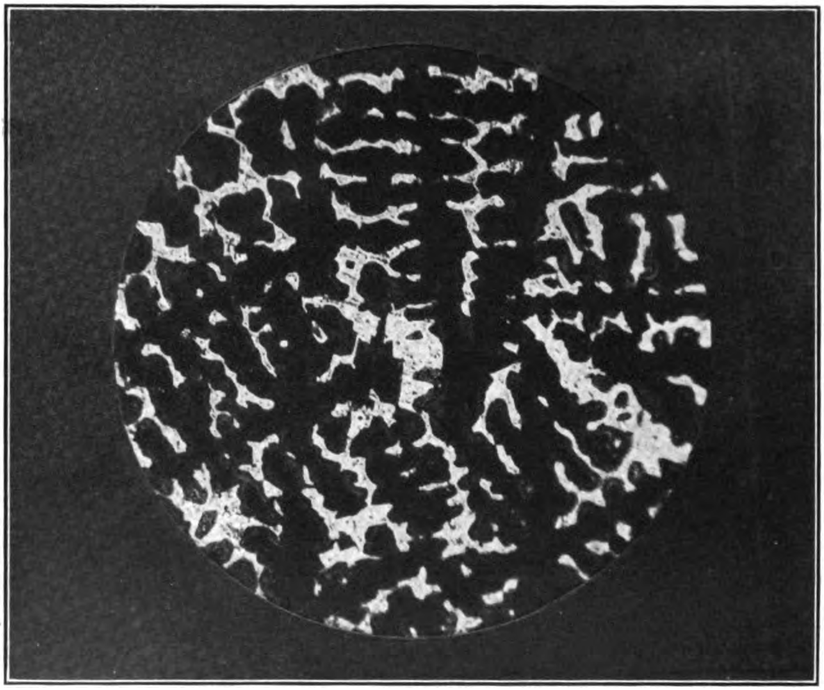


FIG. 19. BRONZE, 16 PER CENT. TIN. THE DARK AREAS REPRESENT THE SOLUTION a AND THE WHITE THE CONSTITUENT δ.
Magnified 200 diameters.

In French foundries working in common bronze (alloys of copper and tin) metallography is now used as follows:

1.—To replace up to a certain point chemical analysis, at least for bronzes containing more than 8 per cent. of tin. These are substantially after slow cooling, composed of two solid solutions (the constituents α and δ of Heycock and Neuville) in proportions which permit us to recognize the composition. (Figure 19).

2.—To know whether the alloy contains foreign substances. Notably we may recognize the presence of oxides which, according to the investigations of Heyn and Bauer, will be stannic acid. This observation permits us to determine whether the metal has been deoxidized by addition of phosphorus, silicon, etc.

Sometimes we may recognize the presence of an excess of phosphorus. In this connection we should direct attention to the method of attack by picrate of soda which was first employed by M. Le Grix. He showed that the normal constituent of bronzes colors brown under the action of picrate of soda, the solution becomes yellowish, and finally the special constituent due to the presence of phosphorus remains very clean white. It appears further that this constituent is very undesirable; a phosphor-bronze well made should show only traces of it.

3.—To determine the homogeneity of the product. This is of much importance in hard-wearing bronze. It often happens that an important segregation of compounds occurs at certain points in the mass of the metal. Reheating at about 700 degrees will suffice to make the metal more homogeneous.

4.—To determine the heat treatment to which the alloy has been subjected and whether this has been proper. Thanks to the admirable memoirs of Heycock and Neuville, the considerable importance of the speed of cooling upon copper-tin alloys is recognized. It is therefore important to determine whether an alloy has indeed the normal constitution after pouring. For example, for a hard-wearing bronze the important constituent is the δ solution; this solution disappears wholly or in part upon rapid cooling.

Rolled or hammered bronzes under the microscope yield very interesting information beyond that indicated above in connection with cast bronzes. This relates to the manner of the heat treatment—temperature, speed of cooling, etc. A single instance may be cited. The rolling of bronzes containing less than 8 per cent. of tin (composed of the α solution) is accomplished in the cold and consequently is accompanied by many annealings. Before annealing the α solution is heterogeneous. Attack by perchloride of iron in hydrochloric-acid solution produces the appearance of spots, some darker than others. These are the parts richest in tin. Annealing makes the solid solution homogeneous. It then forms polyhedra of remarkable distinctness, and of size which is in some degree proportional to the annealing temperature. M. Guillet, who has studied this phenomenon (already noted in the case of brass by M. Charpy) has formulated the following principle: the annealing of every solid solution produces polyhedra very clearly marked, whose dimensions are in relation with the annealing temperature. Now it is known that there is a very close connection between the mechanical properties and the dimensions of these polyhedra. When these are large we find simultaneous lowering of the breaking strength and of the elongation. The metal is said to be "overheated." When the metal is "burned" in the true sense of the word—that is to say, oxidized—we see round grains of oxide formed between the polyhedra.

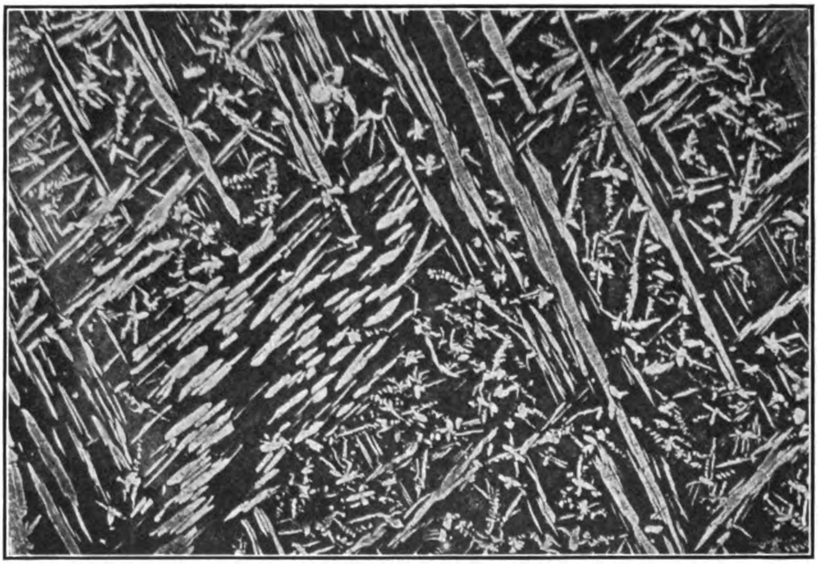


FIG. 20. BRASS, WITH 56.5 PER CENT COPPER AND 43.5 PER CENT ZINC.
Magnified 50 diameters.

Rolled, forged and hammered brasses afford opportunity for an extremely important utilization of micrography. (Figure 20). We know that the alloys of copper and zinc are divided into two distinct categories from the point of view of forging: 1, brass containing 55 to 62 per cent. of copper which may be forged hot; 2, brass containing from 60 to 100 per cent. of copper which is forged cold. There are a few alloys containing from 60 to 62 per cent. of copper, which may be forged either hot or cold. It should be added that alloys containing more than 90 per cent. of copper, if they are very pure, may be rolled hot. Evidently it is very important when, for example, we are casting an ingot which is to be hot-rolled, to know if it actually possesses the desired composition. A simple micrographic examination, without any injury to the ingot, will inform us if the analysis is actually between 55 and 62 per cent. of copper.

As in the case of bronzes, examination of the micro-structure also determines the character of the annealing and indicates the presence of foreign substances. In brasses containing more than 63 per cent. of copper we shall find polyhedra of dimensions dependent always on the conditions of annealing and rolling. We may also draw conclusions similar to those defined above for steel so far as concerns drawn shapes.

In the case of other alloys of copper, metallographic examination will furnish no less useful indications. In copper-nickel alloys consisting of a single solid solution, in copper-zinc-nickel compounds, and in alloys of copper and phosphorus, much employed in the foundry, we may easily fix the percentages by the proportions of the eutectic and the components.

Micrographic methods also replace chemical analysis advantageously and with sufficient closeness of approximation in such alloys as those of lead and antimony, employed for bullets, for accumulator plates, and anti-friction metals; of lead and tin (solder); and of silver and copper used for coin and plate. It is particularly important for anti-friction metals, of which the principal are composed of a complex crystalline eutectic of the combination Sb Sn, and needles of the combination Cu_3Sn. According to the quickness of the cooling very different results are obtained. The crystals are much more strongly developed as the cooling is slower. It appears that the crystals resist wear while the eutectic gives to the alloy the indispensable plasticity. In the ordinary processes of manufacture, anti-frictions are cast, usually in metal moulds; their constitution and consequently their efficiency depend essentially upon this casting, and micrography alone enables us to determine the conditions. Further observation of the micro-structure informs us as to the homogeneity of the product. Traces of copper (1 per cent.) suffice to render a lead-tin-antimony alloy extremely homogeneous.

Finally, microscopic metallography no doubt will soon permit fuller examination of the metals of industry, but French engineers still await the co-ordination of results already obtained to decide upon this practical utilization.

In conclusion, it should be conceded that the new processes complete most usefully the knowledge supplied by chemical analysis or by mechanical tests, but can not supplant all the other methods of examination, either in the laboratory or in the shop.

EFFICIENCY AS A BASIS FOR OPERATION AND WAGES.

By Harrington Emerson.

VII. THE LOCATION AND ELIMINATION OF WASTES.

The parts of Mr. Emerson's series, which began in our issue for July last, already presented have discussed the world-wide evils of inefficiency in almost every branch of human activity; the peculiar national qualities which have thus far helped the leading industrial nations to mitigate the losses due to inefficiency; the necessity for supplementing the line system of organization on which industrial management principally depends with modern staff organization; the relation of standards to organization and to results; and the realization of standards in practice.

Last month, under the heading "The Modern Theory of Cost Accounting," Mr. Emerson laid the foundation of the proposition he completes in the following pages. This is that actual costs must be subdivided into standard costs and preventable wastes; that standard costs must be based on full equivalency in service rendered for money spent; that standard costs must always be predetermined; that average wastes are part of general expense and can be currently anticipated; that the chief duty of the operator is the maintenance of all standards; and that cost standards can only be attained through methods, records, ideals and checks furnished jointly by the comptroller and the efficiency engineer to the executive line officials.—THE EDITORS.

MODERN efficiency cost accounting and expense statements consider separately *actual expenses,* which concern chiefly the comptroller, *efficiency costs,* which concern alone the efficiency engineer, and *allotted costs,* which concern both comptroller and efficiency engineer. Actual expenses need no definition. Efficiency costs are predetermined expenses with the differences added or subtracted to balance actual expenses. Allotted costs are separated into two items, both predetermined, namely, standard cost and current waste. Allotted costs are therefore also predetermined. It is part of the duty of an efficiency engineer to predetermine standard costs either by using existing standards or by a series of assays.

Current wastes are predetermined by assuming that they will be relatively of the same percentage as for an immediately preceding period. The period may be either short or long—a week, a month, a quarter, a year or a longer term. The more rapidly changes occur, the shorter should be the term, but when operations are well standardized and standards regularly attained the term may be longer. Allotted costs are based on two predetermined items, standard costs and current *percentage* of waste.

Standard costs are the mariner's compass of a business enterprise, showing as they do from month to month the proper course of the business ship. Predetermined costs, which include prevailing waste, are knowledge of the latitude and longitude of the location of the ship. Predetermined costs, although of immense practical value, are subject to one slight disadvantage more theoretical than actual which may, nevertheless, prejudice adherents of the old school against the new methods. The drawback is that predetermined costs do not agree with actual expenses over the same period. Let it be remembered, however, that this lack of agreement is no more important than is the lack of agreement (except at two moments of the year) between sidereal time and sun time, the lack of agreement between standard railroad time and local clock time, the non-agreement between magnetic north and true north, the non-agreement of the pole star with the true north, or the non-existence of any constant true north since even the axis of the earth wabbles.

The efficiency engineer needs statements of standard costs, of current wastes, and of predetermined costs, and he needs also a statement of efficiency expenses. Without them he is in the position of a driver who is trying to develop a trotting horse without the advantage of a measured course or of a time piece. The driver would accomplish something, he might indeed force the horse to the limit, but he would never know whether he really had the best horse, or whether some change of harness, shoes, sulky or track was a betterment or a detriment. The efficiency engineer knows that only by the rarest accident will actual costs correspond with allotted costs, which are the sum of standard cost and previous waste percentage. He will never attain exact correspondence between allotment and performance. The comptroller's problem is to reconcile the actual expenses, for whose correct statement he alone is responsible, with the practically valuable and useful allotted costs which he and the efficiency engineer have jointly elaborated and accepted; it is also his task either to maintain for the efficiency engineer, or to assist him in securing, records showing the discrepancies between allotted and actual costs. He can of course adjust allotted costs to actual expenses or he can adjust actual expenses to allotted costs. It is more desirable to do the latter, because in no other way is the attention of all concerned continually called to the important facts of standards and of wastes. A railroad which reports locomotive repair costs of $0.16 per mile, a fact whose importance escapes all but a very few experts, would not be so indifferent to this very great waste if it had to report in the form illustrated at the top of the next page:—

Miles run	30,000,000
Standard cost for repairs per mile	$0.06
Total standard cost	$1,800,000
Preventable waste and repair cost per mile	$0.10
Total cost of preventable waste	$3,000,000
Total actual expense per mile	$0.16
Total actual expense	$4,800,000

Efficiency engineers have also found to their sorrow that unless allotted costs are tied in to current costs by the comptroller it is impossible to attain accuracy in their statement, and there is also no available proof to convince those on whose support they must rely that the methods used are really producing the results promised. On one occasion I discovered that payment for a cow accidentally killed has been charged to the tool-maintenance account, not for the purpose of perpetrating a fraud but simply to close out an omitted item. When the tool account was put on standard allowance, items of this kind sought refuge elsewhere, and the expenses reported were those actually incurred. The old ideals of close time accuracy in the statement of costs are not to be lightly disregarded, but hitherto they have resulted in obscuring the importance, and caused the neglect, of items more important from the profit and loss, from the efficiency aspect. If a worker is overpaid through an error in his rate, if he draws pay for a day on which he is not present, there is quite proper alarm and no hesitancy is shown in correcting the error during the next pay period; but if the same workman destroys valuable material or continuously kills time, no one except perhaps his foreman takes any cognizance of the resulting loss, which in the aggregate probably exceeds a thousandfold the loss due to accounting carelessness. Inaccuracies in money should not receive less attention than hitherto, but efficiency losses should receive more. If a slight time inaccuracy in expense statement results in very great efficiency and other gain, knowing full well what the inaccuracy is, its amount and why it has occurred, we can accept it just as we accept the magnetic compass or the pole star as preferable to the imaginary true north, or standardized sidereal time as preferable to the practically impossible sun time. There is the great gain of continuous efficiency statement, of anticipation of all cost records, so that the cost of any particular operation, however extensive or minute, is known in advance with greater real accuracy as to single items than in the system of accidental costs, and with very small inaccuracy as to the total aggregated expenses of a year. To illustrate by a concrete example. It is better for a monthly or yearly report to state that allotted costs for repairs to locomotive per mile traveled are $0.07 when in reality they are $0.0696, than to state them accurately as $0.101, when no one has any idea how they may be reduced.

The double problem and its solution by comptroller and by efficiency engineer will be shown by an actual practical example. On a great railroad system current actual costs of one of the items of locomotive repair were about $0.10 per unit. A reduction of this account was planned in June, 1904. It was definitely ascertained from the official records:—

1.—That actual expenses for the preceding year had been $487,171;

2.—That actual expenses per unit were $0.1031.

It was definitely stated by the efficiency engineers:—

1.—That standard costs per unit should not exceed $0.06;

2.—That current losses and wastes per unit were at least $0.04.

3.—That on the basis of same volume of business actual expenses should be reduced to $287,000;

4.—That the actual annual saving should be $200,000.

The double problem was to eliminate the inefficiency costs which amounted to 40 per cent of the whole expenses, and to reconcile predetermined costs with actual costs. The tables below and on page 680 illustrate the progress of the work from year to year, although actually the corrections would be made and standards revised from month to month, thus minimizing differences.

ALLOTTED COSTS, ACTUAL EXPENSES AND EFFICIENCY EXPENSES.

	1903-4	1904-5	1905-6	1906-7
Total units	4,725,000	4,785,000	5,776,000	6,462,800
Allotted standard costs	$283,500	$287,124	$336,560	$323,140
Allotted wastes	189,000	191,416	57,760	....
Total allotted cost	$472,500	$478,540	$394,320	$323,140
Discrepancy between record and actual,—				
Increase	14,671	8,080	....	....
Decrease	....	....	18,214	7,296
Actual total expense as it appears in President's report	$487,171	$486,620	$376,106	$315,844
Amount forward,—				
Debit	....	14,671	22,751	....
Credit	....	....	....	4,537
Efficiency expenses	$487,171	$501,291	$398,857	$320,381
Allotted cost	....	$478,540	$394,320	$323,140
Debit forward	....	14,671	22,751	4,537
Current deficit	....	8,080	....	....
Current credit	....	....	$417,071	$327,677
Current credit	....	....	18,214	7,296
Efficiency expense statement	....	$501,291	$398,857	$320,381

UNIT STATEMENT OF EXPENSES AND COSTS.

Total units	4,725,000	4,785,400	5,776,000	6,462,800
Allotted standard cost	$0.06	$0.06	$0.06	$0.05
Allotted wastes	0.04	0.04	0.01	....
Total allotted unit cost	$0.10	$0.10	$0.07	$0.05
Discrepancy,—				
Loss	0.0031	0.0016	....	....
Gain	....	....	0.01	0.002
Actual unit cost	$0.1031	$0.1016	$0.069	$0.048
Efficiency, per cent,—				
Assumed at year's beginning	60.	60.	85.7	100.
As shown at year's end	58.2	57.	87.	104.2
Increase of cost due to inefficiency, per cent,—				
Assumed at year's beginning	66.7	66.7	16.7	....
As shown at year's end	72.	74.	14.9	4*
Increase or decrease of cost, per cent,—				
Compared with original standard	3.1	1.6*	31.*	52*
Compared with current standard.	3.1	1.6	1.4*	4*

* Decrease.

In the year 1903-4, before efficiency work was begun, the actual costs were $487,171, but allotted on a basis of $0.10 they would have been $472,500. The difference between these two amounts could be either cleared at the end of a fiscal year, or, preferably from the efficiency standpoint, carried in the statement of the lapsed year 1903-4 to "Accounts Receivable" or to "Advances on Work not yet Performed" or to some other suitable caption; but at the beginning of the ensuing fiscal year it is charged immediately or in monthly instalments to the maintenance account under consideration. If this is done, in the year 1904-5 the allotted expenses appear as $478,540 but actually amount to $486,620 expended through the year, to which must be added the item of $14,671 brought forward as a charge from the preceding year. The deficit of $22,751 at the end of this year is closed out as before and is carried as an initial charge into the year 1905-6. For 1905-6 the standard cost is continued at $0.06 but, owing to the improvements already effected, wastes are allotted at $0.01, making a total allotted cost of $0.07 per unit. This totals to $394,320 but actual expenses are only $376,106, or $18,214 less than the allotment. The deficit at the beginning of the year was $22,751 from which we subtract the credit of $18,214 leaving a debit of $4,537 to be carried into the year 1906-7. For this year the standard cost was reduced from $0.06 to $0.05 per unit, and no allowance being made for wastes, which by this time were eliminated, the allotment was also reduced to $0.05. The total of allotted allowance was $323,140, the actual expenses were only $315,844, the forward charge was $4,537, making a total of $320,381. At the end of the year 1905-6 this account shows a credit balance of $2,759, the difference between allotment and actual expenses, and this amount can be reported under "Accounts Payable," or "Due for Work Already Done," or any other suitable caption.

It is much to have reduced the total actual cost from $487,171 to $315,844 but the real results attained are shown more clearly in the unit statement. Not only was a standard of $0.06, 40 per cent lower than current practice, adopted, but in the fourth year the standard was revised and a new standard of $0.05 adopted, which was more than attained in the following year. Not only was a waste of $0.04 predetermined but a waste of $0.052 per unit was actually eliminated. The unit expense was reduced more than one-half and the end of improvement was not yet reached. The handling of this account on an efficiency basis of predetermined costs yielded many other instructive experiences. The original computations were made in June, 1904, but July, August and part of September were allowed to slip by before work was seriously taken up. By this time the monthly expenses had risen to $45,129, the unit cost approximating $0.114. There were no sub-records of details available so that the efficiency staff did not know where to begin its work, and the process of betterment required large initial outlays for better facilities, tools and equipment. The cost of making up a complete set of sub-records was considerable. As a consequence the first half of the fiscal year 1904-5 cost $256,891, the unit cost being $0.1073. The detailed records for each month show the tremendous efforts made to stem the rising tide of waste during this first year, but the annual record does not show this internal struggle. Possibly some will claim that the reduction of expense was not due to efficiency standards and efficiency methods. Perhaps not; but the diagnosis of inefficiency was made before beginning any work, standards of cost and waste were established before beginning any work, a large staff using drastic modern methods was exceedingly busy trying to produce results through every means known to efficiency engineers, and where this staff was most active the greatest improvement was attained. On a similar and parallel road, all conditions being closely identical, except efficiency staff, during the same three years actual costs hovered around the unit cost of $0.10.

	A.—Using Efficiency Staff Organization.			B.—Without Efficiency Staff Organization.		
Year.	Output.	Expense.	Unit Cost.	Output.	Expense.	Unit Cost.
1903-4..	47,250	$487,171	$10.31	51,003	$487,150	$9.55
1904-5..	47,854	486,620	10.16	52,037	567,161	10.90
1905-6..	57,760	376,106	6.51	57,034	537,318	9.42
1906-7..	64,628	315,844	4.89	65,076	638,193	9.81

In modern railroad operation an account aggregating less than $500,000, is not of highest importance. The example given has been selected to illustrate methods rather than the results in details. During the same period on the same railroad and in wholly similar manner another account was standardized and reduced as follows:—

	1904-5	1905-6	1906-7
Total units	47,854	57,760	64,628
Standard labor cost per unit	$30.	$31.35*	$32.10*
Standard waste per unit	40.	20.	10.
Allotted cost per unit	$70.00	$51.35	$42.10
Actual expenses per unit	70.15	48.57	43.32

* The weight of units increased.

As to this account the reduction in waste attained on a unit basis amounted to $1,731,030. Smaller accounts were even more successfully handled. In one case the total actual expenses dropped from $12,000 to $500 with the same amount of work.

There are five trunk railroads operating between New York and a western point. Taking the locomotive mileage as a unit, four of them maintain their locomotives in repair approximately as follows:—

	A	B	C	D
Repair cost per locomotive mile	$0.04	$0.08	$0.12	$0.16

Those intimately familiar with conditions on C and D know that locomotives on these roads can be maintained in first-class repair for $0.06 per unit. Railroad C has a locomotive mileage of about 20,000,000, so that its excess of expenses owing to its inefficiency as to this one item is not less than $1,200,000 per annum. Railroad D has a locomotive mileage of 30,000,000 and its excess of expenses owing to its inefficiency as to this one item is not less than $3,000,000 per annum. The total locomotive mileage of all the railroads in the United States is about 2,000,000,000 and a saving of $0.04 per mile is possible on all but a very few. Hence the total waste per annum is about $80,000,000, or about the same as the total annual gold production in the United States—a waste and loss that a change from accounting by retrospect to accounting by anticipation would do very much to correct.

Let it not for a moment be assumed that Government management would result in less waste. Government work not of a scientific nature, eliminating also "star routes service" in which often a bow-legged, bare-headed child, riding on an antiquated mule, carries "The United States Mail," is generally carried on extremely inefficiently. In one of the largest operations conducted by the United States government the following assays were obtained, transcending anything ever revealed in railroad shops.

	Standard Cost.	Waste.	Actual Expense.
1........................	$1.95	$29.65	$31.60
2........................	2.60	13.65	16.25
3........................	6.50	39.00	45.50
4........................	1.30	14.95	16.25
5........................	3.90	35.10	39.00
6........................	13.00	85.00	98.00

Accountants will understand that so vague and unscientific a unit as "locomotive mile" has been used in the above example solely to illustrate a principle. The real standard unit of cost for any operation is the hour, to which in certain cases material costs are added. It costs so much a year to operate an industrial plant or a railroad; the year is subdivided into working hours which may vary in different departments. Every ordinary operation can be reduced to time at a definite cost per hour. The efficiency of any man, any machine, any department, any shop or division, or any plant or railroad can be determined by standard time and rate and the addition of the wastes to time and rates which previous experience revealed. The cost of repairing a particular locomotive for a particular mile run never has been, never can be, ascertained, but the rate of pay for a man for a given hour and his speed of work can be as definitely determined as the length of a race track and the time required by a horse to go around it. It is absurd to standardize the output of a locomotive plant at fifty locomotives a month when the standard labor on one locomotive amounts to 20,000 hours a month and on another locomotive to 5,000 hours. When, however, standard hours of labor for each item of each locomotive are summed into a total of standard hours for each type, then, if the limit does not lie in the machines, the number of men required (with allotted waste added) can be predetermined; or, if the limit of the machines determines the number of men, then the number of hours available fixes the volume of output, which may be high one month at forty locomotives and low another month at sixty of a different type. Costs of locomotives or of locomotive miles, or of track maintainance, or of anything else will take care of themselves when the unit hours of each man and machine are operating at highest efficiency for standard cost, and there is no other way to save millions of dollars than to avoid spending dimes without equivalency. The next essay will show how, on a very large scale, wastes of dimes were reduced.

EDITORIAL COMMENT

The Return to Normal.

RARELY, indeed, does a new year at its very outset hold out such assured promise as this year of 1909, that the good things we have will be steadily increased and multiplied, and that the end of the year will be far better than its beginning.

It is not necessary to demonstrate again here the soundness of the foundations on which this new extension of our industries is building. We need not recapitulate the unprecedented wealth of agriculture, the enormous crops to be moved, the postponed construction that must be resumed, the equipment demanding repair and renewal, the accumulation of money seeking occupation and growing impatient of longer delay.

It is not necessary to point out again that the drastic surgery of the past fifteen months has cut away the unhealthy and unsound parts of the older growth, and left only solid tissue, now healed and full of life and energy. It is, however, important to point out the great advantages which lie in a normal, deliberate increase in the scale of activity, such as the country is experiencing. The greatest danger of a period of resumption is that it may expand into a boom, with certain consequences of undiscriminating haste, unwise or ill-considered action, and resultant reactions more discouraging than the original check to prosperity.

The situation now is well illustrated by the remark recently made by an officer of a very large manufacturing corporation. He said in substance:

"We hope resumption will come gradually and not with a rush. You see our condition now—moderate activity, but a thoroughly sound and highly efficient organization. We have kept the best of everything—men, machines and methods—as a nucleus throughout the period of depression. If our new work comes in gradually we can build up correspondingly, choosing always the most desirable of all material offering; and thus we can keep our efficiency as high as it is now—far higher than it ever was before. If we are overwhelmed with a rush of business we must use all the labor, and any manufacturing policy we can get, to turn out the work. Our efficiency, our discipline, and our system will go to ruin, and the net results will be poorer than we should secure with a smaller volume of business kept under full control."

It seems possible, as already suggested in these columns, that one great and profitable result of the past depression will be closer attention to the attainment of efficiency in manufacturing. General conditions were forcing the issue. Special conditions, operating alike on employers and workmen, have shown by object lessons how much better we can do than we have been doing. The efficiency movement is likely to be one of the very important features of the era of prosperous activity upon which we are now entering.

For the development of this subject, THE ENGINEERING MAGAZINE has adopted the unusual course of sending an editorial representative on a trans-continental tour of examination, study and report. The results observed and the data secured are among the most interesting ever offered to a manufacturing constituency. Aside from their direct value for information and suggestion as to production methods, efficiency standards, and labor relations, they will have an important bearing upon some of the most pressing economic questions disturbing the public today. The series of articles in which these things will be described will begin in an early issue and will give the keynote of the tone of the Magazine for the year. To them will be gathered each month a record of the work and thought of industrial leaders and managers — the discussion of the best equipment, the best methods, the most advanced ideas for every part of the plant—information as to every device that will reduce friction, waste, and expense—instruction for wise use of the unusual opportunities now presented for the installation of new machinery, and for more effective work in standardizing and modernizing machinery and methods already in use. In brief, THE ENGINEERING MAGAZINE for 1909 will be a living handbook of efficiency and economy in industrial engineering and constructive enterprise in the shop, the factory, the power-plant, and the mine.

Legislation and Prosperity.

THE great desire that the situation shall be allowed to work itself out normally with the elements and forces so far set at work is voiced in many quarters, and the demand is likely to increase in volume and intensity. We must have time to digest that which has already been set before us, and must be spared for a time further prescription, lest our industrial dyspepsia become obstinate as well as violent. Legislation against abuses of the past has run riot, and many protests are raised against further legislation until at least certain of the recently passed laws can be thoroughly tested. A significant expression of this feeling is found in resolutions recently passed by the Illinois Manufacturers' Association requesting "all senators and representatives of Illinois in the national and State legislatures to discourage all measures having a tendency to continue or to aggravate the agitation against corporate interests, and to support all legislation which, without injury to their constituents, will tend to allay the hostility toward business conducted under corporate form, including manufacturing, commercial and transportation companies, while the new laws on the statute books are being tried out," and further urging "all municipal and civic bodies, corporations, transportation companies and individuals to refrain from any acts that will cause agitation or disturbance retarding the return of prosperity and favorable business conditions, to the end that in the resulting quiet, commercial and all other interests may have an opportunity to recover more quickly the golden days of prosperity heretofore enjoyed."

To this earnest exhortation there is a fervent chorus of Amens. It is therefore most unfortunate, in our judgment, that the open and official assumption of this attitude by important manufacturing bodies should have been followed almost immediately by concerted action on the part of the railways for the raising of freight rates. The economic argument against such an advance as a solution of the problem by which the roads profess to be embarrassed has heretofore been summarized in these columns. Unquestionably, the development of the demand for transportation facilities puts a constant burden upon the railroads for increased expenditure. Mr. John F. Wallace, in an address recently read before the Southern Commercial Congress, states the case ably:

"The railroad of today is no sooner completed as a single track, than it becomes necessary to provide industrial spurs; additional or enlarged terminals; replace its temporary structures by permanent ones; widen its excavations; strengthen its embankments; provide passing tracks, additional shop facilities, enlarged passenger and freight stations, warehouses, elevators, docks and wharves at water terminals, additional tracks, heavier rail, rock ballast, elimination of curves, reduction of grades, block signals, elimination of grade crossings, heavier engines, larger and better cars, to the end that the constantly growing requirements and exactions of modern traffic conditions may be met; all of which requires increased expenditures, which it is easily seen could not in any event be provided for out of earnings.

"The ability of railroads to construct these improvements, which are so essential to the future prosperity of the South, depends upon the willingness of capital to furnish the necessary funds for the purpose.

"While legislation may control and regulate the returns upon invested capital, there is no process by which it can compel that investment originally. While investment is easily retarded it is difficult to attract."

Nevertheless, a similar condition confronts every manufacturer whose business is expanding, and the constant outlay is justified and recouped by the larger profits drawn from the greater volume of business, and by the decreased cost of production attending the betterments. It can not be met in competitive industries by a horizontal raising of prices, and the disastrous result of resorting to an economic fallacy will be just as certain in the case of the railroads, although the working of the economic laws, on account of the different conditions, may be less immediately and directly evident.

Sources of Energy.

SOME interested readers of Mr. Warren's articles in our October and November numbers, especially of the latter, seem to have reached an incomplete understanding of his argument and have been inclined to criticise a supposed disregard of the energy balance in his proposition that hydrogen might be made available as a fuel. We believe Mr. Warren has not the least intention of overlooking the fact that the same amount of energy is required to break up a molecule of water as is liberated in its formation. His hypothesis is that some form of natural energy not capturable in other or more direct ways may be utilized in effecting this dissociation. One objector to Mr. Warren's hypothesis remarks that "the hydrogen in a drop of water, in so far as its value for the useful production of power is concerned, is in exactly the same position as the water in the bottom of the tail race in the hydraulic plant." This states the point admirably, and at the same time suggests Mr. Warren's reply, which is that Nature is continually raising and transporting that water in the bottom of the tail race in the form of vapor and precipitating it on high mountain slopes, thus returning it with its potential energy at the intake of the penstocks. We simply interpose our hydraulic machinery in a natural cycle, and recover a portion of the energy constantly exerted by that great source of terrestrial energy—the sun. Mr. Warren believes that in some similar manner we may interpose our combustion machinery in a natural (chemical) cycle of water dissociation and hydrogen liberation—a cycle shorter and more direct than that of plant growth and coal formation, which now gives us our carbon fuels by dissociation of carbonic acid. This solution may be remote; it may not even be very probable; but the concept is not contrary to the laws of thought nor the laws of chemistry and physics, and perhaps greater improbabilities have been realized.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

THE PUBLIC FUNCTION OF AN ENGINEERING SOCIETY.

A PLEA FOR A LARGER MEASURE OF CO-OPERATION BETWEEN THE SOCIETY AND THE GENERAL PUBLIC.

Morris L. Cooke—American Society of Mechanical Engineers.

AT the recent annual meeting of the American Society of Mechanical Engineers, Mr. Morris L. Cooke presented an interesting and effective plea for the adoption of methods to familiarize the public with the aims and ideals of the Society, and to make its work of direct benefit to the people. He believes that a number of present day conditions seem to demand a broadening of the lines of professional activity and he offered a specific recommendation as to the means by which the Society can strengthen the position of the mechanical engineer as a member of the community and place at his command powerful forces at present denied to him and yet absolutely necessary for the full accomplishment of his professional mission. Mr. Cooke's suggestions are worthy of careful consideration not only by the American Society of Mechanical Engineers, to whom they were primarily addressed, but by all other national societies; their fulfilment could hardly fail to be productive of great public good. We give a brief abstract of his paper.

"In the work of the engineer there are three parties interested, namely, the engineer, his employer and the public. While always recognizing the claim of this third party, engineers as a class have done little, directly, to satisfy it. The chief service rendered the public by the engineering profession has been one rendered indirectly by serving well the second party interested—the employer. The time is near at hand when in matters in which they are specially qualified engineers must, individually and collectively, labor for the public interest with just as much fidelity and zeal as they work for their employer, and this not as public spirited citizens but rather as members of a public spirited profession."

If the standing of the engineering profession is to grow in public esteem, it will be because of the effort of the profession to familiarize the public with its aims and ideals. There will probably be little protest against the conception of the engineer as the special conservator of the public interest in matters involving engineering. In the history of the Society many instances may be found where its members, individually or collectively, have departed from the professional groove to co-operate in some broad way with a section of the general public. But in the manifold activities of the Society the general public as such has been almost ignored. Among the hundreds of papers which have been read before the Society it is difficult to find a single title which indicates that the author was addressing anyone beyond his professional audience. Among laymen the Society is given full credit for its professional strength but absolutely none for interest in public matters; this is the public's estimate of technical organizations as a class.

The constitution states the object of the Society in such a way as to permit of an almost indefinite extension of function, but it imposes on the membership no duties except those of a purely professional interest. "The object of the Society," it says, "is to promote the arts and sciences connected with engineering and mechanical construction," and it specifies as the means to be used for this purpose "the holding of meetings for the reading and discussion of professional papers and for social intercourse, the publication and distribution of its papers and discussions, and the maintenance of an engineering library." The library may in the future be made to minister to the needs of the layman but up to this time its influence on the great interests of the people has been almost negligible.

A radical, and in every way salutary, change can be brought about in the Society's relations with the general public by the appointment of a committee to be known as the "Committee on Relations with the Public." The work of such a committee "would of course have to be done within carefully thought out and definitely prescribed limits. Even so, the work could be made very broad. The Committee would doubtless seek to establish such relations with the lay press as would make its advice and help sought when engineering matters are up for public discussion. It would also doubtless seek to give publicity to the fact that the Society stands ready to offer disinterested advice through its Council to government officials—municipal, state and national. In most cases, of course, this assistance would not be so much to answer engineering questions as to counsel with government officials as to the proper procedure to obtain answers."

A Committee on Relations with the Public might also provide for courses of lectures to the general public both at headquarters and under the auspices of local societies. Another important part of its work would be to see that a fair proportion of the professional papers presented to the various meetings of the Society should be of direct use and value to the public as well as to the mechanical engineer. It may seem difficult to see now how the work of the mechanical engineer can be made of direct interest to the public but it is reasonable to suppose that should the Society make co-operation with the public a definite part of its work lines of activity would be opened up which cannot now be foreseen. For the time being it would seem policy to interest the public in as much of the work of the engineer as can be made intelligible to them and to give to papers of general interest the widest possible publicity. The Freeman paper "On the Safeguarding of Life in Theatres" received comparatively little notice in the technical press and practically none in the lay press, yet it was of the highest public interest and importance and could have been made a potent influence in moulding public opinion had the Society had a proper organization for giving it the publicity it deserved.

"The matter of the conservation of our natural resources will afford probably for years a practically limitless field for investigation and earnest discussion. The questions involved are so momentous as to warrant the engineer in seeking ways of co-operating with the National and State governments for their solution. No better way could be found for our Society to assist in this work than to provide in its meetings and publications a forum for the discussion of those phases of the general problem in which the mechanical engineer is specially qualified to speak. Many of these questions must be made clear to the layman because legislation will be required for their proper solution.

"This further step in the line of co-operative engineering effort may seem to some of our members to be a radical one. But it appears to be only the logical sequence of those which have gone before. The records of engineering in the early days of the last century show that engineers had not then learned how to co-operate with each other. Up to a comparatively recent date the professional knowledge of an engineer was his own property and he felt that in imparting any of this knowledge to another engineer he was doing himself a decided injury. Discussions between engineers were carried on mainly with the object of doing each other harm rather than good. The large number of engineering societies, with the fundamental object of the free exchange of engineering data between their members, show how thoroughly engineers have learned that the general policy of giving freely of their knowledge to their fellow practitioners increases rather than diminishes their effectiveness and, in proportion, their earning power. In proposing the appointment of this new standing committee, the writer suggests only the extension of this co-operation to include the public. There is good reason to believe that engineers have as much to gain from co-operation with the public as they have undoubtedly gained from co-operation with each other.

"If the Society once expresses a desire to receive papers of interest alike to the engineer and the layman, the time will probably soon arrive when the increasing number of such papers will suggest the necessity for a Section on Public Matters. Such a section would be conducted like any other section of the Society and would promote and receive papers on subjects of special interest to the layman. These papers and the discussion on them would naturally have to be handled in a way to make them not only intelligible but of practical value to the layman. This work would naturally give rise from time to time to broad practical summaries covering the essentials of good practice in fields where the general public is directly interested. These publications might easily become of the greatest value to legislators, national, state and municipal, on matters now generally settled without much professional advice or technical knowledge. Such a section would draw to its membership those members of the Society public spirited enough to be willing to devote some time to the investigation and discussion of technical matters in their application to the public interest. It would also probably attract as affiliates many of that rapidly increasing body of laymen who are giving freely of their time and money for the development of the best in the life of the whole people. The work of this section should be given a world-wide scope and interest. . . . . . .

"As the range of human knowledge widens, the expense involved in carrying on the investigation and experimental work necessary to progress in such a profession as ours increases very rapidly. For the engineering profession to keep pace, for instance, with the progress being made today in medical science, our investigators and experimenters must have larger financial resources at their disposal than they have enjoyed in the past. Such foundations and bequests must come for the most part from those unconnected with the engineering profession and from those who put a value on the engineer's work for mankind. Such assistance will result only from a widespread appreciation of the engineer's achievements for the public good and of the requirements of engineering.

"It is no longer possible for either a profession or a craft to corner information and hold it for its own use. Broadly speaking, those who seek information in any field can obtain it, or at least enough to answer their immediate purposes. And therein lies a danger. This danger would in itself constitute a sufficient reason for the engineer to take the public into his confidence. For after all it is public opinion and not the dictum of the engineering fraternity which finally decides the large questions of engineering practice. How much better it would be then to join forces with the people, to work out with the people the people's problems and to build up in the lay mind such a confidence in our devotion to the people's cause that they will be willing to let us lead in matters where our training especially qualifies us to do so. Only by educating the public to understand and appreciate the work of the engineer, can the public be made to demand the best that can be devised and executed by trained and skillful men. This will have a two-fold beneficial effect on the profession in that it will make more work for the engineer and will give the public that general acquaintance with engineering matters which will make it suspicious of short-cuts. . . . . .

"There may be some who feel that in launching a movement of the kind proposed the Society would run the risk of getting into difficult positions and even of antagonizing friendly interests. Judging from what is going on around us in this Republic today, and in fact throughout the world, a step of this kind will commend itself so powerfully to the public as to bring to our standard a hundred friends for every one we could possibly lose. However, were this not so there is no sacrifice which the profession ought not to be glad to make to put itself in line with the most advanced ideas of public service. For after all the greatest value to come out of the broader activities is the inspiration to the individual engineer in his everyday work from this closer association with that great employer, the people, for whom in the last analysis all useful work is done."

PROGRESS ON THE PANAMA CANAL.

A SUMMARY OF PROGRESS DURING THE YEAR ENDING JUNE 30, 1908.

Annual Report of the Isthmian Canal Commission.

THE Annual Report of the Isthmian Canal Commission which was made public last month reviews the work done and the progress made during the fiscal year ending June 30, 1908. We are unable to give prominence in detail to the many interesting features of the Report but we summarize below the progress made along a few of the more important lines.

In the Culebra division, extending from the Chagres River in the vicinity of Gamboa to include the Pedro Miguel lock, a distance of 9.2 miles, the total amount of material excavated amounted to 12,065,138 cubic yards, place measurement, of which 11,685,253 cubic yards were from the canal and the balance for accessory works. The total number of steam shovels used during the year on this division was 59. Most of the material was hauled over the main line of the Panama Railroad an average distance of ten miles to dumps at Gorgona and Tabernilla on the north and to new dumps at Miraflores and La Boca on the south. Rock from the cut at Bas Obispo has been taken to Gatun, and since March 20, 1908, about 1,300 cubic yards daily have been deposited on the south toe of the dam between the lock site and the temporary spillway, forming part of the dam.

Considerable trouble was experienced on this division with earth slides. On Oct. 4, 1907, the Cucaracha slide started to move toward the east edge of the canal at a rate at first of 14 feet, and, toward the close of the month, of 4 feet, in 24 hours. About 113,000 cubic yards of material moved so as effectually to stop transportation of material through the cut to the south, and it was the end of the month before sufficient space was gained on the moving mass to permit the passage of dirt trains to the south over the old route. The total area of the slide was approximately 34,455 square yards and it was estimated that about 600,000 cubic yards were in motion. A slide at Paraiso gave trouble in April, 1908. The estimated area was 16,700 square yards and the amount of motion was about 140,000 cubic yards, of which about 90,000 were removed. Two smaller slides developed during the dry season at New Culebra and Las Cascadas.

In the Chagres division, covering a distance of about 23 miles and extending from Gatun to a point where the canal crosses the Chagres River at Gamboa, final surveys were completed and the centre line of the canal permanently marked. Slight changes in alignment were made in the final location whereby a saving of 1,264,700 cubic yards, 264,300 cubic yards rock, was effected. The total amount to be excavated in this section is 12,256,300 cubic yards, of which 8,313,500 cubic yards are earth. During the year the total amount excavated was 1,774,124 cubic yards, place measurement, all from the canal prism. The total number of steam shovels in operation was 15.

Dredging was done on the Colon dredging division by two French ladder dredges, two dipper dredges, the 16-inch suction dredge, and by the sea-going suction dredge *Ancon*. A total of 5,087,623 cubic yards of material was removed, of which 4,947,330 cubic yards were from the canal prism and the remainder from accessory works. The dry dock was enlarged to accommodate vessels 298 feet long, 50 feet beam, and 15 feet draught. On the La Boca dredging division the total amount of material to be removed is estimated at 29,212,700 cubic yards, of which at least 1,500,000 cubic yards are rock. A drill scow and a Lobnitz rock breaker have been purchased for breaking up the rock so that it can be handled by the dredges. During the year 5,273,369 cubic yards of material were removed by the sea-going suction dredge *Culebra* and four French ladder dredges.

The dimensions of the locks were increased during the fiscal year so that the width in the clear will be 110 feet, the usable length remaining as before 1,000 feet. At the site of the Gatun locks, borings were continued to ascertain the depths of the strata disclosed by previous borings and to determine whether suitable material extended far enough below the level on which the lock walls are to be built to carry their weight. The borings were carried 50 feet below this level. The strata encountered were argillaceous sandstone, a hard conglomerate, a soft sandstone, volcanic tufa and a dense argillaceous standstone. The borings also disclosed ground water under pressure in small quantities in some of the conglomerate and in the soft sandstone. There is no doubt that the materials will bear the greatest loads that will be transmitted to them by the lock walls if provision is made to prevent the underground flow of water through the softer materials on which part of the walls will rest. It is intended now to use curtain walls connected with the underlying impervious stratum of argillaceous sandstone. Nine shovels were used on the excavations for the locks during the year. The total amount removed from the site was 1,769,115 cubic yards, of which 190,013 cubic yards were placed on the south toe of the dam, 69,432 were used in making a fill for the construction plant on the west side of the lock, and the remainder was used for fills on the relocation of the Panama Railroad.

At the Gatun dam site, extensive investigations were carried on to determine the character and extent of the foundation materials, the amount of ground water, and the amount and character of the available material for constructing the dam. Test pits and wash borings revealed a geological formation similar to that at the lock site. The foundation materials are of ample strength and the small amount of ground water can be prevented from affecting the foundations by sheet steel piling. Suitable construction material can be obtained in sufficient quantities by dredging. Investigations on two experimental dams have shown that a stable and water-tight dam can be built of the materials available by hydraulic methods. The construction work during the year consisted in the removal of 918,920 cubic yards of material from the spillway.

In the motive power and machinery department at the close of the year 2,206 men were carried on the rolls, and the expenditures amounted to $5,645,622.18. Three shops, located at Gorgona, Empire and Paraiso, handle all work except electrical installations. At the Gorgona shops repairs are made to locomotives, unloaders, spreaders and wooden car equipment. Practically one-third of the output was manufactured material, gray-iron, semi-steel, and brass and bronze castings. Labor and material costs per pound were $0.0359 for gray-iron castings and $0,1951 for brass, including the cost of patterns. The Empire shops perform general repairs to steam shovels, steel car equipment, rock drills, and similar excavating machinery. The labor and material cost of shop repairs to steam shovels during the year amounted to $145,479 for the 17,467,161 cubic yards of material excavated, or $0.00833 per cubic yard. The cost of field repairs was $0.01509 per cubic yard.

During the year the total cost of municipal improvements in the Canal

Zone was, for water works and sewers, $2,358,840.44, and for roads, etc., $1,174,778.26. For the construction, improvement and repair of buildings the total expenditure was $3,086,138.01, the 505 new buildings costing $2,181,913.39. The total number of buildings now on hand is 3,313.

The value of the material and supplies received during the year amounted to $11,607,094.63, and that of the disbursed material to $11,685,158.33. Of the material issued, $182,894.56 cover old French material utilized or disposed of during the year, including scrap brass, copper, and cast iron used in the foundries at the Gorgona shops.

Though a net decrease was made in the skilled force during the year, the number of new employees was practically the same as in other years, indicating the shifting character of the force and showing that it is practically renewed every year. The number employed in the United States shows a large decrease and the number employed on the Isthmus a corresponding increase. The increase in the unskilled force amounted to 500 Europeans and 1,000 West Indians. The total imports of unskilled laborers amounted to 4,150 West Indians and 3,650 Europeans.

Thanks to the better sanitation and better food the death rate among the employees was reduced by more than one-half. With an average of 43,057 names on the pay roll the death rate per thousand was 18.32. Among the 12,058 whites it was 15.34, and among the 30,999 blacks, 19.48, per thousand.

Disbursements on the pay rolls of the commission amounted to $18,062,000, the average payment per month to employees on the gold roll being $125.80, and on the silver roll about $40 gold per month. The total appropriations for the canal work up to the present time have been $120,964,468.58, and expenditures up to the close of the fiscal year amounted to $84,572,998.55, leaving a balance of $36,391,470.03 available on July 1, 1908. Of the expenditures, $68,365,320.26 were for construction and engineering, $3,758,896.24 for civil government, and $8,008,614.50 for sanitation and hospitals.

AN ELECTRIC POWER PLANT OF NOTABLE FUEL ECONOMY.

NOTABLE RESULTS OF FUEL ECONOMY TESTS ON THE REDONDO PLANT OF THE PACIFIC LIGHT AND POWER COMPANY.

C. R. Weymouth—American Society of Mechanical Engineers.

THE Redondo Plant of the Pacific Light and Power Company, near Los Angeles, California, one of the most recent examples of steam-driven generating stations in the United States, possesses several features of unusual interest. It is one of the largest plants using California crude oil as fuel and a number of novel features, notably an automatic system of regulation, are embodied in the design of the oil-firing apparatus. The most radical departure from recent practice is the adoption of reciprocating engines as prime movers in lieu of steam turbines. The plant was built under unusual conditions. The design of the whole installation was entrusted to a firm of contracting engineers on a fixed-sum contract, under a guarantee of a definite complete-plant economy subject to penalty and bonus stipulations. The interest of the various features of contract and design is, however, transcended by that of the remarkable results of the various fuel economy tests which were communicated by Mr. C. R. Weymouth to the American Society of Mechanical Engineers at the recent annual meeting. The bare outline of Mr. Weymouth's very comprehensive paper which we are able to give will convey only a part of the significance of his table of results reproduced on the opposite page, but it will serve to indicate the notable economy obtained.

Briefly described, the plant consists of three main units of 5,000 kilowatts each, arranged in general on the panel system. Each plant unit is driven by one McIn-

TABLE SHOWING RESULTS OF VARIABLE AND UNIFORM LOAD TESTS ON ONE 5000-KILOWATT UNIT, ALSO VARIABLE LOAD TEST ON COMPLETE PLANT OF PACIFIC LIGHT AND POWER COMPANY, REDONDO, CAL.

	Variable load average of 15-day tests	2000-kw. load test (Approx.)	3000-kw. load test (Approx.)	4000-kw. load test (Approx.)	5000-kw. load test (Approx.)	Variable load complete plant test
Duration of test, hours.........	24	5	13	14	23	24
Period of warming boilers, hours	....	5:20	5:0	4:50	7:25	5:55
Average steam pressure at engine throttles, lb. per sq. in......	180.03	182.	181.74	180.9	189.3	173.76
Average superheat at engine throttles, deg. F.................	82.46	87.99	92.	96.05	92.78	95.15
Average temperature circulating water inlet, deg. F..........	63.03	61.64	61.41	61.34	62.4	59.33
Average temperature circulating water outlet, deg. F.........	79.15	78.09	79.37	79.02	81.09	82.12
Average vacuum in condenser (corresponding 30 in. bar.), in Hg.	28.334	28.426	28.343	28.214	27.976	27.784
Average temperature of feed water leaving heater, deg. F....	146.9	184.3	167.8	155.9	150.7	177.22
Kilowatt output (including lights), kw-hr.	71615.24	11225.577	47126.457	58745.125	116899.748	215262.438
Deduction for lights, kw-hr......	125.	26.042	78.125	79.917	117.792	....
Net kilowatt output, deducting lights, kw-hr.	71490.24	11199.535	47048.332	58665.208	116781.956	....
Fuel oil as fired (334 lb. to bbl.) bbl.	303.387	50.01	195.458	244.783	496.910	957.566
Heat units per pound oil as fired, B.t.u.	17840.	17038.8	17920.8	17965.8	17838.	17717.
Sulphur in oil (by weight), per ct.	2.34	2.17	2.43	2.39	2.49	2.60
Moisture in oil (by weight), per ct.	2.38	1.82	2.08	1.895	2.70	2.59
Silt in oil (by weight), per cent..	.14	.138	.14	.113	.10	....
Fuel oil corrected as per contract, bbl.	282.746	47.219	183.307	230.764	460.884	883.115
Economy (oil corrected as per contract), kw-hr. per bbl.......	252.842	237.298	256.664	254.252	253.382	243.758
Economy (oil corrected as per contract), B.t.u. per kw-hr......	24438.	26039.	24074.	24302.	24386.	25349.
Economy corrected only for heat units in oil, B.t.u. per kw-hr.	25288.	26742.	24357.	25027.	25347.	26320.
Number of boilers in service.....	5	3	5	5	6	15
Combined efficiency of engine and generator based on separate exciter, per cent............	....	90.2	92.5	94.1	94.75	....

tosh and Seymour double horizontal and vertical, compound, condensing, automatic, gradiron-valve engines, size 34 and 70 by 56 inches, directly connected to an alternator. The rated speed is 100 revolutions per minute and the engines are designed to operate at 175 pounds maintained throttle pressure, with 100 degrees F. superheat at the throttle. Directly connected to each engine is one ATB-60-pole, 5,000 kilowatt, 100 revolutions per minute, 18,000 volt, 50 cycle, three-phase General Electric generator of the flywheel type. In each plant unit are six Babcock and Wilcox boilers, each with 6,042 square feet of heating surface and designed for a steam pressure of 200 pounds, arranged in three batteries of two each, one boiler in each unit being intended for reserve. The boilers are provided with Peabody patent fuel-oil burning furnaces having a depth of 10 feet from boiler front to face of bridge wall. For the firing of the boilers of the unit tested an automatic system of regulation was employed, which controls the supply of oil to the burners, the supply of steam for atomizing purposes, and the supply of air. The condensing, superheating and feed-water heating apparatus are of the most approved type.

The tests made included an official 15-day variable-load test on No. 2 plant unit; uniform load tests on No. 2 plant unit at approximately 2,000, 3,000, 4,000, and 5,000 kilowatts output; and a test of the complete plant at variable load similar to the official test. The results of the tests are shown in the table. In connection with the official variable load test, Mr. Weymouth describes in great detail the provisions of the contract governing the test, the compromise standards applied in correcting the results, the condition of the plant at the time of test, and the organization of the operating force. The uniform load tests were carried out under approximately the same conditions of operation as the official test and these are fully discussed. For this information the reader must be referred to the original paper. We can only note that the guaranteed fuel economy, based on an average quality of Bakersfield crude oil of known furnace performance, was 170 kilowatt-hours per barrel of oil. The actual economy obtained, from 237 to 256 kilowatts per barrel, is striking evidence of the remarkable economy of the complete plant. With regard to the wisdom of using reciprocating engines instead of turbines, Mr. Weymouth says that the best turbine performance on the Pacific Coast based on oil fuel is considerably under that of the Redondo Plant.

OIL FUEL ON SHIPBOARD.

A DISCUSSION OF ITS ECONOMY AND OTHER ADVANTAGES PECULIAR TO MARINE WORK.

Andrew Laing—Cassier's Magazine.

ON another page of this issue some details are given of the notable economy obtained in a large oil-burning land steam plant. That oil fuel is no less adapted to marine work than to land applications, both on the score of economy and because of other advantages which are not apparent in stationary installations, is shown by Mr. Andrew Laing in an article in *Cassier's Magazine* for November, 1908, from which we take the following extracts.

"The question of the use of oil for boilers in ships is largely one of pounds, shillings and pence, excepting in warships. Strategical and tactical considerations must predominate in this as in all matters associated with the fighting ship. This embraces, of course, the weight factor, where the advantage is with oil, and to this reference will be made later. But an additional point favourable to the naval service is the facility with which oil can be dealt with. In recharging a ship with fuel the gain in time is enormous as contrasted with the refilling of coal bunkers. In getting coal from distant bunkers at the end of or during a running fight, much labour is required when all hands may be needed for serving the guns. Even then the speed of a ship may be checked through insufficient supply. At such times, too, there is always danger of fires being choked with clinker, whereas with oil no such serious disadvantage can arise. In small craft, such as destroyers, the saving in weight makes it possible to realize speeds far in advance of those possible with coal. Thus, 30-knot destroyers using coal for raising steam for reciprocating engines require 25 tons of coal for 4-hours' run at 6,000 indicated horse-power, equal to 120 nautical miles at full speed. The displacement was 335 tons, so that the consumption of coal per 100 ton-mile was 139 pounds. It is not necessary to enforce the great increase of power required for 34 knots in the later British destroyers, especially as the vessels are larger and more seaworthy, being of 890 tons displacement. These vessels steamed at a speed of more than 34 knots for 6 hours, or for 207 nautical miles for 68¼ tons of fuel. Notwithstanding the greater power, nearly three times that of the 30-knot boats, the oil consumption was only 83 pounds per 100 ton-mile. Part of the credit for this result is no doubt due to the higher efficiency of the Parsons steam turbine at high speeds, but without oil fuel this speed result could not be achieved. The gain is applicable in practically the same degree to large fighting ships.

"In the merchant service the main consideration is financial, which is concerned not only with the relative calorific value for a given expenditure, but with the less weight and easier stowage of oil fuel, and consequently greater passenger and cargo capacity within a ship of given dimensions, and the greater facility of handling and resultant reduction in staff. Experience goes to show that one ton of liquid fuel is of the same value as 1½ tons of average coal as a steam-raising agent. This ratio may be taken as well within the mark, as some authorities state that 1 ton of oil is equivalent to 1¾ tons of coal.

"The volume of 1 ton of oil runs out at about 38 cubic feet, whereas 44 cubic feet of bunker space must be allowed for each ton of coal. From the above data it will be seen that for any given vessel, if oil fuel is adopted, the capacity of the bunkers can be reduced nearly 45 per cent., as compared with what they would require to be if burning coal; since not only is the weight of fuel to be carried reduced by 33 per cent., but also the oil fuel compared with coal requires per ton a very much reduced cubic capacity. The capacity thus saved is available for cargo space, or for the reduction in size and displacement, and therefore in power for a given speed.

"A very considerable saving is effected by the reduction of the number of firemen required, and also in the rapidity of loading liquid fuel as compared with the time required for bunkering coal. Space for crew accommodation is reduced.

"Where occasion arises for a sudden alteration in the load or power, oil fuel is much more suitable than coal, as considerably less time is occupied in adjusting consumption to suit the variation in the rate of evaporation required from the boilers.

"The burners can be so adjusted under all normal conditions that the installation shall be practically smokeless, and they should be so adjusted that the slightest possible trace of smoke is apparent at the chimney. This is preferable to the adoption of an absolutely smokeless installation, where an excess of air may be admitted to the furnace without means of detection, a condition which precludes the obtaining of the maximum of economy.

"It has been found in practice that where marine installations have been converted from coal to oil burning, there has been a marked improvement in the ability to secure and maintain a higher speed than was the case with coal.

"The oil is forced into the furnace in the shape of a conical spray of exceedingly fine particles, which burst into flame at a distance of 6 to 8 inches from the nozzle. The flame being conical, and there being no fire-bars fitted in the furnace, the whole circumference of the furnace is available for heating surface. This is a great advantage in the ordinary multitubular boiler, as the lower portion of the boiler becomes heated sooner than would be the case with coal, and consequently the circulation of water in the boiler is improved. Moreover, as the lower portion of the boiler is heated up uniformly with the upper portions, and as there is no inrush of cold air, since the furnace doors are never opened, there is practically none of that straining action which results from unequal expansion and contraction, due to rapid changes consequent on the opening of the door in coal stoking.

"From the point of view of upkeep, a considerable economy is obtained. The repairs to the bunkers, a very considerable item in coal-burning ships of any age, is entirely obviated, as the liquid fuel is a preservative of steel. These advantages can be worked out on a monetary basis; but the conditions vary in each trade, and it is, therefore, difficult to make a precise comparison. From data carefully taken from practical working on sea voyages, it is seen that in burning coal the cost per ton runs out at about 2s. for natural draught to 2s. 6d. for forced draught, including wages, victualling, repairs to furnace tools, stokehold plates, lamps, etc., but excluding the cost of the fuel, this being a separate item.

"If oil fuel be adopted, the cost of burning per ton of oil would be about 9d. for natural draught to 7½d. for forced draught for moderate-sized cargo steamers, and as low as 4d. per ton in large liners. It must be borne in mind that not only is the cost per ton for burning greatly reduced, but the amount burned is also less in the proportion of 1 of oil to 1½ or 1¾ of coal."

Mr. Laing gives a short review of the development of oil-burning apparatus for marine work and discusses at some length the Körting system. He draws particular attention to the economy of pre-heating the oil before its introduction into the boiler furnace. "Experience has shown that when the oil is heated before it is sprayed into the furnace, more economical results are obtained. In the Körting system a heater of the tubular type is fitted between the oil-fuel pumps and the burners, and in it the oil is heated to the required temperature for giving the most economical results. The temperature is largely dependent upon the rate of combustion aimed at. During experiments under natural-draught conditions 15 pounds of water were evaporated from and at 212 degrees F. when burning about 280 pounds of oil in one burner in a furnace which would be reckoned as having a 20-square-foot grate. The temperature in this case was 212 degrees F., and the pressure of oil at the nozzle 60 pounds per square inch. With best Mickley picked coal the evaporation per pound of coal in the same boiler was 9.31 pounds, so that in this instance, on comparative trials under natural draught, 1 pound of oil was equal to 1.61 pounds of the coal named.

"With a closed stokehold on the same boiler nearly the same rate of evaporation per pound of fuel (14.06 pounds) was got under 1⅛-inch pressure on the water gauge, and the rate of oil fuel combustion was increased to 610 pounds of oil per burner, larger nozzles being used. To attain this result the pressure of oil at the nozzle had to be increased to 140 pounds per square inch, but as the disintegration of the liquid fuel increases with greater pressures, a lower temperature (110 degrees F.) was possible. Thus the rate of combustion can be enormously increased (in the cases quoted it was considerably more than doubled), while the rate of evaporation only fell off slightly. This is a great advantage for high-speed vessels. Nor was the economy in oil spray greatly affected, as the steam saved by the reduction in temperature partly compensated for that required for the increased pressure. . . . . . .

"Indeed, there is no unsurmountable obstacle from the mechanical point of view to the universal application of oil fuel for steam raising under all conditions. Even if the price of oil were much greater than coal there might be financial gain in ship propulsion, in view of the direct and indirect economies realizable, as already enumerated. The advisability of fitting our large Atlantic liners with oil-burning installations has been considered. This is quite feasible, but in this, as in so many cases, the question is one of economics, and concerns the certainty of obtaining the oil conveniently in sufficient bulk and at a price which would establish a financial superiority to coal."

THE COMPARATIVE EFFICIENCY OF MARINE ENGINES AND TURBINES.

A COMPARISON BASED ON THE PERFORMANCES OF THE "KAISER WILHELM II" AND THE "LUSITANIA."

R. Caird—Cassier's Magazine.

PREVIOUS to the building of the *Lusitania*, the *Kaiser Wilhelm II* held the blue ribbon of the Atlantic with a speed of 23.73 knots. Her length was 706.5 feet and her displacement 26,000 tons. The indicated power of her engines was 20,000 horse power. The *Lusitania* with a length of 785 feet and a displacement of 38,000 tons, driven by turbines developing 65,500 shaft horse power, has easily attained the speed of 25 knots for which she was designed, but, in the opinion of many, at much lower efficiency than the older and slower vessel driven by reciprocating engines. In an article in *Cassier's Magazine* for November, 1908, Mr. R. Caird discusses the relative efficiency of piston engines and turbines with reference to these two vessels, from which we take the following extracts. His data on the *Lusitania* are taken from the paper read by Mr. Thos. Bell before the Institution of Naval Architects and abstracted in these columns in our issue for June, 1908.

"It is noteworthy that in fixing the dimensions of the *Kaiser Wilhelm II* and of the *Lusitania* the naval architects have been careful to select the most suitable lengths and coefficients of fineness, having regard to the maximum designed speed. Hence, in comparing performances it is safe to assume that both vessels are, as regards size and form, respectively, as suitable as, in the present state of our knowledge it is possible to design them. . . . .

"There are several methods of comparison of the performances of steamers. One very commonly used is that afforded by what is known as the Admiralty or $D^{2/3}$ coefficient, which assumes that the coefficient varies directly as the product of the $2/3$ power of the displacement and the cube of the speed, and inversely as the indicated horse power. Applying this to the German steamer and to the Cunarder at maximum speeds, the relative coefficients work out at 293 and 257. That is to say, on this criterion the piston engine is 14 per cent. more efficient than the turbine. For strict comparison an allowance should be made in favour of the German steamer, the coefficient being *ipso facto* higher for greater displacement. In this calculation the shaft horse power, as given in Mr. Bell's paper, has been taken as 97 per cent. of the indicated horse power. It is difficult to determine exactly what the percentage should be, but there is not much range for error in the above if we consider that the German tests of the ratio of shaft horse power to indicated in reciprocating engines was less than 94 per cent.—exactly 93 per cent. by torsion meter tests in the case of the *Kaiser Wilhelm II.*

"The low propulsive efficiency of the *Lusitania* as given in Mr. Bell's paper, and the exceptionally low rate of coal consumption, point to either inaccuracies in the torsion meter readings or to a very high engine efficiency or to both. But the coefficients given above would not be materially affected even if the initial and working friction of these turbine engines were taken as nil, provided that a proper correction were made for greater displacement. The steam efficiency of the *Lusitania* is so high that the reason for the low general efficiency found from the $D^{2/3}$ coefficient must be sought for elsewhere. It seems that it must be looked for in the application of the power through the propellers, whether in the propeller efficiency or in the thrust deduction due to the position of the propellers it is impossible to say without full information. It must be borne in mind that the *Kaiser Wilhelm* has two screws and the *Lusitania* four, and the wing propellers being less immersed than the centre ones, have less hydraulic head and are probably less efficient. Be that as it may, the fact remains that the *Lusitania* is about 14 per cent. less efficient than the *Kaiser Wilhelm* on the Admiralty coefficient test.

"There is another test which may be applied, that of the coal consumed for every 1,000 tons displacement per 1,000 nautical miles run per knot speed. The *Lusitania* takes 1.93 tons and the *Kaiser* 1.7 tons, the former being 13.5 per cent. less efficient when tested by this formula. This agrees very closely with the figure got by the Admiralty constant, and, as in that case, some further credit is due to the German steamer in respect of the *Lusitania's* greater displacement. Speaking generally, the *Kaiser* is about 15 per cent. more efficient than the *Lusitania.*

"What are the benefits to set off against this loss? Of course the appeal to the imagination of the public has an advertising value. It is questionable, however, if this will be lasting, or even if it has proved to be of much value. It is claimed for turbines that an almost entire absence of vibration may be counted upon; but experience does not bear this out, and it is difficult to see how the effect of the couples set up by varying thrusts in a horizontal plane exerted through the shafts can be obviated.

"Another advantage claimed for turbine engines is the reduction of weight of machinery; and the claim must be conceded, chiefly on account of the reduction of boiler weight, due to decreased pressure in the case of the turbine. It does not seem, however, that in large installations much reduction in weight has been effected: and even if it had been, the greater amount of coal to be carried, due to the lower efficiency, would more than offset the gain.

"It may be interesting to consider for a moment what economies might be effected in a *Lusitania* fitted with piston engines. It is somewhat difficult to put the necessary calculations sufficiently clear for general comprehension within the space available in any other than tabular form, but a comment running through the figures may prove useful. Taking the mean displacement at 37,080 tons, draught 32 feet 9 inches, the effective horse-power from Mr. Bell's diagram is 31,700. For prudence, taking the resistance due to the bosses with three propellers as 5 per cent. more than with four, the shafts being of greater diameter, and assuming a hull efficiency of 90 per cent., the thrust horse-power works out at 36,983.

"With three propellers of 25 feet diameter, having 200 square feet surface on three blades, or a surface ratio of 40.7 per cent. and 80 revolutions per minute, set at a pitch of 35 feet, the apparent slip is 9.5 per cent., and the propeller efficiency by Froude's latest curves nearly 74 per cent.

"Assuming an engine efficiency of 90 per cent. and a propeller efficiency of 70 per cent. the indicated horse-power at 25 knots is 58,700; the Admiralty coefficient 296, and the propulsive coefficient 54 per cent. These efficiencies are all taken lower than those deduced from the best practice. The horse-power passed through each shaft is less than that in the *Kaiser Wilhelm der II.*

"Three sets of quadruple expansion engines of the following dimensions would be sufficient to develop the required power: Cylinders 51 inches, 73 inches and 103 inches; two of 103-inch; stroke 6 feet. Boiler pressure 215 pounds.

"The coal consumption at 1.35 pounds per indicated horse power per hour would be 850 tons per day, or 250 less than that of the big Cunarders—a saving sufficient to drive the C. P. R. *Empress of Britain* at 19½ knots.

"Two of the Cunarder's double-ended boilers could be dispensed with. The following table shows approximately the actual and estimated trial results in the turbine and piston-engine cases respectively:

	Lusitania.	Proposed.
Speed, knots	25	25
Revolutions	186	80
Slip, per cent	15.5	9.5
Shaft horse-power	65,500	52,830
Propulsion efficiency on shaft horse-power, per cent	48.4	60

THE BONUS SYSTEM OF WAGES.

A DISCUSSION OF ITS VALUE IN TRAINING WORKMEN IN HABITS OF INDUSTRY AND CO-OPERATION.

H. L. Gantt—American Society of Mechanical Engineers.

MR. BENDER, in his comparative review of systems of wages and their influence on efficiency in THE ENGINEERING MAGAZINE for December, 1908, emphasized the fact that psychology is quite as important a factor in the success of wage systems as any other condition. Commenting on the Gantt bonus system, he expressed a belief that it shows certain psychological disadvantages in practice, chief among them being an understanding among the men not to do better than standard times. Mr. H. L. Gantt, the originator of the system, however, holds no such view. In a paper read at the recent annual meeting of the American Society of Mechanical Engineers he gives the results of several years' experience with the system, which he considers the most effective plan yet developed for training workmen in habits of industry and co-operation. We give below a brief abstract of his paper.

"The widespread interest in the training of workmen which has been so marked for several years is due to the evident need for better methods of training than those now generally in vogue. The one point in which these methods as a class seem to be lacking is that they do not lay enough stress on the fact that workmen must have industry as well as knowledge and skill. Habits of industry are far more valuable than any kind of knowledge and skill, for with such habits as a basis, the problem of acquiring knowledge and skill is much simplified. Without industry knowledge and skill are of little value, and sometimes a great detriment. If workmen are systematically trained in habits of industry, it has been found possible, not only to train many of them to be efficient in whatever capacity they are needed, but to develop an effective system of co-operation between workmen and foremen."

Men are most successfully trained in these habits under the bonus system of rewarding labor. "Under this system each man has his work assigned to him in the form of a task to be done by a prescribed method with definite appliances and to be completed within a certain time. The task is based on a detailed investigation by a trained expert of the best method of doing the work; and the task setter, or his assistant, acts as an instructor to teach the workmen to do the work in the manner and time specified. If the work is done within the time allowed by the expert, and is up to the standard for quality, the workman receives extra compensation (usually 20 to 50 per cent. of the time allowed) in addition to his day's pay. If it is not done in the time set, or is not up to the standard for quality, the workman receives his day's pay only."

As Mr. F. W. Taylor has repeatedly emphasized, tasks should be set only as the result of a scientific investigation. The scientific investigation of a process which has grown up without the assistance of science has an educational value which can hardly be over-estimated; it always reveals possibilities of improvement in methods and of reduction in costs. The results of investigations, however, are of little practical value unless workmen can be taught how to use them and then can be induced to do as they are taught.

For this purpose an instructor, a task and a bonus have been found most useful. While workmen prefer to work at the speed to which they have been accustomed, they are usually willing to work at any reasonable speed and in any reasonable manner if a suitable inducement is offered and they are so trained as to be able to earn the reward. The bonus system is of course most effective when the men are already skilled, but with the bonus as an incentive and with a proper instructor a large proportion of the unskilled are brought to a high degree of efficiency and succeed in performing a task which was at first entirely beyond them. Once skilled in a certain line of work, they readily learn others; they form better habits of work, lose less time and become more reliable.

The formation of proper habits of work is one of the most important results of the task and bonus system. In all work both quantity and quality must be considered. The task method demands a maximum quantity, all of which must be up to the standard for quality. Workmen trained under the system acquire the habit of doing a large amount of work well; in fact, the quickest workers almost always do the best work when following instructions. In a workman ability and willingness to do are at least as important as knowing how. Under the bonus system the workman is taught how and trained to do efficiently at the same time, and the habit of doing efficiently what is laid out for him becomes so fixed that he performs without hesitation tasks at which a man not trained to follow instructions would absolutely fail. Learning to obey orders is often the hardest part of the workman's task, but once he has acquired the habit he learns that the skilled investigator can learn more about doing a piece of work than he knows "off hand" and in the endeavor to earn his bonus he soon becomes, if he has the natural ability, a rapid and skillful workman.

In a shop operated on this system, where each workman has his task, the gang boss of each group of workmen, who supplies them with work and appliances and removes the work when finished, is paid a bonus depending on the amount of bonus earned by the men under his charge. He thus has an incentive for giving the workmen all the help he can and for keeping their efficiency up to the highest possible point.

In starting a shop on task work, an instructor capable of teaching a workman how to perform his task must be constantly on hand. Instruction as a rule is given individually. The instructor may be the man who investigated the work and set the task or he may simply be capable of following out the work of the investigator. After the workman has done the task in the manner and time specified he is given an opportunity of suggesting a better or quicker method. Unless an investigator is able to develop methods a great deal better than those suggested by the workmen he is not retained in his position. Working at tasks is good training for setting them and a number of workmen in Mr. Gantt's employ have risen to the rank of task setter.

After a satisfactory method has been established, a large proportion of the work of the task setter is the study of the time in which operations can be performed and he is popularly known as the "time study" man. This term has led to a misconception of his duties. Many managers have thought it sufficient for the introduction of the bonus system to determine by stop watch how quickly their best men were doing certain work. They have in many cases been able to establish more accurate piece rates by this method, but they are still far from the ideal of the bonus system in which the best expert available investigates the work, standardizes the appliances and methods and sets a task that involves using them to their very best efficiency. Stop-watch observations on work done inefficiently or with ill-adapted machines or by poor methods is absurd.

To make real and permanent progress, the expert must be able to standardize appliances and methods and write up such instructions as will enable an intelligent workman to follow them. Such standards become permanent and if the workman is paid a proper bonus for doing the work in the manner and time set, he not only helps to maintain the standards, but soon begins to exert his influence to help the progress of standardization. With increasing efficiency of the workmen the standards always have a tendency to become higher.

The principal difficulty in the introduction of the system is that it forces every man connected with the organization to do his duty. When carried out properly it is no respecter of persons. The man who wishes to force the workman to do his task properly must see that the task is properly set and that proper means are available for doing it. The workmen have the right to report whatever interferes with the earning of a bonus and the man responsible for unfavorable conditions has to see that they are remedied or make way for someone else. The main opposition to the introduction of the system develops on the part of those who are not sure of making good under it. The principal help comes from the workmen themselves. They soon learn that the system is to their advantage and the sentiment grows rapidly in favor of task work.

The system is really a combination of the best features of the day-rate and piece-work systems. While learning to do his task the workman is on a day rate; when he has learned to do it the compensation for the task is a fixed quantity, really equivalent to piece rate. The method of payment then is day rate for the unskilled and piece work for the skilled. The system has none of the disadvantages of either system, for the day worker who has no ambition to become a bonus worker usually seeks work elsewhere of his own free will and the working force soon becomes composed of bonus workers and day workers who are trying to become bonus workers.

When 25 per cent of the workers are bonus workers, they, with the day workers who are trying to reach the bonus class, control the sentiment and a strong spirit of co-operation develops. This benefits the employer by increasing production, improving quality and lowering costs. It benefits the worker by giving him better wages, increased skill and better habits of work. The development of skilled workmen by this method is sure and rapid, and its proper establishment solves the problem of securing satisfactory help.

"The fact that under this system everybody, high and low, is forced by his co-workers to do his duty, for someone else always suffers when he fails, acts as a strong moral tone to the community, and many whose ideas of truth and honesty are vague find habits of truth and honesty forced upon them. This is the case with those in high authority as well as those in humble positions, and the man highest in authority finds that he also must conform to laws, if he wishes the proper co-operation of those under him."

THE APPLICATION OF MOTORS TO MACHINE TOOLS.

A DISCUSSION OF THE MOTORS SUITED TO VARIOUS CLASSES OF WORK AND METHODS OF SPEED CONTROL.

Dexter S. Kimball—The Mechanical Engineer.

THE economy of the individual motor drive for machine tools, as opposed to the group system, was exhaustively discussed by Mr. Howard S. Knowlton in THE ENGINEERING MAGAZINE for December, 1908. In *The Mechanical Engineer* for November 27, 1908, Mr. Dexter S. Kimball makes a similar argument for the individual drive and, in addition, discusses at length the types of motors adapted to various classes of work and the principal methods of speed control. With the first part of Mr. Kimball's paper we shall not deal: his conclusions are in the main those of Mr. Knowlton; but we present below an abstract of the concluding section, dealing with the choice of motors and the methods of connecting them to the machines.

"Machine tools may for this purpose be classified into the following groups: (*a*) machines requiring a constant speed, in which the torque may vary with the demand for power; (*b*) variable-speed machines requiring maximum power at minimum speed; in this class are most machine tools where automatic regulation is needed; here the cutting speeds are practically constant for a given material, but the cuts are larger on the larger work; (*c*) variable-speed tools requiring heavy starting torque, as cranes, etc., where regulation of speed is by hand; (*d*) machines requiring a torque increasing with the speed, as blowers and fans which give variable blast, a rather unimportant class."

There is no trouble in meeting the requirements of the constant-speed machines but the problem of variable speed has received no entirely satisfactory solution. No mechanical speed-changing device has yet been produced that will answer the purpose. Many have been devised that will give any speed within the limits of the mechanism, but they all depend on friction and are very large and cumbersome. The devices which are positive in their action give only several speeds between the limits and are therefore not entirely satisfactory, though a number of those now on the market can be used with success in many places.

On the electrical side two distinct systems of distribution are offered, the alternating- and direct-current systems. In general it may be said that when the alternating-current system can be used it is preferable, as the wiring is smaller on a large system and the generators and motors are simpler and more reliable. It has, however, limitations to its application to the driving of machine tools.

The alternating-current system offers two kinds of motors, the synchronous and the induction motor. The former is not self-starting and, except in a few cases, as for instance when used in connection with induction motors for steadying the line and helping the power factor where heavy shafts are to be run for some length of time, it has no place in machine-tool driving. In small sizes it is not at all suitable. The induction motor is self starting and, like the synchronous motor, tends to run at constant speed. Though by nature not a variable speed machine, it can be made so in several ways, none of which, however, has so far proved adequate to the demands of machine-tool driving. Speed variation can be obtained by putting resistance in the secondary. Induction motors controlled in this manner are successfully used on cranes and similar devices. Fairly successful speed variation has been obtained in at least one plant using induction motors by varying the frequency, but as yet the induction motor cannot be considered as the equal of the direct-current motor for variable speed work. If a plant contains constant-speed machines principally, however, the induction motor in connection with a mechanical speed-changing device will generally prove to be the best, and where all the machinery is of the constant-speed type it is much preferable.

The direct-current system offers three kinds of motors, the combined characteristics of which cover much more closely the requirements of the case than do those of the alternating-current motor. These are the series-wound, compound-wound, and shunt-wound motors.

"The series motor is a variable-speed motor with great starting torque. It can be controlled throughout its whole range of speed, and would seem at first glance to be almost ideal for lathes and boring mills. It is, however, very uneconomical, as the control is obtained by resistance in its circuit. It also requires an expensive controller on account of the heavy current to be handled, and must be controlled by hand, as its speed varies inversely with the load, and under light loads it will run away. It is an excellent motor for cranes, elevators, etc., and occupies a very important place in the equipment. It therefore covers the requirements of the tools in class (*c*).

"The compound-wound motor is suitable where small variations of speed are needed, coupled with a large starting torque. It will, of course, give constant speed when set for any set of conditions within its range.

"The shunt motor is, in its standard form, a constant-speed motor. When set to run at a given speed it will not vary appreciably under varying load up to its capacity. It can be made to vary its speed in a number of ways, those which are most used being as follows: by varying the current in the armature; by varying the strength of the field; by varying the voltage applied to the armature terminal. These characteristics make the shunt-wound motor most suitable of any for the purposes of machine-tool driving, and by means of these methods of control, either singly or in combination with each other or in combination with gearing, most of such work is now accomplished.

"A discussion of the principal methods of speed control may be of interest. If the armature current in a shunt-wound motor be decreased by inserting resistance, the field remaining constant, the speed of the motor will decrease. But when this method of control is used the motor loses one of its most valuable qualities. It will no longer run at constant speed under varying load. Besides, this method of control, like that of the series-wound motor, is very wasteful, and the controller must likewise be large and complicated to handle the large current which must be broken. This method, therefore, has ceased to be used to any great extent.

"If the field strength of the shunt motor is varied the speed will vary accordingly, and in this method of control the bad features of the above method do not appear. The field current is small, and therefore the resistance loss small and the controller simple and cheap. The motor, likewise, retains its good quality of steady running. The power, however, falls off, for now the commutating ability of the field has decreased, so that less current can be passed through the armature. In order, therefore, to get a given output at higher speed with field control the motor must be larger than one built for the same output at the normal fixed speed, and to get a large range in this manner the motor must be very large. It will be noticed, however, that the characteristic of the motor fits the requirements of tools in class (*b*), and it is therefore much used for driving this class.

"If the field strength is kept constant and the impressed volts at the armature terminals be varied, the speed of the shunt-wound motor will vary accordingly. Theoretically, this is a most excellent method of speed control, as it allows the use of a smaller motor than in the method of field control, and the efficiency of the motor at the various voltages is high. In practice, however, the number of voltages that can be supplied is limited, and therefore in its simplest form the system has the same defect as the method of controlling alternating induction motors by changing the frequency. It is usual, therefore, to make the motors large enough to have field control sufficient to reach between voltages, which makes a system that completely covers the range between voltages and extends the range beyond the speed normal at highest voltage."

Mr. Kimball shows by practical examples how this method may be applied on 4- and 3-wire systems. Of the former case he says: "Undoubtedly this system works well, but like all the others it has its defects. It is not desirable to carry high voltage round manufacturing plants, for obvious reasons, so that in order to get a large range in this manner the lowest voltage must be very low. To obtain the full output at low speed—and it has been seen that generally the greatest output is required at the lowest speed—the current must be increased; so that the expense of wire runs up rapidly for wiring the low voltages, or if the mains are kept down in size, the line losses are heavy, and the impressed volts drop off, the motor slowing down accordingly. Further, the obtaining of only six voltages by a 4-wire system introduces considerable complication, as is easily seen, besides the extra expense for controllers, wiring, and the machines for giving the various voltages. Generally a motor-generator set of some form is run from the main series of the principal generating set which splits the voltage of these mains. Thus a 250-volt circuit can be divided by two wires from such a set into 60, 80, and 110 volt steps, and the combinations of these give six voltages.

"If it is not desired to use the excessively large motor resulting from entire field control or the complication of multi-voltage, a combination of field control and gearing can be used. This method, which is a compromise between the other systems, has many good points. The wiring and generating systems are simple, as only a single voltage is necessary, and the motor need not be excessively large for the work, as it can be worked at the maximum range of speed which is allowable for gear connection. The voltage is always the highest permissible, hence the wiring is small; and while the multi-voltage system gives somewhat quicker change of speed, the difference in well-designed machines will not be very great. In the writer's opinion it is a logical system, and will be very widely used in machine-tool work, mainly on account of its electrical simplicity. The efficiency of such a system is good, and if the gearing is properly designed the range covered by the motor alone need not be great enough to make it large and clumsy."

Mr. Kimball gives a table showing the relative sizes of motors which must be used with the 4 to 1 field control, 4-wire multi-voltage, 3-wire multi-voltage, and 2 to 1 field control with 2 to 1 gearing systems, to cover the range from 400 to 1,600 revolutions per minute and with a maximum voltage of 240. He concludes:

"It is easily seen that the range of any of the above systems of speed control is somewhat limited, the 4-wire multi-voltage having the widest for the same size of motor. But even this is limited as here laid down to about 6 to 1 when using field control on the highest voltage. It is true that it can be extended by using either higher or lower voltages, both of which are undesirable. Now machine tools which require variable speed may have a range of as high as 50 to 1. While, no doubt, many tools are furnished with a greater range than absolutely necessary, 6 or 8 to 1 being found sufficient for many purposes, at present none of the systems outlined will conveniently cover such ranges. Resort must therefore be made in most cases to gearing to finish out the range even with multi-voltage. When the range to be covered is very great this last system has an advantage, but for most machines the range required can be covered with a field control of 2 to 1 and two sets of gears, and for the larger ranges which are not so frequent, a field control of 3 to 1 can be used.

"Where a 3-wire system is already installed the application of variable speed drives is easily accomplished by the system outlined. But when the case of a new plant is under discussion, careful consideration should be given to the foregoing principles, and the system should depend largely on the ratio of variable-speed tools to constant speed tools. If the plant is large enough, an alternating system with proper transforming devices might prove the best, and in the writer's opinion many large plants now equipped with direct-current distribution would be much more economically run if so provided."

THE ELECTRIC STEEL FURNACE.

A SUMMARY OF THE INSTALLATIONS OF THE ELECTRIC FURNACE FOR STEEL PRODUCTION NOW IN USE OR UNDER CONSTRUCTION IN ALL PARTS OF THE WORLD.

Stahl und Eisen.

A TABLE published in *Stahl und Eisen* for October 7, 1908, and reproduced in full below, gives what is believed to be a complete summary of the electric furnaces for steel production now in use or under construction in all parts of the world. It is abundantly evident from the size and wide distribution of the installations that the electric furnace for this class of work has emerged from the experimental stage and has won for itself an important place in the metallurgy of iron and steel. The table is divided into two parts, covering, respectively, furnaces of the induction and arc types. Of the former the total number in use or under construction is 35, and of the latter, 43.

TABLE OF ELECTRIC STEEL FURNACE INSTALLATIONS NOW IN USE OR UNDER CONSTRUCTION IN ALL PARTS OF THE WORLD.

I. INDUCTION FURNACES.

a. KJELLIN.

Firm.	Capacity, Kilogrammes.	Power Requirements, Kilowatts.	Current.	Remarks.
1. Röchlingsche Eisen- und Stahlwerke, Völklingen	8,500*	750	Single phase	....
2. Fried. Krupp A.-G., Essen	8,500	750	" "	....
3. Oberschlesische Eisenindustrie-A. G., Gleiwitz, Germany	1,500	180	" "	....
4. Poldihütte, Kladno, Bohemia..................	4,000	440	" "	....
5. J. Brauns' Söhne, Vöcklabruck, Austria........	400	65	" "	....
6. Allg. Kalziumkarbid-Genossenschaft, Gurtnellen, Switzerland	....*	330	" "	....
7. Vidua de Urigoitia è Hijà, Araya, Spain......	1,500	215	" "	....
8. Alti Forni Gregorini, Lovere, Italy............	1,500†	330	" "	....
9. Eisenwerk Domnarfvet, Gysinge, Sweden......	1,500	175	" "	....
10. Metallurgiska Aktiebolaget, Trollhättan, Sweden	2,000†	300	" "	....
11. Vickers, Sons & Maxim, Sheffield, England.....	550	150	" "	....
12. Gröndal-Kjellin Co., London, England.........	100	60	" "	Experimental furnace.
13. American Electric Furnace Co., Niagara Falls..	800	150	" "	....
14. " " " " " " ..	100	60	" "	....

b. RÖCHLING-RODENHAUSER.

Firm.	Capacity, Kilogrammes.	Power Requirements, Kilowatts.	Current.	Remarks.
1. Röchlingsche Eisen- und Stahlwerke, Völklingen	3,500	400	Single phase	Charge taken from Bessemer converter. (1–3)
2. " " " " "	8,500†	750	" "	
3. " " " " "	2,000	275	Three phase	
4. Bergische Stahlindustrie, Remscheid, Germany.	5,000†	500	Single phase	....
5. Le Gallais, Metz & Co., Dommeldingen, Germany	700	100	" "	Charge, molten pig iron; later will use molten steel from the large furnaces.
6. " " " " " "	8,500†	300	" "	Charge, molten pig iron. (6–7)
7. " " " " " "	3,500†	300	" "	
8. " " " " " "	1,500†	275	Three phase	Charge, molten steel from the large furnaces.
9. Aciéries Liègoises, Bressoux-les-Liège, Belgium	1,000†	200	" "	For steel castings. Charged cold.
10. J. Knöpfel, Walzenhausen, Switzerland........	1,000†	175	" "	" " " "

	Firm.	Capacity Kilo-grammes.	Power Require-ments, Kilo-watts	Current.	Remarks.
	c. SCHNEIDER.				
1.	Schneider & Co., Creusot, France	1,000	...	....	Experimental furnace.
	d. SCHNEIDER-GIN.				
1.	——— Plettenberg, Germany	4,500†	400	Single phase	....
	e. COLBY.				
1.	H. Disston & Sons, Philadelphia, U. S. A.	90	...	Single phase	Current, 240 volts, 50 periods.
	f. FRICK.				
1.	Fried. Krupp A.-G., Essen	10,000	750	....	....
2.	John Brown & Co., Sheffield, England	1,800	200	....	....
3.	Wm. Jessop & Sons, Sheffield, England	3,000*	450	....	....
	g. WALLIN.				
	No longer used.				
	h. HIORTH.				
	No longer used.				
	i. A.-G. ELECTROMETALL, LUDVIKA, SWEDEN.				
1.	——— Arkiva, Sweden	1,000	175	Three phase	
2.	——— Hagfors, Sweden	500†	125	" "	For steel production.
3.	St. John del Rey Mining Co., Brasil	2,000†	300	" "	" "

A 450-kilowatt three-phase furnace of this type is used at the Eisenwerk Domnarfvet, Gysinge, Sweden, for the production of pig iron. It has a capacity of 2,000 tons per year.

2. ARC FURNACES.

	Firm.	Capacity Kilo-grammes.	Power Require-ments, Kilo-watts	Current.	Remarks.
	a. HEROULT.				
1.	Stahlwerke Richard Lindenberg A.-G., Remscheid-Hasten	3,000	370	Single phase	Produces tool steel. Charged with molten steel from the open-hearth furnace.
2.	Stahlwerke Richard Lindenberg A.-G., Remscheid-Hasten	1,800	300	" "	" " "
3.	Bismarckhütte, Bismarckhütte, Germany	3,000	400	" "	Produces tool steel. Charged molten or cold.
4.	" " "	1,000	260	" "	" "
5.	Deutsch-Oesterreichische Mannesmannröhren-Werke, Burbach	3,000†	400	" "	Charged with molten open-hearth steel. Product used for seamless tubes and steel castings.
6.	Danner & Co., Judenburg, Austria	2,000	300	" "	Produces tool steel. Charged from the open-hearth furnace.
7.	Gebrüder Böhler & Cie., A.-G., Kapfenberg, Austria	2,500	350	" "	" "
8.	Gebrüder Böhler & Cie., A.-G., Kapfenberg, Austria	....†	...	" "	....
9.	Georg Fischer, Schaffhausen, Switzerland	1,000	250	" "	Charged cold. Product for steel castings. (9–11)
10.	" " " "	5,000†	...	" "	
11.	" " " "	5,000†	...	" "	
12.	Société Electrométallurgique Française, La Praz, France	3,000	370	" "	Charged cold.
13.	Aciéries du Saut du Tarn, St. Juery, France	5,000	600	" "	" "
14.	Aktiebolaget Héroults Elektriska Stal, Kortfors, Sweden	4,500	300	" "	" "
15.	Halcomb & Co., Syracuse, U. S. A.	5,000	...	" "	Charged with molten pig.
16.	The Nolde Electric Co., Baird, U. S. A.	5,000	...	" "	....
17.	The Firth Sterling Steel Co., McKeesport, U. S. A.	10,000†	...	" "	....
18.	Società Tubi Mannesmann, Dalmine, Italy	6,000†	736	" "	Charged cold. Product for seamless tubes.
19.	" " " " "	6,000†	736	" "	

Three furnaces of this type are in use for the production of pig iron at Welland and Sault Ste. Marie, Canada, and Héroult-on-the-Pitt, California.

	Firm.	Capacity Kilo-grammes.	Power Require-ments, Kilo-watts	Current.	Remarks.
	b. DU GIFFRE.				
1.	Société des Hauts-Fourneaux et Forges, Allevard, France	3,200	500	....	....
2.	Société des Hauts-Fourneaux et Forges, Allevard, France	3,200	500	....	....
	c. KELLER.				
1.	Holtzer & Co., Unieux, France	....	...	....	Charged with molten steel.

* Not in use.

† Under construction.

	Firm.	Capacity Kilo-grammes.	Power Require-ments, Kilo-watts	Current.	Remarks.
	d. Girod.				
1.	S. A. Electrométallurgique, Ugine, France.....	1,800	800	Single phase	Charged cold.
2.	" " " "	2,000†	800	" "	" "
3.	" " " "	2,000†	800	" "	" "
4.	" " " "	8,000 to 10,000†	1,200	" "	Charged cold. Four electrodes.
5.	" " " "	8,000 to 10,000†	1,200	....	" "
6.	Oehler & Co., Aarau, Switzerland.............	2,000	300	Single phase	For foundry. Charged cold.
7.	Joh. Cockerill, Seraing, Belgium........	3,000 to 4,000†	450	" "	Produces special steels. Cold or molten charge.
8.	A. Stotz, Stuttgart-Kornwestheim, Germany....	2,000†	300	" "	Charged cold. For steel castings.
9.	Marrel Frères, Rive de Gier, France..........	....†	...	" "	....
10.	Ternitzer Eisen- und Stahlwerke, Ternitz, Austria	....†	...	....	....
	e. Stassano.				
1.	Bonner Fräserfabrik, G.m.b.h., Bonn, Germany	1,000	185	Three phase	Tool steel and steel castings. Current, 110 volts, 50 periods.
2.	" " " " "	1,000†	185	" "	" "
3.	Forni Termoelettrici Stassano, Turin, Italy....	5,000	750	" "	Special steels and steel castings. Current, 150 volts, 50 periods.
4.	" " " " "	5,000	750	" "	" "
5.	" " " " "	900	180	" "	Special steels and steel castings, Current, 100 volts, 50 periods.
6.	" " " " "	900	180	" "	
7.	" " " " "	900†	180	" "	....
8.	" " " " "	400	75	" "	Steel castings. Current, 80 volts, 50 periods.
9.	" " " " "	400	75	" "	" "
10.	Imperial Arsenal, Turin......................	700	150	" "	Projectile and armor steel. Current, 80 volts, 50 periods.
11.	" " "	700†	150	" "	" "

† Under construction.

THE GAYLEY DRY-AIR BLAST.

AN APPRECIATIVE ESTIMATE OF ITS TECHNICAL AND COMMERCIAL IMPORTANCE.

R. W. Raymond—American Institute of Mining Engineers.

TWO papers on the Gayley dry-air blast were presented at the recent meeting of the American Institute of Mining Engineers, the first, by Mr. Edward B. Cook, detailing experiences with the process at the Warwick furnaces, Pottstown, Pa., and the second, by Dr. R. W. Raymond, dealing with the technical and commercial improvements in blast-furnace management which are made possible by drying the blast. The former paper contains a great deal of very interesting and valuable information but since the results of the introduction of the Gayley process at the Warwick furnaces are dealt with at some length in Dr. Raymond's paper, the following review is devoted wholly to the latter.

It has been established beyond controversy that the use of the Gayley dry-air blast reduces the cost of pig iron about $1 per ton. The first reports of this direct economy were received with incredulity on both sides of the Atlantic. They were rejected as theoretically impossible according to generally accepted notions and formulæ. Dr. Raymond believes, however, that the accepted method of determining the economy of the blast-furnace process by means of thermo-chemical equations and heat balances, based as it is on averages which are assumed to represent uniform conditions, does not always furnish a safe criterion of alleged or possible technical economies. The method is scientifically sound but it is applied to data too roughly determined for such precise mathematical discussion. It is particularly lacking in that it fails accurately to take into account the grade of the iron produced, especially the "off iron" which is invariably a part of blast-furnace product in present practice. Dr. Raymond offers this inaccuracy of methods of calculating blast-furnace economy as an explanation of the hasty conclusions of certain experts as to the impossibility of obtaining the reported technical economy of the Gayley process. The technical economy is, however, fully established and, Dr. Raymond says, "as regards commercial economy, there is no room for doubt or contradiction. If a blast furnace is 'running on' (*i. e.*, managed with the purpose of producing) a particular kind of pig iron, and if Mr. Gayley's process will deliver it altogether, or to an unprecedented degree, from the risk of producing incidentally another kind, not called for, and probably not desired or not readily salable at a profit, the commercial value of this insurance is beyond measurement by any technical formula that has been, or could be, constructed. The case presented in Mr. Cook's paper on 'Experience with the Gayley Dry Blast at the Warwick Furnaces,' furnishes a striking illustration of this proposition.

"As already observed, the testimony from iron works both in the United States and abroad agrees in declaring that the Gayley process reduces the cost of pig iron about $1 per ton; but this saving, though important, is trivial, compared with the commercial advantage of a more effective control of the operation and product of the furnace. To state the case roughly, the Warwick Iron & Steel Company was caught, with innumerable others, in the financial revulsion of 1907, which stopped for a time the market for pig iron. The company had a profitable contract with solvent customers for iron of a special grade; but the old and almost dilapidated furnace which it had kept in blast for the purposes of that contract was running so irregularly that only half—or less—of its product could be delivered under the contract, and the rest would have to be stored as not immediately salable, and, indeed, as never likely to be salable at a price covering the special expenses incurred for the purpose of producing the special, and more costly, grade of product for which the furnace had been burdened and operated.

"Under these circumstances, the interest on the capital represented by the 'off iron' would have exceeded the profits on the proportion of special iron delivered under the specifications of the contract; and a prudent manager would have been obliged to accept the unwelcome alternative (adopted, in fact, by most of our American merchant furnaces) of sacrificing his pending contract, blowing out his furnace, and submitting to the loss in general expenses, interest, etc., and the even greater damage caused by the scattering of skilled and trusted workmen and the inability to take immediate advantage of a general revival of business, or of a sudden special opportunity for a local resumption of work. These disastrous effects of a suspension of operations are, as I need scarcely say, those most dreaded by technical managers, since, besides their direct financial results, they involve the immeasurable anxiety and responsibility of efficient reorganization.

"Fortunately for the Warwick Company it had just completed the installation of an expensive plant for the Gayley process; and the operation of this plant, under all the disadvantages of new and untried apparatus, inexperience of both manager and workmen, and dilapidated condition of the furnace then in blast, enabled the company to raise the proportion of its immediately and profitably marketable product from below 50 to above 80 per cent.; to fill its pending contract; and to realize, instead of industrial demoralization and financial loss, a substantial profit from continued operations. Indeed, it is no secret that, through the total gains of this campaign, the entire cost of the installation of the Gayley system, including the sum paid for the patent right, was repaid in a few months, though the certified saving of $1 per ton in the average cost of pig iron would not by any means have accomplished that result in so short a time.

"The situation above described is one which any manager of a 'merchant' blast furnace (*i. e.*, a furnace selling its product to outside customers) may at any time encounter. But it carries a meaning also for establishments like the works connected with the United States

Steel Corporation and other great concerns, which have a use for the 'off iron' produced by their blast furnaces. For such 'off iron' could be manufactured at smaller expense than when it is turned out as an unwelcome by-product from a furnace charged and operated, at extra cost, to yield a more valuable product. In short, every blast-furnace manager knows that both technical and commercial economy as well as relief from personal anxiety, would be secured if he could only be sure of making what he is trying to make.

"This brings us back to the inquiry: What is the bearing of Mr. Gayley's invention upon this desirable element of certainty, through complete and intelligent control, in the operation of the blast furnace?

"As I have already observed, we have sought to secure such certainty through minute analyses of all the raw materials, etc., except the air of the blast, which weighs more than all the rest put together. But when we come to consider this element, we perceive at once that it cannot be usefully analyzed like ore, flux or fuel. We cannot determine its composition and then store it until we wish to use it; and if we could analyze it as it enters our blowing engines our knowledge would come too late to permit any effective action on our part, based upon such information. If we would attain that certainty of control which constitutes the perfection of an art, we cannot treat the air of the blast as we do all the other elements of the charge, which we regard as variables to the character of which we adjust our practice. The air, most variable of all, cannot be thus dealt with. We must make it practically a constant. Mr. Gayley has shown us that the only way to do this is to freeze the moisture out of it. No attempts at vague amelioration by partial measures will meet the case. What we want is, first, to know just what we are putting into the furnace through the blast, and, second, how we can continue to do that particular thing without variation.

"Mr. Gayley, after years of costly experiment, has shown us for the first time how to attain this object; and I am not surprised that leading ironmasters in this country and abroad have recognized his invention as the greatest advance in blast-furnace practice since the introduction of the hot blast by Neilson. It is scarcely too much to say that this invention, completing our mastery of conditions previously uncontrollable, has elevated the manufacture of pig iron from the category of processes which are partly art and partly accident to that of the true arts, which may be practiced with approximate scientific certainty."

THE POSSIBILITIES OF THE GASOLENE TURBINE.

AN ESTIMATE OF THE POSSIBLE COMBINED EFFICIENCY OF TURBINE AND COMPRESSOR.

Frank C. Wagner—American Society of Mechanical Engineers.

An important contribution to the discussion of the possibilities of the gas turbine was made at the recent annual meeting of the American Society of Mechanical Engineers in a paper read before the Gas Power Section by Prof. Frank C. Wagner. Prof. Wagner presented no data obtained experimentally but his deductions from calculations based on theoretical considerations are in the highest degree interesting, since they indicate the possibility of attaining a combined efficiency of a gasolene turbine and a compressor which compares very favorably with the best results obtained with gasolene engines. We give a brief abstract of his paper.

"Two methods of reducing the temperature of the gases themselves are possible. One method is to use an excess of air in burning the gas or gasolene, sufficient to keep the temperature of the gases after expansion in the nozzles within safe limits. The other method is to inject a liquid, preferably water, into the gases. The liquid absorbs heat, becoming superheated vapor, and the vapor furnishes work during expansion. It is the purpose of this paper to compare the above methods of reducing the temperature of the gases, and especially to consider how such a comparison is affected by variations in the efficiencies of the turbine and the air compressor.

"The cycle of the type of gasolene turbine here considered is similar to that of the Diesel engine, with complete expansion. The efficiency of this cycle may be readily found if both compression and expansion be assumed to be adiabatic. Since the net mechanical work done equals the difference between the heat absorbed and the heat rejected during a complete cycle," Prof. Wagner shows that the efficiency can be expressed by the following formula:

$$\text{Eff.} = 1 - \frac{T_4}{T_2} = 1 - \rho^{\frac{1-\gamma}{\gamma}}$$

where T_4 is the absolute temperature of the air just before compression; T_1 the temperature at the end of compression; ρ the ratios of the pressures at the extremities of the adiabatic change—the compression pressure ratio—which is the same for the expansion line as for the compression line, assuming the expansion to be complete; and γ the ratio of the specific heats.

"The interesting feature of this expression for efficiency is that the theoretical efficiency depends only on the ratio of compression. It does not depend on the maximum temperature reached. Consequently, from a theoretical standpoint it makes no difference whether the fuel is burned with the theoretical amount of air or with a considerable excess. If a sufficient excess of air is used the temperature of the gases when they strike the turbine blades can be brought down to a value for which the strength of steel retains a high value.

"When practical efficiencies are considered, however, it is found that the proportion of air to fuel becomes important. Of the theoretical power that can be developed, only a fraction is actually converted into mechanical power. Consequently a much larger proportion of the available power must be consumed in compressing the air than is allowed in the theoretical expression for efficiency. The greater the proportion of air to fuel, the more will the practical efficiency fall off from the theoretical. The question arises whether with practicable mechanical efficiencies for the turbine and the compressor a sufficient excess of air can be used to bring down the temperature of the gases to a proper value and still give a reasonable efficiency for the complete operation."

Prof. Wagner has made a large number of calculations of the theoretical efficiency of the gas turbine under various conditions, and of total efficiencies for various mechanical efficiencies of turbine and compressor, and the results are incorporated in his paper in diagrams and tables which, unfortunately, we have not space to reproduce. A sample calculation is also shown. He has limited his consideration to the velocity stage type of turbine in which the gases may be expanded completely in a nozzle of refractory material before striking the wheel; this type he believes to be best suited for use as a gas turbine.

"The formula for theoretical efficiency indicates that high compressions are favorable to efficiency. To produce high compressions it is practically necessary to use two-stage or three-stage compressors. It occurred to the writer that it might be an advantage to use intercoolers between the stages of such compressors. Calculations have accordingly been made for the purpose of comparing the efficiencies obtainable with intercoolers and without them, with the general result that while theoretically the best efficiency is obtained by adiabatic compressions without intercoolers, yet with such values as are practically obtainable for the mechanical efficiencies of turbine and compressor the use of intercoolers is decidedly advantageous.

"Calculations have been made for a two-stage compressor having total compression ratios of 9 and 16, and for a three-stage compressor with a ratio of 27 for each of the three cases, first, when the compression is completely adiabatic, second, when the compression is adiabatic in each stage but the air is cooled between stages, and, third, when water is injected. . . . .

"A calculation of the total efficiencies for various efficiencies of turbine and compressor shows that a combination of water injection and intercooling gives a slightly higher total efficiency than water injection without intercooling. It is not probable that both would be used in the same machine and consequently the calculations have been limited to the case of water injection with true adiabatic compression. . . . .

"An inspection of the diagrams shows that for all values of the mechanical efficiencies that seem obtainable at present, true adiabatic compression gives a lower total efficiency than either intercooling or water injection.

"It also appears that water injection gives a higher efficiency under some conditions than air dilution, while under other conditions the reverse is true. The diagrams show this very clearly. The slope of the total efficiency lines is such that the total efficiency line for water injection corresponding to a certain compressor efficiency may intersect the line for air dilution with intercooling corresponding to the same compressor efficiency.

"Comparing the diagrams for different compression ratios, not only are the total efficiencies greater for the higher pressures, but the relative effects of the different methods employed for keeping down the temperature of the gases upon the total efficiencies change decidedly.

"What can be expected of the gasolene turbine in practice?

"Air compressors of the piston type have been constructed which give a mechanical efficiency of 85 per cent. The best mechanical efficiency obtained with steam turbines is in the neighborhood of 65 per cent. Whether a velocity stage gas turbine of equal efficiency is possible can only be determined by actual trial. Some of the points of difference are as follows:

"In the steam turbine, the wheel revolves in gaseous mediums varying from a considerable density at the higher pressures to a very small density in the vacuum at the exhaust end. In the gas turbine, the gaseous medium is at atmospheric pressure, but on account of its high temperature the density will be only a little more than a third of that of air under ordinary atmospheric conditions. It is quite possible that the wheel friction will be no greater on the whole for a gas turbine than for the best steam turbine.

"The velocity of the gases leaving the expansion nozzle for a compression ratio of 27 would be about 4,600 feet per second, which is much higher than occurs in steam turbine practice. The effect of friction at such high velocities is yet to be determined. The experiments quoted by Professor Thomas in his book on Steam Turbines indicate that up to 220 pounds per square inch pressure the percentage of friction loss in a properly shaped nozzle diminishes with increase of pressure. If this law continues, the use of high jet velocities may not detract from the efficiency.

"It seems, therefore, within the range of possibilities to construct a gas turbine giving an efficiency of 60 per cent. and a three-stage air compressor of 85 per cent. efficiency. From the diagrams the combined efficiency for air dilution with intercooling is found to be 19.5 per cent., and for water injection, 15 per cent.

In Bulletin 191 of the U. S. Department of Agriculture, Lucke and Woodward detail tests of engines using gasolene and alcohol. The smallest fuel consumption with gasolene was about 0.7 pound of gasolene per brake horse power, obtained only with the most perfect adjustment in a very few tests. The average fuel consumption was nearer 1.25 pounds, which probably represents more nearly the average practice. A fuel consumption of 0.7 pound of gasolene per horse power corresponds to an efficiency of about 18 per cent., while a fuel consumption of 1.25 pounds of gasolene per horse power corresponds to a fuel efficiency of 10 per cent.

"The gasolene turbine appears to offer advantages in reliability, comparative simplicity of adjustments, and freedom from annoying troubles as compared with the explosion engine. Whether it can compete with the latter in power developed per unit of weight remains to be determined. A further advantage which the gasolene turbine has over the explosion engine is that the gasolene turbine can burn crude oil, which is a cheaper fuel."

THE ENGINEERING INDEX

"THE KEYSTONE IN·THE·ARCH·OF·APPLIED·SCIENCE"

The following pages form a descriptive index to the important articles of permanent value published currently in about two-hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

CIVIL ENGINEERING

BRIDGES.

Blackwell's Island.

The Safety and Carrying Capacity of the Blackwell's Island Bridge. Two Expert Reports. Reports of Henry W. Hodge and William H. Burr, setting forth in detail the condition of the structure. Also editorial. Ills. 13500 w. Eng News—Nov. 12, 1908. No. 232.

Stresses in the Blackwell's Island (Queensboro) Bridge Under Full Specified Loading. Gives stress sheet of Bolles and Hodge. 4000 w. Eng News—Nov. 19, 1908. No. 379.

The Method of Calculating Stresses for the Blackwell's Island Bridge, as Used in Bolles and Hodge's Recomputation. Explanation. 2000 w. Eng News—Nov. 19, 1908. No. 381.

Reports on the Blackwell's Island Bridge. A statement of the conclusions of experts appointed to investigate this structure. Also editorial. 4200 w. Eng Rec—Nov. 7, 1908. No. 144.

The Cantilever Without Suspended Span. Appendices to the reports on this bridge. 2500 w. Eng Rec—Nov. 21, 1908. No. 417.

We supply copies of these articles. See page 747.

Cantilever.

See Blackwell's Island, under Bridges.

Drawbridges.

Weaver Drawbridge Lift-Rail Locking. Illustrated description of this apparatus. 1200 w. Sig Engr—Nov., 1908. No. 280.

Earthquakes.

A Study of the Damage to Bridges During Earthquakes. William Herbert Hobbs. Read before the Am. Assn. for the Adv. of Science. Gives data from earthquakes of recent date. Ills. 5000 w. Jour of Geol—Oct.-Nov., 1908. No. 492 D.

Failures.

The Collapse During Reconstruction of a Span of the Baltimore & Ohio R. R. Bridge Across the Susquehanna. An illustrated account of this accident, describing the construction, the collapse, and the condition of the wreckage. 2500 w. Eng News—Oct. 1, 1908. No. 214.

Lift Bridges.

Electrically Operated Lift Bridge, the "New Bridge," at Cette (Le Pont Neuf, Pont-levant à Manœuvre Electrique au Port de Cette). M. Herrmann. Illustrated description of the construction and operating mechanism of this bridge, the middle span of which is lifted vertically to allow the passage of boats. 4300 w. Ann d Ponts et Chaussées—1908-III. No. 502 E + F.

Manhattan.

The Construction of the Manhattan Bridge Approaches. Illustrated description. 1500 w. Eng Rec—Nov. 21, 1908. No. 414.

The Manhattan Bridge Approach Viaducts. Illustrated detailed description. 2000 w. Eng Rec—Oct. 31, 1908. No. 27.

Pontoons.

Design and Construction of an Iron Pontoon Foot Bridge (Construction und Berechnung einer Schwimmenden eisernen Fussgängerbrücke). W. Schulz. Mathematical. Ills. Serial. 1st part. 1700 w. Elektrotech Rundschau—Oct. 17, 1908. No. 590 D.

Reinforced Concrete.

The Concrete Arch vs. the Concrete Girder Bridge. Frank Barber. Compares two recent reinforced concrete bridges as to efficiency and cost. Ills. 1200 w. Can Engr—Nov. 20, 1908. No. 404.

The Mill River Bridge of the New York, New Haven & Hartford Railroad. Illustrated description of this six-track railroad bridge, consisting of two arches of reinforced concrete. 2500 w. Eng Rec—Nov. 14, 1908. No. 255.

The Construction of the Pelham Bridge, New York. Illustrated detailed description of the general design and the construction operations of a concrete bridge with pile foundations. 2500 w. Eng Rec —Oct. 31, 1908. No. 20.

Some Reinforced Concrete Bridges in France. Illustrates and describes two railway and one foot bridge recently constructed, designed by M. A. Considère. 1500 w. Engr, Lond—Oct. 30, 1908. No. 197 A.

Steel.

Concerning High Unit-Stresses in Steel Bridge Design. Editorial on the tendency toward using higher unit-stresses, considering that there is no valid reason for the change. Also discusses the causes. 3000 w. Eng News—Nov. 19, 1908. No. 380.

Sydney Harbor Bridge. Describes a scheme which is to cost about £2,000,000. 1200 w. Engr, Lond—Nov. 6, 1908. No. 328 A.

Bridge Over the River Wear at Sunderland. Illustrated description of a double-deck bridge of unusually large proportions, and the methods of erection. Plates. 3500 w. Engng—Oct. 23, 1908. No. 76 A.

The Reconstruction of the Humboldt Bridge of the Berlin Railway (Die Auswechslung der Humboldthafenbrücke der Berliner Stadtbahn). Herr Wambsganss. Illustrates and describes important work in strengthening this steel bridge. Serial. 1st part. 4000 w. Glasers Ann—Oct. 1, 1908. No. 584 D.

See also Blackwell's Island, Failures, Manhattan, and Pontoons, under Bridges.

Timber.

Method and Cost of Constructing a Wooden King Post Truss Bridge with Concrete Abutments in Cuba. Charles M. Kercher. Description and cost data. Diagrams. 500 w. Engng-Con—Nov. 11, 1908. No. 240.

Transporter.

See Transporter Bridges, under MECHANICAL ENGINEERING, Transporting and Conveying.

CONSTRUCTION.

Boring.

Test-Boring Methods. Investigations for New Bridges at Santa Cruz, Cal. James K. James. Illustrated description of drilling methods. 2500 w. Cal Jour of Tech—Oct., 1908. No. 343.

Brick.

See Stacks, under Construction.

Coal Bunkers.

Reconstructing Coal Bunkers in a Steam Power Plant. Explains the difficulties of work carried out in New York City in reconstructing coal bunkers destroyed by fire. 3200 w. Eng Rec—Nov. 14, 1908. No. 250.

Columns.

The Strength of Solid Cylindrical Round-Ended Columns. W. E. Lilly. Read at Dublin meeting of British Assn. for the Pro. of Science. Describes experiments made to determine the constants to be used in the formulae for their design. 4000 w. Engng—Nov. 13, 1908. No. 447 A.

The Crushing Strength of Concrete-Filled Steel Columns (Die Knickfestigkeit betongefüllter Mannesmann-Stahlrohrsäulen). A. Gessner. Gives results of tests. 2100 w. Beton u Eisen—Oct. 26, 1908. No. 571 F.

Concrete.

Methods of Constructing Concrete Vaults for Valves. Carroll Beale. Illustrates and describes economical method of construction. 800 w. Engng-Con—Nov. 18, 1908. No. 372.

Casting the Concrete Lions for Connecticut Ave. Bridge, Washington, D. C. Gives a view of one of the finished lions, and describes the methods used in casting. 1500 w. Eng News—Nov. 19, 1908. No. 374.

See also Foundations and Tunnels, under CONSTRUCTION; and Pavements, under MUNICIPAL.

Failures.

Failure of a Reinforced-Concrete Floor of Unusual Design. H. Alexis d'O. Saurbrey. An account of the failure of a new manufacturing plant in Cleveland, Ohio, and the repair work. Ills. 1300 w. Eng News—Nov. 5, 1908. No. 99.

Floors.

See Failures, under CONSTRUCTION.

Foundations.

Renewing Foundation of a Water Tank. William Martin. Describes work at Pittsburg where a timber foundation was replaced by concrete. Discussion. 4000 w. Pro Engrs' Soc of W Penn—Oct., 1908. No. 349 D.

Substructure of Farmers' Loan & Trust Company's Building, New York. Illustrates and describes interesting details to meet conditions, and in the treatment of adjacent buildings. 2500 w. Eng Rec—Oct. 31, 1908. No. 19.

Foundations for the New Singer Building, New York City. T. Kennard Thomson. An illustrated detailed description of the construction of the pneumatic caisson foundations for this very tall building. 3500 w. Pro Am Soc of Civ Engrs—Oct., 1908. No. 488 E.

Foundations for the New Courthouse in Düsseldorf (Künstliche Fundierung des Geschäftsgebäudes für das Oberlandesgericht zu Düsseldorf). Franz Boerner. The first part deals with the examination of the ground. The foundation was of reinforced-concrete. Serial. 1st part. 2700 w. Beton u Eisen—Oct. 26, 1908. No. 573 F.

Foundations on a Solid Mass of Concrete Set in Bottomless Caissons on a Riprap Bed in a Swift Current (Fondations sur Massif de Béton immergé dans des Caissons sans Fond reposant sur un Lit d'Enrochements dans un Courant rapide). M. Armand. Describes method of constructing foundations for harbor works. Ills. 2000 w. Ann d Ponts et Chaussées—1908-III. No. 506 E + F.

Grain Elevators.

Grain Elevators (Etude sur les Magasins à Grains). M. Barbet. A general discussion of their design and equipment and a detailed description of the elevator at the port of Rosario. Ills. Serial. 1st part. 7500 w. Rev de Mécan—Oct., 1908. No. 520 E + F.

High Buildings.

The Skyscraper and the Street. David Knickerbacker Boyd. Discusses the present phases of the question and proposes a scheme for correcting most of the difficulties. Ills. 3000 w. Am Archt—Nov. 18, 1908. No. 358.

Masonry.

See Dams, under WATER SUPPLY.

Reclamation Work.

Building a City at Long Beach, Long Island. Illustrates and describes the work of converting 2000 acres of salt marsh, tidal channels and sand dunes into a fine residence city. 3000 w. Eng Rec—Nov. 21, 1908. No. 415.

Reinforced Concrete.

Is Concrete Steel a Permanent Construction? J. A. Fitzpatrick. A brief account of an unusual example of deterioration of steel framing in buildings. 600 w. Sci Am—Nov. 28, 1908. No. 472.

The Spacing of Reinforcement in Concrete Beams (Eisenabstände in Plattenbalken). B. Löser. Mathematical. Ills. 2100 w. Beton u Eisen—Oct. 26, 1908. No. 574 F.

Continuous Beams with Elastic Column Connections (Kontinuierlicher Träger mit elastisch verbundenen Stützen). Mario Genel. Mathematical. Ills. 4500 w. Beton u Eisen—Oct. 9, 1908. No. 575 F.

A Note on the Design of Rectangular Slabs (Ein Beitrag zur Berechnung der rechteckigen Platten). Jovo Simic. A mathematical discussion of stress distribution, etc. Ills. 4000 w. Zeitschr d Oest Ing u Arch Ver—Oct. 30, 1908. No. 583 D.

See also same title, under BRIDGES; Failures, Foundations, Retaining Walls, and Roofs, under CONSTRUCTION; Reinforced Concrete, under MATERIALS OF CONSTRUCTION; Sewers, under MUNICIPAL; and Canals, Lighthouses, and Piers, under WATERWAYS AND HARBORS.

Retaining Walls.

The Construction of Reinforced-Concrete Retaining Walls (Die Konstruktion von Eisenbetonstützmauern). F. Baumstark. Mathematical. Ills. 2000 w. Beton u Eisen—Oct. 26, 1908. No. 572 F.

Roofs.

A Flat Roof Supported by Reinforced-Concrete Beams (Solai a Travicelli di Cemento Armato, Soffittati in Piano). C. Marzocchi. Mathematical discussion of the design. Ills. 5500 w. Ann d Soc d Ing e d Arch Ital—Sept. 15, 1908. No. 539 F.

Stacks.

The World's Largest Chimney: 50 x 506 ft. Brick Stack for the Boston & Montana Smelter at Great Falls, Mont. States the requirements and gives an illustrated description of the design and construction. 4000 w. Eng News—Nov. 26, 1908. No. 639.

Steel.

Structural Features of the Pope Building, Cleveland, Ohio. Illustrates and describes interesting features due to difficult foundations and irregular plan. 1600 w. Eng Rec—Oct. 31, 1908. No. 21.

The Humboldt Savings Bank Building, San Francisco. C. Derleth, Jr. Describes building methods for this earthquake district adopted since the fire. Ills. 5500 w. Eng Rec—Nov. 21, 1908. No. 413.

See also Ferry Houses, under WATERWAYS AND HARBORS.

Tunneling Machines.

A Machine for Boring Rock Tunnels. Illustrated description of the Terry, Tench and Proctor Co.'s rock tunnel drilling machine. 1200 w. Eng News—Nov. 19, 1908. No. 378.

Tunnel Lining.

Method of Lining the Second Bergen Hill Tunnel of the Lackawanna Railroad. Describes the interesting forms used, the methods of bringing in the materials, and the excellent surface and alignment. 2500 w. Eng Rec—Oct. 31, 1908. No. 23.

Reinforced-Concrete Tunnel Lining in the Göttelborn Mine (Eisenbetonausbau einer Richtstrecke in der Königl. Steinkohlengrube Göttelborn, Saargebiet). W. Stark. Illustrated description of the work. 2200 w. Beton u Eisen—Oct. 9, 1908. No. 576 F.

Tunnels.

Special Concrete Structures, in the Hudson River Tunnels. W. M. Torrance. Illustrated description of the design and construction, with discussion. 9500 w. Jour W Soc of Engrs—Oct., 1908. No. 357 D.

The Tunnel of the New York, New Haven & Hartford Railroad at Providence, R. I. An account of railroad improvements, especially describing the tunnel, about 5,080 ft. long. Ills. 4500 w. Eng Rec—Nov. 7, 1908. No. 138.

Waterproofing.

Methods of Waterproofing Concrete Covered Steel Floors for Railway Bridges with Some Figures on Cost. Methods given in a committee report before a recent convention of the Assn. of Am. Ry. Supts. of Bridges and Buildings. Ills. 3000 w. Engng-Con—Nov. 4, 1908. No. 118.

MATERIALS OF CONSTRUCTION.

Cement Testing.

Report of the Committee on Testing Cement and Cement Products. E. S. Larned. From Pro. Nat. Assn. of Cement Users. On the use of cement blocks, giving standard specifications. 5000 w. Cement—Oct., 1908. No. 115 C.

The Micrographic Examination of Cement (Ueber migrographische Zementuntersuchung). Ernst Stern. Describes the utility of microscopic examination, methods used, etc. Ills. 3000 w. Stahl u Eisen—Oct. 21, 1908. No. 547 D.

Concrete.

Destruction of Concrete by Alkali. William P. Headden. Gives results of experiments. 2500 w. Colo Agri College, Bul. 132—Sept., 1908. No. 651 N.

Reinforced Concrete.

Tests on Reinforced Concrete Beams. E. Brown. Gives results of tests made at McGill University, during 1906-07. Ills. 20000 w. Can Soc of Civ Engrs—Oct. 15, 1908. No. 285 N.

Some Results of Recent Reinforced-Concrete Tests Made by the Firm of Dyckerhoff and Widmann (Einige Ergebnisse neuerer Eisenbeton-Versuche der Firma Dyckerhoff & Widmann A.-G.) W. Luft. Reports tests on beams. Ills. Serial. 1st part. 2200 w. Deutscher Bau—Oct. 14, 1908. No. 559 B.

Steel.

The Growth of the Angle Bar. M'Leod Thomson. Illustrated review of development and progress giving some new patterns thought to embody the most recent ideas. 2500 w. R R Age Gaz—Nov. 6, 1908. No. 127.

Timber Preservation.

A Primer of Wood Preservation. W. F. Sherfesee. Considers decay and how it can be retarded; and preservatives and processes used in the United States. 6000 w. U S Dept of Agri, Circ. 139—Feb. 8, 1908. No. 477 N.

MEASUREMENT.

Range Finders.

The Short-Base Range-Finder and Its Principles of Construction. H. Dennis Taylor. Discusses the principles, and the difficulties, and explains a new form of construction. 2500 w. Engng—Nov. 13, 1908. Serial. 1st part. No. 441 A.

Surveying.

See same title, under MINING AND METALLURGY, MINING.

Testing Laboratories.

The Testing Laboratory of the Bureau

of Sewers, Brooklyn, and Some Tests of Sewer Pipe. Describes the laboratory, its equipment and methods. Ills. 3000 w. Eng Rec—Nov. 21, 1908. No. 416.

MUNICIPAL.

Pavements.

Cement Sidewalks. Discusses materials and methods of construction. Ills. 1600 w. Munic Jour & Engr—Nov. 4, 1908. No. 84.

The Proper Construction of Brick Street Pavements. Will P. Blair. Read before the Am. Soc. of Munic. Imp. Points out the essentials of good brick pavements. 5000 w. Munic Engng—Nov., 1908. No. 345 C.

Refuse Disposal.

City Refuse and Its Disposal. H. deB. Parsons. Brief discussion of methods. 2500 w. Cal Jour of Tech—Oct., 1908. No. 344.

A New Refuse Destructor for West New Brighton, Borough of Richmond. New York City. Gives an official report by J. T. Featherston of a destructor recently put in operation. Ills. 3000 w. Eng News—Nov. 5, 1908. No. 98.

Operating Results of the Buffalo Refuse Utilization Plant. Illustrates and describes a successful plant and its operation. 2000 w. Eng Rec—Nov. 7, 1908. No. 141.

Utilization and Incineration of Household Refuse (Utilization et Incinération des Ordures Ménagères). Emile Burelle. Reviews methods of collection, transportation and utilization or destruction. Ills. 4000 w. Rev. d'Econ Indus—Oct. 16. 1908. No. 507 D.

Tests in Burning Various Kinds of Refuse in the Dörr Destructor (Verbrennungsversuche mit verschiedenen Müllarten im Dörrschen Müllverbrennungsofen). Gives results of tests. 3300 w. Gesundheits-Ing—Oct. 17, 1908. No. 587 D

Roads.

What the World's Roads Congress Deducted. W. F. Bradley. A review of the discussions and opinions advanced. Ills. 2200 w. Automobile—Nov. 5, 1908. No. 116.

Wear and Tear of Roads. W. J. Taylor. Read at Paris Int. Road Cong. Information concerning changes in material and maintenance adopted in England, and the improvements needed. 2500 w. Surveyor—Nov. 13, 1908. No. 424 A.

Effect of Traction Engine and Heavy Motor Traffic Upon Road Foundations. R. J. Thomas. Read at Paris Int. Road Cong. Information based on the examination of various English roads. 3500 w. Surveyor —Nov. 13, 1908. No. 426 A.

The Effect of Modern Traffic on Broken Stone Roads. L. W. Page. Read at Paris Int. Road Cong. Reports a study of this subject, giving results of tests. 2200 w. Surveyor—Nov. 13, 1908. No. 425 A.

The Future Road; Its Wearing Surface. Philip W. Henry. Read before the Int. Road Cong. Mainly a discussion of bituminous cement as a wearing surface. 3500 w. Eng Rec—Oct. 31, 1908. No. 22.

Labor Cost of Constructing Eight Macadam Roads and Data on the Average Labor Cost of Macadam Construction. Information concerning roads built by the Illinois Highway Commission. 4000 w. Engng-Con—Nov. 18, 1908. No. 373.

Modern Road Management. E. Purnell Hooley. Read before the Int. Road Cong. Discusses the construction of roads to meet changed conditions of self-propelled traffic, favoring the tarmac road. 2200 w. Eng Rec—Nov. 7, 1908. No. 140.

Petrolithic Pavement — An Improved Method of Oiled Road Construction. J C. Black. Describes the construction and the required outfit. 2500 w. Cal Jour of Tech—Oct., 1908. No. 341.

Septic Tanks.

Septic Tank Patents. Prof. A. Marston. Gives a brief review of their history and of court decisions. 3500 w. Munic Engng—Nov., 1908. No. 346 C.

Sewage Disposal.

Modern Methods of Sewage Disposal as Applied to Public Institutions. Frank Grove. Prize paper. Briefly considers the methods of treatment by irrigation, by chemical treatment, and biological filtration. Ills. 2200 w. Surveyor—Oct. 23, 1908. No. 64 A.

A New Method of Sewage Purification (Der Emscherbrunnen, ein neues Verfahren der Abwasserreinigung). P. Kurgass. Describes a system adapted to cities of moderate size. Ills. 3300 w. Zeitschr d Ver Deutscher Ing—Oct. 24, 1908. No. 605 D.

Sewage Purification.

Sewage Purification versus Water Filtration. George C. Whipple. Read before the Am. Soc. of Munic. Imp. A discussion of the place and value of each, and the need of both. 2500 w. Eng Rec—Oct. 31, 1908. No. 24.

See also Purification, under WATER SUPPLY.

Sewers.

Reinforced Concrete Intercepting Sewer. Alexander J. Taylor. Illustrates and describes a sewer at Wilmington, Del., explaining the difficulties. 3000 w. Munic Jour & Engr—Nov. 18, 1908. No. 331.

The Water-Works and Sewerage of Monterey, Mex. Illustrated account of the water supply and main drainage works being constructed by Monterey Railway, Light and Power Company. Plate. 1500 w. Engr, Lond—Nov. 6, 1908. Serial. 1st part. No. 327 A.

Street Grading.

The Seattle Regrade, with Particular Reference to the Jackson St. Section Louis P. Zimmerman. An illustrated description of the extensive re-grading and leveling of the hilly streets and adjacent property. 2200 w. Eng News—Nov. 12, 1908. No. 230.

WATER SUPPLY.

Analysis.

The Mineral Analysis of Water for Industrial Purposes and Its Interpretation by the Engineer. Herman Stabler. Presents simple calculations and formulae of assistance in classifying waters for industrial purposes. 5000 w. Eng News—Oct. 1, 1908. No. 211.

Conduits.

The Dulzura Conduit of the Southern California Mountain Water Co.; Extension of San Diego Water Supply. M. M. O'Shaughnessy. Illustrated description of the construction of a 13-mile open conduit, in connection with the water supply work for San Diego. 3000 w. Eng News—Nov. 26, 1908. No. 638.

Design of Conduits of Variable Diameter on the Basis of Maximum Economy of Material (Calcolo delle Condotte d'Acqua a Diametri Variabili in Base al Criterio della Massima Economia di Materiale). Mario Dornig. Mathematical and theoretical. Ills. 3000 w. Ann d Soc d Ing e d Arch Ital—Sept. 15, 1908. No. 540 F.

Dams.

The Closure of the Charles River Dam. Edward C. Sherman. An illustrated account of the dropping of the gates of the "shut-off" dam at Boston. 900 w. Eng News—Nov. 5, 1908. No. 102.

Construction of the Pathfinder Dam, North Platte Project, United States Reclamation Service. E. H. Baldwin. Illustrates and describes the construction of this masonry dam of the modified arch type. 2500 w. Eng Rec—Nov. 7, 1908. No. 136.

The Movable Dams and Lock at the Power Plant on the Chicago Drainage Canal. Plan and illustrated description of the locks and dams for controlling water flow and passing navigation at the Lockport, Ill., power plant. 3000 w. Eng News—Nov. 12, 1908. No. 231.

The Strength of Masonry Dams (Der Spannungszustand einer Staumauer). O. Mohr. Mathematical and theoretical. Ills. Serial. 1st part. 2700 w. Zeitschr d Oest Ing u Arch Ver—Oct. 2, 1908. No. 579 D.

Diversion Damages.

The Adjustment of Diversion Damages by Storage Compensation. Robert E. Horton. Describes English practice, discussing the difficulty of employing it in the United States. 7000 w. Jour N Eng W-Wks Assn—Sept., 1908. No. 665 F.

Filtration.

Cincinnati's Water Filtration Plant. Illustrated description of the plant that gives the city a pure, clean, water supply. 2500 w. Munic Jour & Engr—Nov 4, 1908. No. 83.

The Torresdale Preliminary Filters of the Philadelphia Water Supply. Illustrates and describes mechanical filters for removing suspended particles without the use of a coagulant. 4500 w. Eng Rec—Nov. 14, 1908. No. 248.

See Sewage Purification, under MUNICIPAL; and Philadelphia, under WATER SUPPLY.

Fire Protection.

Calcium Chloride as a Preventative of Freezing in Automatic Sprinkler Systems. Rutger B. Green. Reports the successful use of this substitute for compressed air. 800 w. Eng News—Nov. 19, 1908. No. 376.

Fire Extinguisher Installation in the Milton Car House of the Boston Elevated Railway Company. Illustrated description of a system containing about 2400 sprinkler heads. 1200 w. Elec Ry Jour—Nov. 7, 1908. No. 109.

Insurance Rates and the Water Service. Frank A. Barbour. Describes improvements in supply for fire service that led to reduction in insurance rates. Discussion. 4500 w. Jour N Eng W-Wks Assn—Sept., 1908. No. 665 F.

Ground Waters.

The Indirect Determination of the Capacity of a Spring (Determinazione Indiretta della Portata di una Sorgente). Carlo Fossa-Mancini. Illustrated mathematical description of method. 4500 w. Ann d Soc d Ing e d Arch Ital—Oct. 1, 1908. No. 541 F.

Notes on the Hygienic Aspect of the Breslau Ground Water Supplies (Gedanken über die Sanierung der Breslauer Grundwassergewinnungsanlagen). Dr. Lübrig. Discusses the quality of the water supply, purification methods, etc. Serial. 1st part. 8800 w. Gesundheits-Ing—Oct. 3, 1908. No. 586 D.

Irrigation.

Irrigation in South-Eastern Australia. Describes the conditions and the scheme of water regulation. 2500 w. Engr, Lond—Nov. 13, 1908. No. 449 A.

National Irrigation and Flood Control. Arthur P. Davis. Outlines the work of the Reclamation Service, discussing results thus far. 1200 w. Eng Rec—Nov. 14, 1908. No. 254.

London.

Private Water Supply in London. Explains present conditions and the excessive charges for water, and the ease of obtaining an artesian supply. Ills. 2000 w. Engng—Nov. 13, 1908. No. 443 A.

Meters.

Meters and Water Consumption of the Hartford Water Works. Ermon M. Peck. An account of the metering of the service pipes and the results. 1800 w. Jour N Eng W-Wks Assn—Sept., 1908. No. 662 F.

Philadelphia.

The Water Supply of Philadelphia, with Special Reference to the Filtration Works Now Under Construction. John C. Trautwine, Jr. Describes conditions before the works were begun, discussing the plan adopted. 8000 w. Jour Fr Inst—Nov., 1908. No. 350 D.

Pipe.

Modern Welded Pipe for Water and Gas. F. N. Speller. Read before the Am. Gas Inst. Discusses the comparative value of wrought iron and steel pipe. 2800 w. Eng News—Nov. 5, 1908. No. 101.

Pipe Corrosion.

Electrolysis of Water Mains in Newark, N. J. From the report of William E. Foss, appointed to investigate the conditions. 2000 w. Eng Rec—Nov. 14, 1908 No. 251.

Pipe Joints.

Rubber Pipe Joints. Robert Spurr Weston. Describes this process, giving information regarding the method. Discussion. 3500 w. Jour N Eng W-Wks Assn—Sept., 1908. No. 664 F.

Pipe Lines.

The Sub-Aqueous Pipe and Electric Cable Way at Gloucester, Mass. Herman W. Spooner. Explains the conditions and gives an illustrated detailed description of the engineering work. 6300 w. Jour N Eng W-Wks Assn—Sept., 1908. No. 661 F.

Purification.

Importance of the Proper Operation of Water and Sewage Purification Plants. George W. Fuller. Read before the Am. Soc. for Munic. Imp. Outlines features of operation necessary to secure efficiency. 3500 w. Eng Rec—Oct. 31, 1908. No. 26.

Rates.

Meter Rates. Walter H. Richards. Discusses the calculation of meter rates. General discussion. 8000 w. Jour N Eng W-Wks Assn—Sept., 1908. No. 663 F.

San Francisco.

The Water Supply of San Francisco, Cal. C. E. Grunsky. Explains the problems, describing the works now in use and the proposed Tuolumne River project. Maps. 24000 w. Jour Assn of Engng Socs—Sept., 1908. No. 352 C.

Water Works.

Water-Works Valuation and Fair Rates, in the Light of the Maine Supreme Court. Decisions in the Waterville and Brunswick Cases. Leonard Metcalf. 25000 w. Pro Am Soc of Civ Engrs—Oct., 1908. No. 489 E.

Some Common Mistakes in the Construction and Maintenance of Water Systems. W. G. Yorston. Read before the Nova Scotia Soc. of Engrs. Discusses briefly the different parts of a water system, calling attention to mistakes in construction. 5000 w. Can Engr—Nov. 6, 1908. No. 154.

See also Accounting, under INDUSTRIAL ECONOMY.

Weirs.

The Design of Canal Diversion Weirs on a Sand Foundation. W. G. Bligh. Shows the means adopted to insure the safety of such structures. 5500 w. Can Engr—Oct. 30, 1908. No. 1.

WATERWAYS AND HARBORS.

Canals.

The Marne-Saône Canal (Le Canal de la Marne à la Saône). O. Jacquinot. The first part describes its position as a part of the French system of inland waterways, discusses its history and begins a description of the canal works. Ills. Serial. 1st part. 4500 w. Génie Civil—Oct. 10, 1908. No. 534 D.

Repair of the Chazilly Conduit of the Bourgogne Canal with Reinforced Concrete (Sur la Réfection de la Rigole de Chazilly du Canal de Bourgogne au Moyen de Chapes en Béton Armé). M. Hégly. Illustrated description of a reinforced-concrete lining applied to a trench supplying water to the Chazilly reservoir. 3000 w. Ann d Ponts et Chaussées—1908-III. No. 503 E + F.

Dredges.

See same title, under MARINE AND NAVAL ENGINEERING.

Dredging.

Methods and Costs of Dredging the St. Lawrence River. Describes the work and the outfit used, the methods of dredging, and gives itemized cost. 5000 w. Engng-Con—Nov. 4, 1908. No. 241.

Dry Docks.

See same title, under ELECTRICAL ENGINEERING, Power Applications.

Estuary Channels.

Estuary Channels and Their Treatment. Brysson Cunningham. Describes the adequate maintenance of these approach channels to meet the requirements of modern commerce. Ills. 4500 w. Engng—Oct. 30, 1908. Serial. 1st part. No. 189 A.

Ferry Houses.

The Municipal Ferry House Substructure, New York. Illustrates and describes the fireproof steel structure at Battery Park which is to accommodate all the municipal ferries located at this point. 4000 w. Eng Rec—Nov. 7, 1908. No. 143.

Flood Prevention.

See Irrigation, under Water Supply.

Flood Protection.

Flood Protection in Grand Rapids, Mich. An account of the extensive scheme for protection from floods in the Grand River. Ills. 5000 w. Eng Rec—Oct. 31, 1908. No. 25.

Floods.

The Floods of the Mississippi Delta: Their Causes, and Suggestions as to Their Control. William D. Pickett. 7800 w. Pro Am Soc of Civ Engrs—Nov., 1908. No. 647 E.

France.

France's Investment in Marine Transport Facilities, Harbors and Canals (Mise au Point de notre Outillage Maritime—Ports et Canaux). M. G. Hersent. An exhaustive discussion of marine and inland water transport in its relation to French industry. Ills. 28000 w. Bul Soc d'Encour—Oct., 1908. No. 518 G.

Great Lakes.

The Low Stage of Lakes Huron and Michigan. C. E. Grunsky. A study of the effect of water storage in Lake Superior upon the water elevation in Lakes Huron and Michigan, and a discussion of the causes of the low stages. 5500 w. Pro Am Soc of Civ Engrs—Oct., 1908. No. 487 E.

Lighthouses.

The Guiding Lights of Our Coasts. C. H. Claudy. Gives a diagram showing the relative intensities of lights of different orders and different characters, with other information regarding lamps and lighthouses. Ills. 1000 w. Sci Am—Nov. 28, 1908. No. 473.

An Open-Sea Ferro-Concrete Lighthouse. Illustrated description of a recently completed structure in the Straits of Malacca, and of the methods and difficulties of construction. 1000 w. Prac Engr—Nov. 6, 1908. No. 303A.

Locks.

See Dams, under WATER SUPPLY.

Ohio River.

The Proposed Reservoir System in the Ohio River Basin. M. O. Leighton. A reply to an article by Major H. C. Newcomer. 7000 w. Eng News—Nov. 5, 1908. No. 103.

The Improvement of the Ohio River. William L. Sibert. A review of the various engineering projects proposed for the improvement of this river. Ills. 13000 w. Pro Am Soc of Civ Engrs—Oct., 1908. No. 490 E.

Piers.

Reinforced-Concrete Piers in Baltimore Harbor. Illustrates and describes the type of construction used. 1000 w. Eng News—Oct. 1, 1908. No. 212.

River Regulation.

Forests and Reservoirs in Their Relation to Stream Flow with Particular Reference to Navigable Rivers. Discussion of the paper by H. M. Chittenden. 7500 w. Pro Am Soc of Civ Engrs—Nov., 1908. No. 650 E.

The Report of the Pennsylvania Water Supply Commission: Forests, Stream Flow, and Flood Control. Reviews points of special interest in the report relating to the three subjects referred to above. 1800 w. Eng News—Nov. 19, 1908. No. 377.

See also Ohio River, under WATERWAYS AND HARBORS.

Saint Nazaire.

The New Approach and New Harbor Works at the Port of Saint Nazaire (La nouvelle Entrée et les Travaux de Transformation du Port de Saint-Nazaire). M. Mallat. Describes recently completed works begun in 1896 to make this harbor on the west coast of France capable of accommodating the largest merchant and naval vessels. Ills. 2500 w. Ann d Ponts et Chaussées—1908, III. No. 501 E + F.

Water Powers.

The Use and Conservation of Water Power Resources. H. von Schon. This third and closing article of a series analyzes typical cases and suggests programmes for their development. 4000 w. Engineering Magazine—Dec., 1908. No. 674 B.

The Conservation of the Forests and Water Powers of Wisconsin. E. M. Griffith. An account of the work in progress and in prospect and its objects. Ills. Discussion. 6000 w. Jour W Soc of Engrs—Oct., 1908. No. 356 D.

The Water Powers of Sweden, Norway and Switzerland (Die Wasserkräfte Schwedens, Norwegens und der Schweiz). Eduard Engelmann. Gives detailed information of the hydraulic power available in these three countries and of present developments. Ills. Serial. 1st part. 4700 w. Zeitschr d Oest Ing u Arch Ver—Oct. 16, 1908. No. 581 D.

MISCELLANY.

Building Removal.

Note on the Work of Raising and Moving the Antwerp-Dam Station Building. Albert Morglia. Illustrated detailed description. 5800 w. Bul Int Ry Cong—Oct., 1908. No. 167 G.

Raising and Moving the Antwerp Station (Notes sur le Rehaussement et le Déplacement de la Station: Anvers-Dam). P. Deprez. Illustrated description of the work. 3000 w. All Indus—Oct., 1908. No. 526 D.

Contracts.

Loose Specifications and Dishonest Contracts. Editorial criticism of the framing of certain contracts. 1200 w. Eng News—Oct. 1, 1908. No. 213.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cables.

See Submarine Cables, and Telephone Cables, under COMMUNICATION.

Radio-Telegraphy.

Post-Graduate Lectures on Radio-telegraphy and Radiotelephony. Prof. J. A. Fleming Abstract of lectures being given at the University College, London. 1500 w. Engng—Oct. 30, 1908. Serial, 1st part. No. 191 A.

Recent Patents in Wireless Telegraphy and Telephony. W. H. Eccles. Considers recent patent specifications that deal with apparatus of importance or interest. Diagrams. 2000 w. Elect'n, London—Nov. 6, 1908. Serial, 1st part. No. 311 A.

The Artom System of Radiotelegraphy. From a paper by Prof. Alessandro Artom before the Italian Elec. Assn. Brief description of this system. Ills. 1800 w. Elec Rev, N Y—Nov. 28, 1908. No. 620.

The Actual State of Wireless Telegraphy (L'Etat Actuel de la Télégraphie sans Fil). The first part discusses the general theory and principles. Ills. Serial, 1st part. 2500 w. Génie Civil—Oct. 17, 1908. No. 535 D.

See also Hertzian Waves, under ELECTRO-PHYSICS.

Radio-Telephony.

See Radio-Telegraphy, under COMMUNICATION.

Submarine Cables.

Injury to Submarine Cables by Steam Trawlers. Report of the Inter-Departmental Committee appointed to inquire into the injury caused by trawlers, and to suggest means of preventing such injury. 3800 w. Elect'n, London—Oct. 23, 1908 No. 74 A.

Telautograph.

A New Form of Telautograph. Dr. Robert Grimshaw. Illustrated description of Grazanna's apparatus and its action. 800 w. Sci Am—Nov. 21, 1908. No. 332.

Telegraph Offices.

The Reconstruction of the Vienna Central Telegraph Office (Der Umbau der Wiener Telegraphenzentrale). J. Jokisch. Detailed description of the new building. Ills. 6500 w. Oest Wochenschr f d Oeffent Baudienst—Oct. 10, 1908. No. 577 D.

Telegraphy.

Diplex-Duplex Realisable by Means of Ordinary Instruments and Without Balance (Diplex-Duplex réalisable au Moyen des Appareils ordinaires et sans Balance). M. Henry. Illustrated description of method. 3500 w. Soc Belge d'Elecns—Oct. 1908. No. 510 E.

Telephone Cables.

Telephone Cables with Iron Wire Covering (Beitrag zur Berechnung von Fernsprechkabeln mit Eisendrahtumspinnung). Absalon Larsen. A mathematical discussion of the design of cables with increased inductance. Ills. 5000 w. Elektrotech Zeitschr—Oct. 22, 1908. No. 614 B.

Telephony.

The Development of Telephony. Sergius P. Grace. An illustrated review with discussion. 7400 w. Pro Engr's Soc of W Penn—Oct., 1908. No. 348 D.

The Condenser in Telephony. G. M. B. Shepherd. A short description of their use and applications in this field. 2200 w. Elec Engng—Nov. 5, 1908. No. 308 A.

The Central Battery System and its Application to Paris (Le Système Téléphonique à Batterie Centrale; son Application à Paris). Eugène H. Weiss. Illustrated description of the system, the conditions in Paris and proposals for their improvement. 4500 w. Génie Civil—Oct. 3, 1908. No. 532 D.

The Arrangement of Party Lines in Austrian Telephone Practice (Die Einrichtung der Gesellschaftsanschlüsse im österreichischen Telephonbetriebe). Karl Fuchs. Serial, 1st part. 3300 w. Elektrotech u Maschinenbau—Oct. 18, 1908. No. 595 D.

DISTRIBUTION.

Autotransformers.

The Autotransformer. R. H. Fenkhausen. Describes types and their applications. Ills. 1000 w. Power—Nov. 17, 1908. No. 292.

Industrial Plants.

Electrical Distribution Systems for Industrial Plants. Warren H. Miller. Why 440 volts is the preferred layout, with suggestions for its installation. 4000 w. Elec Wld—Nov. 7, 1908. No. 95.

Switchboards.

See same title, under GENERATING STATIONS.

DYNAMOS AND MOTORS.

A. C. Motors.

See Railway Motors, under DYNAMOS AND MOTORS.

A. C. Turbo-Generators.

Practical Considerations in the Selection of Turbo-Alternators. M. Kloss. Abstract of paper before the Manchester Loc. Sec. of Inst. of Elec. Engrs. Deals with ventilation, voltage regulation and power factor. 2500 w. Elect'n, London—Nov. 6, 1908. No. 315 A.

We supply copies of these articles See page 747.

Design.

Calculation of Wire for Shunt Field Circuit. A. M. Bennett. Gives chart for finding the nearest proper size of wire for a given m. m. f. in ampere-turns, shunt field voltage and number of poles. 900 w. Elec Wld—Nov. 14, 1908. No. 227.

Failures.

Typical Electric Motor Failures. Discusses a number of recent failures and ways of avoiding them. 2200 w. Elec Wld—Nov. 7, 1908. No. 96.

Railway Motors.

Alternating-Current Commutator Motors as Applied to Traction Work. M. Ostros. Abstract translation from *Elektrotechnische Zeit.* A report of an investigation of types. 1800 w. Elect'n, London—Oct. 23, 1908. Serial, 1st part. No. 73 A.

ELECTRO-CHEMISTRY.

Corrosion.

Rust. M. Thornton Murray. Read before the Staffordshire Iron & Steel Inst. Discusses theories of rust formation, influence of composition, protective measures, non-metallic rust preventives, etc. 5000 w. Ir & Coal Trds Rev—Nov. 13, 1908. No. 456 A.

Theory of Electrolytic Corrosion. A. F. Ganz. Explains the theory of electrolysis, and the way stray currents from electric railways cause electrolytic corrosion. 2500 w. Sib Jour of Engng—Oct., 1908. No. 353 C.

The Corrosion and Decay of Metals. J. T. Milton. Lecture at the Franco-British Ex. to the Inst. of Marine Engrs. Briefly considers the causes and the methods of protection, etc., showing that electric currents may be made to protect as well as to corrode. 3000 w. Mech Engr—Oct. 30, 1908. Serial, 1st part. No. 181 A.

The Attack of Iron by Water and Aqueous Solutions (Ueber den Angriff des Eisens durch Wasser und wässerige Lösungen). E. Heyn and O. Bauer. A report from the Imperial German Testing Station. Ills. 6000 w. Stahl u Eisen—Oct. 28, 1908. No. 548 D.

ELECTRO-PHYSICS.

Alternating Currents.

Non-Harmonic Alternating Currents. Dr. Benjamin F. Bailey. Calls attention to features of complex harmonic e. m. f. s. and currents. 2000 w. Elec Wld—Nov. 28, 1908. No. 634.

Hertzian Waves.

Hertz's Investigations on Electrical Waves (Ueber die Hertzschen Versuche mit elektrischen Wellen). L. Zehnder. Discusses the investigations and the theoretical and practical value of the results. Ills. 5000 w. Elektrotech Zeitschr—Oct. 15, 1908. No. 612 B.

History.

The History of Electrical Theories. P. Gruner. Abstract translation of a paper read before the Keplerbund at Frankfort. Traces the changes which discovery has wrought. 2000 w. Sci Am Sup—Nov. 28, 1908. No. 474.

GENERATING STATIONS.

Accumulators.

Storage Batteries. W. B. Kouwenhoven. Suggestions for their care and operation. Ills. 2000 w. Ry & Loc Engng—Nov., 1908. No. 10 C.

Researches on a Light Accumulator (Recherches sur un Accumulateur léger). Robert Goldschmidt. Describes researches on a zinc-potassium carbonate-nickel oxide cell. 4500 w. Soc Belge d'Elecns—Oct., 1908. No. 508 E.

Austria.

Details of Austrian Electrical Plants Built or Extended in 1906 and 1907 (Statistik der österreichischen Elektrizitätswerke welche im Jahre 1906 und 1907 erbaut und erweitert wurden). Tables. 4000 w. Elektrotech u Maschinenbau—Oct. 25, 1908. No. 596 D.

Central Stations.

Recent Central Station Developments at Hartford, Conn. Describes the plants and their equipment, discussing recent improvements. Ills. 3000 w. Elec Wld—Nov. 28, 1908. No. 633.

Producer Gas-Engine Central Station Plant. Illustrates and describes features of interest in the system at Keene, N. H. 2500 w. Elec Wld—Nov. 14, 1908. No. 225.

The Liège Power Station at Sclessin (La Centrale Electrique du Pays de Liège, à Sclessin). J. Izart. A 6,000 kw station driven by Parsons turbines. Ills. Serial, 1st part. 4000 w. L'Elecn—Oct. 3, 1908. No. 528 D.

Electric Light and Power Plants in Connection with the Altoona Power Station and the Ohlsdorf Stations and Shops (Elektrische Licht- und Kraftanlagen im Anschluss an das Kraftwerk Altona und der Betriebs- und Werkstätten-Bahnhof Ohlsdorf). H. v. Glinski. Illustrated detailed description. Serial, 1st part. 2500 w. Glasers Ann—Oct. 15, 1908. No. 585 D.

Cost.

The Progress of Electrical Design in Relation to the Reduction of Capital Cost. Miles Walker. Abstract of presidential address before the Manchester Local Section of the Inst. of Elec. Engrs. 2200 w. Elec. Engr, London—Nov. 13, 1908. No. 433 A.

Economics.

Isolated Power Plant Costs and Their Relation to Central Station Service. W. F. Lloyd. An analysis of costs and discussion of rates. 2500 w. Elec Wld—Nov. 28, 1908. No. 635.

Hydro-Electric.

Hydro-Electric Plant in British Columbia. Illustrated description of the West Kootenay power scheme, with description of the region. 5500 w. Engr, Lond—Nov. 6, 1908. No. 326 A.

The Hydro-Electric Plant of the Uncas Power Company at Scotland, Conn. Illustrated description of a power development on the Shetucket River; the power to be transmitted to Norwich, 11 miles distant. 4500 w. Eng Rec. Nov. 21, 1908. No. 411.

Hydro-Electric Power Plant on the Piabanha River, Brazil. Illustrated description of one of the largest hydro-electric stations in South America. 1800 w. Elec Wld—Nov. 14, 1908. No. 224.

German 50000-Volt Transmission System. Illustrated description of a new municipal hydro-electric plant recently completed for the city of Munich. 3500 w. Elec Wld—Nov. 28, 1908. No. 632.

The Augst Water-Power Plant near Basel (Wasserkraftanlage Augst bei Basel). Josef Rosshändler. Illustrated description of this 30,000 horse power plant. 2500 w. Zeitschr d Oest Ing u Arch Ver—Oct. 9, 1908. No. 580 D.

Hydro-Electric Plants on the Kerka River in Dalmatia (Hydroelektrische Anlagen am Kerkaflusse in Dalmatien). Hugo Tenzer. Illustrated description of several plants. Serial, 1st part. 1600 w. Elektrotech u Maschinenbau—Oct. 4, 1908. No. 593 D.

See also Water Powers, under CIVIL ENGINEERING, WATERWAYS AND HARBORS.

Isolated Plants.

Electric Power Plant of the Missouri State Penitentiary. Illustrated description of a plant practically operated by convict labor. 1700 w. Elec Rev, N Y—Nov. 14, 1908. No. 276.

Switchboards.

Switchboard Notes. S. Q. Hayes. Considers features in connection with projects requiring distant control, etc. 3000 w. Elec Age—Oct., 1908. No. 48.

See also Instruments, under MEASUREMENT; and Electric Power, under MINING AND METALLURGY, MINING.

Switch Gear.

The Reyrolle Ironclad Switch-Gear. Illustrates and describes a type of high-tension switch-gear consisting of separate ironclad units, hand-operated. 3000 w. Engng—Nov. 6, 1908. No. 323 A.

United Kingdom.

The Electric Power Companies of the United Kingdom and Their Prospects. G. L. Addenbrooke. A review of progress. 2200 w. Elec Rev, Lond—Oct. 23, 1908. No. 72 A.

LIGHTING.

Illumination.

The Absorption-of-Light Method of Calculating Illumination. A. S. McAllister. Outlines the method. 1000 w. Elec Wld—Nov. 21, 1908. No. 340.

Incandescent Lamps.

A German View of the Future of the Metal-Filament Lamps. A summary of their position as compared with rivals, as given by H. Remané in the E. T. Z. 700 w. Elec Rev, Lond—Oct. 30, 1908. No. 184 A.

Mercury-Vapor Lamps.

The Küch Quartz Mercury Vapor Lamp. O. Bechstein. Illustrated description of a lamp substituting quartz for glass. 1000 w. Sci Am Sup—Nov. 28, 1908. No. 476.

A New Carbon-Filament Mercury Vapor Lamp (Eine neue Kohlenfaden-Quecksilberlampe). Robert Hopfelt. Illustrated description and photometric curves. 3000 w. Elektrotech Zeitschr—Oct. 8, 1908. No. 609 B.

Progress.

Progress in Electric Lighting. Gives details of the newer metallic filament lamps and their use for street lighting, a résumé of arc lamp development, and interesting fittings for both. Ills. 10000 w. Elect'n, Lond—Nov. 13, 1908. No. 437 A.

Recent Progress in Electric Lighting (Les Récents Progrès dans le Domaine de L'Eclairage Electrique). M. L. Flesch. A general review. Ills. Serial, 1st part. 3000 w. L'Elecn—Oct. 24, 1908. No. 530 D.

Street.

Illumination of Seventh Avenue, Manhattan Borough, New York City. Illustrates and describes the installation chosen after many tests; arc lamps being considered as best meeting the conditions. 1400 w. Elec Wld—Nov. 7, 1908. No. 94.

Theatres.

Regulators for Stage Lighting (Bühnenregulatoren). V. Paetow. Illustrated description of various types of dimmers. 5000 w. Elektrotech Zeitschr—Oct. 22, 1908. No. 613 B.

POWER APPLICATIONS.

Dry Docks.

Electricity Applied to a Tyneside Dry Dock. Illustrated description of an up-to-date example of electrical equipment in shipyard work. 2500 w. Elec Rev, Lond—Oct. 23, 1908. No. 71 A.

Machine Tools.

See Electrical Driving, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

Printing Presses.

Two-Motor-Drive Web Printing Press, Manual Control. S. H. Sharpsteen. Discusses the essentials of web-press equipment. 3000 w Elec Rev, N Y—Nov. 7, 1908. No. 156.

Progress.

Recent Progress in the Applications of Electricity (Le Mouvement Récent des Grandes Applications de l'Electricite). Maurice Levy. Reviews progress in methods of transmission and utilization of electrical energy. 3500 w. Rev Gen d Sci—Oct. 15, 1908. No. 522 D.

Regulations

Police Regulations Governing the Installation, Operation and Supervision of Electrical Plants (Polizeiverordnung betreffend Einrichtung, Betrieb und Ueberwachung elektrischer Starkstromanlagen). Proposed by representatives of the German Assn. of Elec. Engrs. as alternative to the regulations of the Prussian Department of Commerce. Ills. 5000 w. Elektrotech Zeitschr—Oct. 15, 1908. No. 611 B.

Rolling Mills.

Electrically-Driven Brass and Copper Rolling Mills. C. A. Ablett. Abstract of paper read before the Birmingham Assn, of Mech. Engrs. An account of methods of driving such mills, describing a typical installation. 4500 w. Ir & Coal Trds Rev—Nov. 13, 1908. No. 459 A.

See also same title, under MINING AND METALLURGY, IRON AND STEEL.

Textile Mills.

Electrical Driving in Cotton Mills. W. H. Booth. An investigation of some of the misconceptions in respect to turning moments. 2500 w. Elec Rev, Lond—Nov. 13, 1908. Serial, 1st part. No. 435 A.

MEASUREMENT.

Barometer.

An Electrical Barometer (Un Baromètre électrique). Robert Goldschmidt. Illustrated description. Ills. 1500 w. Soc Belge d'Elecns—Oct., 1908. No. 509 E.

Dynamo Testing.

The Testing of Alternators. S. P. Smith. Abstract of a paper before the Birmingham Loc. Sec. of the Inst. of Elec. Engrs. Shows the incorrectness of existing methods and explains an accurate method. 2200 w. Elect'n, Lond—Nov. 13, 1908. No. 436 A.

The Influence of Shaft Twist on the Measurement of Irregularity Factors. Mathematical explanation given by Moritz Kroll, in *Elektrotechnik und Maschinenbau*. 1000 w. Elec Engr, Lond—Nov 6, 1908. No. 309 A.

Hysteresis.

Experimental Determination of the Hysteretic Exponent. Nicholas Stahl. Shows how the hysteretic exponent may be evaluated. 500 w. Elec Wld—Nov. 21, 1908. No. 339.

Instruments.

Three-Phase Switchboard Instruments. E. P. Peck. Discusses the instruments necessary for showing the important factors. 2000 w. Elec Wld—Nov. 14, 1908. No. 228.

Measurements with Portable Instruments. F. P. Cox. Comments on conditions that influence such measurements, causes of error, accuracy, etc. 4000 w. Elec Age—Oct., 1908. No. 49.

Iron Losses.

A Method of Measuring Iron Losses in Bundles of Straight Strips. Robert Beattie. Describes experiments made to determine whether the wattmeter method proposed would work with short specimens. 3000 w. Elect'n, Lond—Nov. 6, 1908. No. 314 A.

Resistance.

The Construction and Measurement of High Resistance. Howard L. Bronson. Condensation of paper presented before the Am. Elec. Chem. Soc. Reports a study of this problem, and the difficulties. 2500 w. Elec Rev, N Y—Nov. 14, 1908. No. 277.

Speed.

The Development of Electrical Speed-Measuring Instruments (Die Entwicklung der elektrischen Fahrgeschwindigkeitsmessung). Paul Bautze. Illustrated description of types for railroads and automobiles. 5500 w. Elektrotech Zeitschr—Oct. 15, 1908. No. 610 B.

Transformer Testing.

Some Practical Notes on Transformer Testing. E. M. Wood. Notes based on experience of various methods. 2,000 w. Can Elec News—Nov., 1908. No. 223.

Units.

The Mercury Ohm. Shows the needless complications introduced by the present definition of the ohm, suggesting the amendment. 1500 w. Prac Engr—Nov. 6, 1908. No. 302 A.

TRANSMISSION.

Conduits.

Pipe Lines, under CIVIL ENGINEERING, WATER SUPPLY.

Fault Location.

Practical Fault Localizing on Electric Supply Networks. E. P. Austin. A short account of fault localization on a system without a cable-testing outfit. 800 w. Elec Rev, Lond—Nov. 13, 1908. No. 434 A.

Lightning Arresters.

Methods of Guarding Against Lightning. W. T. Ryan. Describes four types of arrester. 1200 w. Power—Nov. 17, 1908. No. 293.

Methods of Guarding Against Lightning. W. T. Ryan. Illustrates and describes different types of lightning arresters, discussing the essential features. 1500 w. Power—Nov. 10, 1908. No. 163.

Line Construction.

Overhead Construction. H. B. Gear and P. F. Williams. Discusses distributing line work and accessories. Ills. 5800 w. Elec Age—Oct., 1908. No. 47.

Protective Relays.

A New System of Sub-Station Relays for Incoming Transmission Lines. Paul MacGahan. Brief description of devices previously used, with reasons for their failure to give complete protection, with description of the latest device for this purpose. 2500 w. Elec Jour—Nov., 1908. No. 209.

Substations.

Apparatus for Direct-Current Substation. E. W. Allen. Abstract of paper read before the Assn. of Edison Ill. Co. Concerning the advantages and disadvantages of the different machines used. 2200 w. Elec Wld—Nov. 14, 1908. No. 229.

Transformers.

Characteristics and Uses of Transformers. R. H. Fenkhausen. Considers their selection and care, how to connect them up, etc. Ills. 1500 w. Power—Nov. 3, 1908. No. 41.

The Parallel Operation of Transformers. J. Murray Weed. A study of the distribution of current, losses, and action. 3500 w. Elec Wld—Nov. 21, 1908. No. 337.

Parallel Operation of Stationary Transformers. H. Bewlay. Gives a method of calculating the loading of each transformer and an investigation of the probable errors. 800 w. Elec Wld—Nov. 21, 1908. No. 338.

Interconnections of Transformers in Four-Wire Three-Phase Systems. K. Faye-Hansen. Diagrams of connections, with explanatory notes. 1000 w. Elec Wld—Nov. 28, 1908. No. 636.

The Distribution and Conduction of Heat in an Annular Plate (Ueber die Verteilung und Leitung der Wärme in einer kreisringförmigen Platte). Karl Kohler. Refers principally to methods of improving the temperature conditions of transformers. Ills. 3200 w. Elektrotech u Maschinenbau—Oct. 18, 1908. No. 594 D.

See also Transformer Testing, under MEASUREMENT.

Voltage Regulation.

Alternating-Current Feeder Regulators. W. S. Moody. Considers types of regulators and their control. Ills. Discussion. 5500 w. Pro Am Inst of Elec Engrs—Nov., 1908. No. 667 D.

MISCELLANY.

Exhibitions.

Electrical Exhibition at Manchester, England. Sidney Ransom. A general survey, with illustrations. 1200 w. Elec Wld—Nov. 14, 1908. No. 226.

INDUSTRIAL ECONOMY

Accounting.

The Accounting of Industrial Enterprises. William M. Lybrand. Discusses pools, trusts, holding companies, advantages of combination, evils of monopoly, etc. 3000 w. Jour of Acc—Nov., 1908. Serial, 1st part. No. 478 C.

Establishment Expenses and Their Relation to Cost Accounts. Henry Spencer. An examination and comparison of alternative general practices. 2000 w. Engr, Lond—Nov. 13, 1908. Serial, 1st part. No. 451 A.

The Office, Accounting and Cost-Keeping System; Department of Greater Water Supply, Peoples Water Company, Oakland, Cal. Langdon Pearse. Explains the system used and the conditions. 4000 w. Eng Rec—Nov. 14, 1908. No. 253.

Foundry Accounting Methods. John Doughton. Read before the Phila. Found. Assn. Discusses the proper handling of customers' orders. 3000 w. Ir Age—Nov. 12, 1908. No. 217.

A Model Foundry Accounting System. R. W. McDowell. Explains method of recording orders, billing, and charging. 1800 w. Foundry—Nov., 1908. No. 55.

Apprenticeship.

Apprenticeship Training. The report of C. W. Cross to the Master Mechanics' Assn. on the progress made in the apprenticeship systems for railroad shops. 3000 w. Boiler Maker—Nov., 1908. No. 13.

Practical Results from a Modern Apprenticeship System. C. W. Cross. Concerning results obtained from the apprenticeship system of the New York Central lines. Also discussion. 6500 w. Pro Ry Club of Pittsburgh—Sept. 25, 1908. No. 204 C.

Cost Systems.

Systematic Foundry Operation and Foundry Costing. C. E. Knoeppel. This third article of a series enumerates and classifies the elements entering into production costs. 5000 w. Engineering Magazine—Dec., 1908. No. 677 B.

Depreciation.

Repairs, Renewals, Deterioration and Depreciation of Workshop Plant and Machinery. James Edward Darbishire. Suggestions for a system which shall provide for proper upkeep and replacement. 3300 w Inst of Mech Engrs—Oct. 16, 1908. No. 18 N.

Education.

The Training of Engineers. Inaugural address of Prof. Charles Frewen Jenkin, delivered at Oxford Univ. 5000 w. Mech Engr—Nov. 13, 1908. No. 431 A.

The Education of a Marine Engineer. W. E. Dalby. Reviews marine educational systems, particularly in England. 3000 w. Cassier's Mag—Nov., 1908. (Special No.) No. 389 D.

The Relative Positions of Manual Training, Trade Training and Technical Education. Brief discussion of the work of each and their relation to each other. 2000 w. Am Mach—Vol. 31, No. 46. No. 221.

Technical and University Education (L'Enseignement technique dans ses Rapports avec l'Enseignement universitaire). Henry Le Chatelier. Reviews conditions in France. 3000 w. Rev de Métal—Oct., 1908. No. 517 E + F.

Eight-Hour Day.

The Eight-Hour Day and Sunday Rest in Mining (Zur Enquete über den Achtstundentag und die Sonntagsruhe beim Bergbau). Heinrich Reif. A German view of the question. Serial, 1st part. 1800 w. Oest Zeitschr f Berg- u Hüttenwesen—Oct. 10, 1908. No. 550 D.

Engineers.

The Engineer as a Cultured Specialist. Alex. C. Humphreys. Address delivered at the inauguration of President Sparks, of Penn. State College. 3500 w. Stevens Ind—Oct., 1908. No. 485 D.

Industrial Legislation.

Some Medical and Insurance Problems Arising Out of Recent Industrial Legislation. Thomas Oliver. Some effects of the Workmen's Compensation Acts in Great Britain are discussed. 5000 w. Col Guard—Nov. 20, 1908. No. 736 A.

Management.

The Basic Cause of Increased Efficiency. Walter M. McFarland. Argues that increased efficiency is to be obtained principally through the stimulation of the human element by rewards. 3000 w. Engineering Magazine—Dec., 1908. No. 668 B.

Efficiency as a Basis for Operation and Wages. Harrington Emerson. This sixth article of a series discusses the modern theory of cost accounting. 5000 w. Engineering Magazine—Dec., 1908. No. 669 B.

The Profit-Earning Casting Plant. H. Cole Estep. Calls attention to possible economies. Ills. 2000 w. Foundry—Nov., 1908. No. 58.

An Automatic Follow-Up System. Read before the Phila. Found. Assn. Describes a system of keeping records of orders in the foundry and laying out work for the moulders. 2500 w. Foundry—Dec., 1908. No. 759.

Training Workmen in Habits of Industry and Coöperation. H. L. Gantt. Outlines a system discussing the application, obstacles, etc. 4500 w. Jour Am Soc of Mech Engrs—Mid-Nov., 1908. No. 652 F.

Securing the Co-operation of the Workman in the Improvement of Workshop Methods, etc. R. W. Kenyon. Abstract of paper before the British Found. Assn. Gives an outline of the scheme in operation at Accrington and discusses the subject generally. 6500 w. Mech Engr—Oct. 23, 1908. No. 69 A.

Staff Organization in Large Manufacturing Plants. W. H. A. Robertson. Points out inefficiencies due to indefiniteness of authority and the overlapping of duties. 1000 w. Ir & Coal Trades Rev. Nov. 6, 1908. No. 329 A.

See also Accounting, Cost Systems, and Depreciation, and Wages under INDUSTRIAL ECONOMY; and Shop Practice, under MECHANICAL ENGINEERING, MACHINE WORKS AND FOUNDRIES.

Marine Transport.

Japan Winning the Pacific. Edward G. Bogart. Discusses the probability of Japan winning because of cheap ships, cheap labor, and cheap food. Maps. 3500 w. World's Work—Nov., 1908. No. 29 C.

Patents.

The American Patent Law. John D. Morgan. Discusses its attitude toward inventors. 2500 w. Ir Age—Nov. 5, 1908. Serial, 1st part. No. 87.

Wages.

Systems of Wages and Their Influence on Efficiency. Carl Bender. Shows the nature, effect and limits of the best known wage systems. 4000 w. Engineering Magazine—Dec., 1908. No. 680 B.

MARINE AND NAVAL ENGINEERING

Ammunition.

Smokeless Powder. Conclusions of the Commission appointed to investigate the disaster on the Jena. 2500 w. Engng—Oct. 30, 1908. No. 193 A.

Battleships.

The Russian Cruiser-Battleship Rurik. Benjamin Taylor. Illustrated description of the vessel and its equipment, with report of trials. 1200 w. Int Marine Engng—Nov., 1908. No. 7 C.

A Measure of the Values of Warships. Sidney G. Koon. An illustrated article discussing a comparative basis for the military value of naval vessels. 1500 w. Cassier's Mag—Nov., 1908. (Special No.) No. 395 D.

The Design of Modern Warships. Prof. J. J. Welch. Outlines developments affecting warship design and some types of war vessels, tracing the progress and reviewing the principles underlying their design. Ills. 8500 w. Cassier's Mag—Nov., 1908. (Special No.) No. 385 D.

Modern Armored Ships (Les Cuirassés Modernes). A. Croneau. The first part discusses the evolution of the armored vessel, with especial reference to offensive power. Ills. Serial, 1st part. 6300 w. Rev Gen d Sci—Oct. 15, 1908. No. 523 D.

British Navy.

The Future of the British Fleet in Its Relation to the Two-Power Standard. Archibald S. Hurd. An explanation of the "Two-Power Standard," and its development. Ills. 5000 w. Cassier's Mag—Nov., 1908. (Special No.) No. 387 D.

Compasses.

Deviation of the Compass Aboard Steel Ships and its Avoidance and Correction. L H. Chandler. A statement of the general mathematical principles involved with illustrations from the results obtained aboard the vessels of the U. S. battleship fleet. Plates and tables. 16500 w. Soc of Nav Archts and Marine Engrs, No. 6—Nov., 1908. No. 265 N.

Condensers.

Steam Condensing Plant for Cargo Steamers. D. B. Morison. Illustrates and describes recent improvements. 2500 w. Cassier's Mag—Nov., 1908. (Special No.) No. 401 D.

Cruisers.

The Oldest Iron Ship in the World. Henry Penton. An account of the U. S. Man-of-War Michigan, in service on the Great Lakes. 1200 w. Soc of Nav Archts and Marine Engrs, No. 1½—Nov., 1908. No. 287 N.

Trials of the U. S. Scout-Cruiser Chester. Charles P. Wetherbee. Reports trials of a cruiser fitted with Parsons turbines. Plates. 1000 w. Soc of Nav Archts & Marine Engrs, No. 10—Nov., 1908. No. 271 N.

U. S. Scout-Cruiser Birmingham. Theo. C. Fenton. Illustrations, with description of machinery and report of official trials. 3500 w. Jour Am Soc of Nav Engrs—Aug., 1908. No. 660 H.

U. S. Armored Cruiser North Carolina. Theo. C. Fenton. Illustrations, with description of machinery and official trials. 4500 w. Jour Am Soc of Nav Engrs—Aug., 1908. No. 657 H.

Dockships.

German Naval Dockship Vulkan. Brief illustrated description of a vessel for docking and salving submarines. 400 w. Engr, Lond—Oct. 30, 1908. No. 199 A.

Dredges.

Sea-Going Suction Dredges. Thomas M. Cornbrooks. Describes dredges for the Engineer's Department of the U. S. Army. Plates. 500 w. Soc of Nav Archts & Marine Engrs., No. 15—Nov., 1908. No. 269 N.

Bucket Dredges (Die Eimerkettenbagger). R. Richter. General discussion of their design. Ills., Serial, 1st part. 3200 w. Zeitschr d Ver Deutscher Ing—Oct. 24, 1908. No. 603 D.

Dry Docks.

The Influence of Free Water Ballast upon Ships and Floating Docks. T. G. Roberts. A discussion of the stability and strength. Plates. 6000 w. Soc of Nav Archts & Marine Engrs, No. 7—Nov., 1908. No. 266 N.

Education.

See same title, under INDUSTRIAL ECONOMY.

Electric Power.

The Electrical Plant and Means of Interior Communication of a Modern Ocean-Going Passenger and Cargo Vessel. Charles J. Dougherty. Describes the plant installed on the new steamship "Momus." 8000 w. Marine Rev—Nov. 5, 1908. No. 151.

Fire Boats.

Centrifugal Pump Fire Boats. Charles C. West. Gives the result of a test made on the first of two 9,000-gallon boats just delivered to the city of Chicago. Plates. 1700 w. Soc of Nav Archts & Marine Engrs, No. 14—Nov., 1908. No. 273 N.

Floating Cranes.

Twin-Screw Floating Cranes. Illustrates and describes cranes recently built for the Argentine Government. 1500 w. Engng—Nov. 13, 1908. No. 445 A.

Gas Engines.

Gas Engine Experiments on H. M. S. Rattler. The Marquis of Graham. A report of recent trials. Ills. 1500 w. Cassier's Mag—Nov., 1908. (Special No.) No. 399 D.

Gasoline Engines.

The Internal-Combustion Engines. W. G. Winterburn. A description of the gasoline engine as used for propelling small vessels. 2200 w. Marine Rev—Nov. 5, 1908. No. 153.

Marine Gasoline Engine Design. E. W. Roberts. Points out some special requirements for designing marine petrol engines according to modern ideas. Ills. 3500 w. Int Marine Engng—Nov., 1908. No. 6 C.

German Navy.

The Naval Policy of Germany, Its Progress and Aims. Count Ernst von Reventlow. An illustrated review of the progress and aims of the German sea power. 6000 w. Cassier's Mag—Nov., 1908. (Special No.) No. 388 D.

Internal-Combustion Engines.

Internal Combustion Engines for Marine Purposes. Sir John L. Thornycroft. An illustrated article showing the increasing use of gas power for propulsion. 2500 w. Cassier's Mag—Nov., 1908. (Special No.) No. 402 D.

International Competition.

The Contest for Ocean Supremacy. Lawrence Perry. An account of preparations by German steamship companies to build faster ships than any now afloat, and the probability of still faster British liners. Ills. 6000 w. World's Work—Nov., 1908. No. 28 C.

Motor Boats.

The British International Trophy Race of 1908. W. P. Stephens. Reviews earlier races of motor-boats, describes the boats entered, and gives report of the 1908 race. Plates. 6500 w. Soc of Nav Archts & Marine Engrs, No. 16—Nov., 1908. No. 274 N.

Oil Fuel.

Oil Burning on Board Ship. Andrew Laing. An illustrated discussion of the importance and practicability of the use of liquid fuel. 3000 w. Cassier's Mag—Nov., 1908. (Special No.) No. 394 D.

Ordnance.

Naval Ordnance. A. Trevor Dawson. An illustrated study of modern naval artillery. 4500 w. Cassier's Mag—Nov., 1908. (Special No.) No. 397 D.

Progress.

Advances in Marine Engineering. James Denny. Abstract of presidential address at the Inst. of Marine Engineers. 4000 w. Mech Engr—Nov. 6, 1908. No. 307 A.

Propellers.

Theory of the Screw Propeller. von J. W. Haeussler. The mechanics of the design of the screw. 7000 w. Jour Am Soc of Nav Engrs—Aug., 1908. No. 658 H.

Further Propeller Analysis. Clinton H. Crane. Outlines the method used. Plates. 400 w. Soc of Nav Archts & Marine Engrs, No. 5—Nov., 1908. No. 270 N.

Resistance.

Further Experiments Upon Longitudinal Distribution of Displacement and Its Effect Upon Resistance. Herbert C. Sadler. Gives particulars of recent experiments in this field. Plates. 1400 w. Soc of Nav Archts & Marine Engrs, No. 4—Nov., 1908. No. 264 N.

The Influence of Midship-Section Shape Upon the Resistance of Ships. D. W. Taylor. Gives information obtained from experiments at the U. S. Model Basin during the past year. Plates. 2000 w. Soc of Nav Archts & Marine Engrs, No. 3—Nov., 1908. No. 263 N.

Rudders.

Clyde Rudders and Rudder Posts. Sketches and descriptions of general practice. 1800 w. Int Marine Engng—Nov., 1908. No. 5 C.

Shipbuilding.

America's Greatest Shipbuilding Establishment. Illustrated description of the plant of the Newport News Shipbuilding & Dry Dock Co. 2500 w. Naut Gaz—Nov. 12, 1908. No. 239.

Shipbuilding on the Great Lakes. Robert Curr. Describes a vessel of the hopper type being built on the mold system. Ills. 5000 w. Soc of Nav Archts & Marine Engrs, No. 12—Nov., 1908. No. 272 N.

The Shipbuilding and Engineering Company of Burmeister & Wain. Axel Holm. Illustrated description of this plant at Copenhagen, Denmark. 1500 w. Int Marine Engng—Nov., 1908. No. 2 C.

Shipbuilding Cranes (Hellingkrananlagen). W. Laas. The first part is devoted principally to examples in American shipyards. Ills. Serial, 1st part. 5000 w. Zeitschr d Ver Deutscher Ing—Oct. 10, 1908. No. 600 D.

Ship Design.

The Shearing Strength of Riveter Seams in Shell Plating. R. E. Anderson. Explains shearing forces and methods of calculation. 3000 w. Int-Marine Engng—Nov., 1908. No. 3 C.

Notes on Naval Science Topics. Arthur R. Liddell. Explains a method of approximately determining the stability of vessels of full form. 2500 w. Int-Marine Engng—Nov., 1908. No. 4 C.

Ship Repairing.

The Repair and Maintenance of Ships. C. H. Hall and S. H. Bunnell. Illustrates and describes interesting emergency work in shipyards. 3000 w. Cassier's Mag—Nov., 1908. (Special No.) No. 390 D.

Ships' Bottoms.

Electric Scrubber for Cleaning Ships' Bottoms Without Dry Docking. Illustrated description. 900 w. Sci Am—Nov. 7, 1908. No. 105.

Ship Testing.

Practical Methods of Conducting Trials of Vessels. Colonel E. A. Stevens. Brief explanation of the system in use in the U. S. Navy. Plates. 1500 w. Soc of Nav Archts & Marine Engrs, No. 2—Nov., 1908. No. 262 N.

Speed.

The Influence of the Depth of Water on Speed. A. F. Yarrow and W. W. Marriner. An illustrated article on the behavior of high-speed boats in shallow water. 2000 w. Cassier's Mag—Nov., 1908. (Special No.) No. 398 D.

Steam Boilers.

Gunboat Boilers. Charles S. Linch. Illustrated description of boilers installed on the Wilson Line steamboats. 1800 w. Boiler Maker—Nov., 1908. No. 12.

The Development of the Marine Boiler (Ueber die Entwicklung der Schiffskessel). F. Romberg. A general review of recent progress. 2500 w. Schiffbau—Oct. 28, 1908. No. 563 D.

Steam Engines.

The Mechanical Efficiency of Marine Engines. Refers to paper by J. Hamilton Gibson on "Torsion Meters in Marine Work," and discusses the determination of torque in shafting. Ills. 2000 w. Engr, Lond—Nov. 13, 1908. No. 450 A.

Piston Engines versus Turbines on the Atlantic. R. Caird. A comparative study of engine and turbine efficiency. 1500 w. Cassier's Mag—Nov., 1908. (Special No.) No. 396 D.

The Development of the Modern Marine Engine. J. W. Reed. Illustrated description of the latest practice in the powering of steamships. 7500 w. Cassier's Mag—Nov., 1908. (Special No.) No. 393 D.

Steamships.

The Design of Fast Ocean Steamers. E. W. De Rusett. An illustrated review of the progress and development. 5000 w. Cassier's Mag—Nov., 1908. (Special No.) No. 391 D.

The Design and Building of Modern Cargo Steamers. S. J. P. Thearle. States the requirements of such vessels, and describes methods of British shipbuilders, illustrating vessels in different stages of construction. 4000 w. Cassier's Mag—Nov., 1908. (Special No.) No. 386 D.

Some Recent Inventions as Applied to Modern Steamships. W. Carlile Wallace. Remarks on recent inventions that tend to increase safety and comfort of passengers. Plates. 5000 w. Soc of Nav Archts & Marine Engrs, No. 8—Nov., 1908. No. 267 N.

The Steamer Commonwealth. Warren T. Berry and J. Howland Gardner. Illustrations, drawings, and description of a vessel for night service between New York and Fall River. 3000 w. Soc of Nav Archts & Marine Engrs, No. 13—Nov. 1908. No. 286 N.

Service Test of the Steamship Harvard. C. H. Peabody, W. S. Leland and H. A. Everett. Plates. 1500 w. Soc of Nav Arcts & Marine Engrs, No. 9—Nov., 1908. No. 268 N.

The New Mallory Line Steamship Brazos. Illustrated detailed description of a fine steamship for service between New York and Galveston, Texas, and its performance. 5000 w. Naut Gaz—Nov. 12, 1908. No. 238.

The Great Ore Carriers on the Great Lakes. James Cooke Mills. Illustrates and describes special methods of construction used. 2500 w. Cassier's Mag—Nov., 1908. (Special No.) No. 392 D.

The Triple-Screw Turbine-driven Pacific Liner "Tenyo Maru." Illustrated detailed description of this first of these sister ships for the Oriental Steamship Co., of Japan. 7500 w. Plates. Engng—Oct. 30, 1908. No. 195 A.

The Turbine Steamship "Tenyo Maru." (Der Turbinendampfer "Tenyo Maru"). W. Kaemmerer. Illustrated description of this new vessel of the Japanese merchant marine. 3500 w. Zeitschr d Ver Deutscher Ing—Oct. 17, 1908. No. 602 D.

The First Year's Operation of the "Kronprinzessin Cecilie," the "Lusitania" and the "Mauretania." (Die Schnelldampfer "Kronprinzessin Cecilie," "Lusitania" and "Mauretania" im ersten Betriebsjahre). S. Bock. A comparison of service results. 5200 w. Schiffbau—Oct. 14, 1908. No. 562 D.

Steam Turbines.

Some Remarks on the Steam Turbine. J. W. Powell. Explains the principles of the action and reaction turbines, and gives a brief historical review of the development. Plates. 4200 w. Soc of Nav Archts & Marine Engrs, No. 11—Nov., 1908. No. 288 N.

Recent Developments in the Marine Steam Turbine. R. J. Walker. A review of progress in turbine propulsion in merchant and naval vessels. Ills. 2500 w. Cassier's Mag—Nov., 1908. (Special No.) No. 400 D.

See also Steam Engines and Steamships, under MARINE AND NAVAL ENGINEERING.

Submarine Mines.

Submarine Mines and Mining. Richmond P. Davis. Describes these mines and methods of mining, discussing in detail the factors and their use in harbor defense. Ills. 6500 w. Jour Am Soc of Nav Engrs—Aug., 1908. No. 659 H.

Submarines.

Transportation of Submarines. W. J. Baxter. Describes an actual, successful and economical solution of the problem of over-sea transportation of submarines. 4 plates. 1000 w. Soc of Nav Archts & Marine Engrs, No. 17—Nov., 1908. No. 275 N.

Submarine Naval Warfare. G. Laurenti. An illustrated review of the development of the submarine boat. 5500 w. Cassier's Mag—Nov., 1908. (Special No.) No. 403 D.

See also Dockships, under MARINE AND NAVAL ENGINEERING.

Tank Steamers.

Holmes' Tube Tanker—A New Form of Construction for Tank Steamers Carrying Petroleum in Bulk. Samuel Holmes. Explains the main features of a new form proposed. 2500 w. Marine Rev—Nov. 5, 1908. No. 152.

Torpedo Boats.

Surface or Submarine Torpedo Boats. Brief discussion of their development, claims and performance. 2000 w. Engr, Lond—Nov. 13, 1908. No. 448 A.

MECHANICAL ENGINEERING

AUTOMOBILES.

Axles.

Bevel-Geared Live Back Axles for Motor Cars. Discusses important points in their design, methods of construction, certain defects, and related matters. Ills. 4000 w. Engng—Nov. 6, 1908. Serial, 1st part. No. 322 A.

B. S. A.

The B. S. A. Cars. Illustrated description of the two models made. 1200 w. Autocar—Oct. 31, 1908. No. 172 A.

Carburettors.

The Flow of Liquid Fuel Through Carburettor Nozzles. Robert W. A. Brewer. Reports a series of investigations made to show how it becomes an easy matter to ascertain the size of carburettor orifice to satisfy the conditions of cylinder and carburettor dimensions, and to point out some interesting problems in connection with the carburettor. Plates. 5500 w. Soc of Engrs—Nov. 2, 1908. No. 283 N.

Commercial Vehicles.

Recent Developments in Motor Vehicles for Industrial Purposes. Harry Wilkin Perry. Illustrates and describes some of the adaptations to special uses. 6000 w. Engineering Magazine—Dec., 1908. No. 671 B.

Daimler.

The 1909 Daimler Cars at Olympia. Illustrates and describes the chassis. 1000 w. Auto Jour—Nov. 14, 1908. No. 418 A.

Driving.

How to Drive a Motor Car. The first of a series of articles giving practical hints on the driving of motor vehicles. 4500 w Auto Jour—Oct. 31, 1908. Serial, 1st part. No. 173 A.

Electric Equipment.

Electric Equipment of Steam and Gasoline Automobiles. F. R. Babcock. An account of the various devices, combinations and arrangements which have been used for illumination, signalling, speed changing, etc. 3000 w. Jour W Soc of Engrs—Oct., 1908. No. 355 D.

Fire Apparatus.

New American Motor Fire Apparatus. Illustrated descriptions of extension ladder, hose wagons, etc., fitted with motors. 1200 w. Com Vehicle—Nov., 1908. No. 46 C.

Lancia.

The Lancia Petrol Cars at Olympia. Illustrated description of these Italian touring cars. 1200 w. Auto Jour—Nov 14, 1908. Serial, 1st part. No. 422 A.

The Lancia Cars. A 15-h. p. four-cylinder, and 30-h. p. six-cylinder engined chassis are described and illustrated. 1400 w. Autocar—Nov. 7, 1908. No. 300 A.

Mass.

The 1909 Mass Petrol Cars at Olympia. Illustrates and describes the interesting features of these cars. 1200 w. Auto Jour—Nov. 14, 1908. No. 420 A.

Motor Cooling.

Non-Freezing Solution for Radiators J. E. Stacey Jones. Practical tests and recommendations. 1600 w. Autocar—Nov. 14, 1908. No. 423 A.

Winter Troubles with Cooling Water. States the properties of a satisfactory cooling medium, considering the solutions at present used. 2500 w. Automobile—Nov. 19, 1908. No. 370.

Motor Rating.

The Rating of Petrol Engines. Editorial discussion of formula rating. 2000 w. Engng—Nov. 13, 1908. No. 444 A.

Motors.

The Daimler Company's New Engine. C. Y. Knight. Abstract of paper read before the Roy. Auto Club. An account of the development of the ideas and a reply to criticisms. 7500 w. Auto Jour—Oct. 24, 1908. No. 63 A.

See also Cast Iron, under MATERIALS OF CONSTRUCTION.

Napier.

The 1909 Napier Petrol Cars at Olympia. Illustrated description of the 30 h. p. 6-cylinder model. 1200 w. Auto Jour—Nov. 7, 1908. No. 297 A.

Opel.

The 40-H. P. Opel Petrol Car at Olympia. Illustrated description. 1500 w. Auto Jour—Nov. 14, 1908. No. 421 A.

Pressure Indicators.

Pressure Indicator for Motor-Car Engines. Illustrates and describes an instrument of French origin, called the "Acrometer." 600 w. Engng—Oct. 30, 1908. No. 194 A.

Shock Absorbers.

The General Utility of Shock Absorbers. Thomas J. Fay. Considers types, methods, maintenance, and cost. Ills. 2200 w. Automobile—Nov. 19, 1908. No. 369.

Siddeley.

The New Siddeleys. Describes improvements, and also a new model. Ills. 2000 w. Autocar—Oct. 24, 1908. No. 61 A.

Six-Cylinder 20-Horse-Power Siddeley Motor-Car. Illustrated detailed description of car for the Olympia exhibition. 1800 w. Engng—Nov. 6, 1908. No. 324 A.

Six-Wheeled.

Six-Wheeled Automobiles (Voitures Automobiles à Six Roues). M. Janvier. Discusses the advantages of the six-wheeled vehicle, their construction, steering, etc. Ills. 4000 w. Bul Soc d'Encour—Oct., 1908. No. 519 G.

Sizaire-Naudin.

The 12-H. P. Sizaire-Naudin Light Car at Olympia. Illustrated description of a single-cylinder, low power and low price car. 1000 w. Auto Jour—Nov. 14, 1908. Serial. 1st part. No. 419 A.

Speed Changing.

A New Speed-Changing Device for Automobiles (Nouvel Appareil de Changement progressif de Vitesse pour Automobiles). M. P. Hoffet. Illustrated description of a new Swiss device. 2000 w. Bul Tech d l Suisse Romande—Oct. 10, 1908. No. 525 D.

Speed Indicators.

See Speed, under ELECTRICAL ENGINEERING, MEASUREMENT.

Springs.

About Automobile Spring Suspensions. Thomas J. Fay. An illustrated discussion of types of springs and their action. 1500 w. Automobile—Nov. 5, 1908. Serial. 1st part. No. 117.

Tires.

How to Prolong the Life of a Tire. Hiram Percy Maxim. Thinks tires are not properly inflated. Advocates the use of a tire pressure gauge. Ills. 1300 w. Automobile—Nov. 26, 1908. No. 622.

Valveless.

The 25-H. P. Valveless Car at Olympia. Illustrated description. 700 w. Auto Jour—Nov. 7, 1908. No. 298 A.

Vinot.

The 12-16-H. P. Vinot Car. Illustrated detailed description. 1200 w. Auto Jour—Oct. 24, 1908. Serial. 1st part. No. 62 A.

White.

The 1909 White Steam Cars at Olympia. Illustrates and describes the 15 h.p. White chassis, and the Joy valve-gear. 2000 w. Auto Jour—Nov. 7, 1908. No. 299 A.

COMBUSTION MOTORS

Gas Cleaning.

See Blast-Furnace Gas, under MINING AND METALLURGY, IRON AND STEEL.

Gas Engines.

100 Horse-Power Horizontal Gas Engine. Illustrated description of the latest model of a single-cylinder gas engine built by the National Gas Engine Co., Ltd. 800 w. Engr, Lond—Nov. 13, 1908. No. 454 A.

See also same title, under MARINE AND NAVAL ENGINEERING.

Gasoline Engines.

The Design of Cams for High-Speed Motors. Considers the type of valve-gear most general on petrol motors. 1500 w. Mech Wld—Nov. 13, 1908. No. 429 A.

See also same title, under MARINE AND NAVAL ENGINEERING.

Gas Power Plants.

See Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Gas Producers.

How to Run a Suction Gas Producer. F. C. Tryon. Discusses the starting and operating of such a plant. 1800 w. Power—Nov. 17, 1908. No. 294.

Oil Engines.

Crude-Oil Engines at the Jubilee Exhibition in Prague. Describes exhibits. 4000 w. Engng—Nov. 13, 1908. No. 442 A.

Valve Gears.

Krupp's Valve Gear for Internal-Combustion Engines. Drawings and description of the valve-gear and its working. 1800 w. Mech Engr—Nov. 6, 1908. No. 306 A.

See also Gasoline Engines, under COMBUSTION MOTORS.

HEATING AND COOLING.

Central Plants.

Central Heating Plants (Fernheizwerke). Max Hottinger. Discusses the various systems and the design of plants. Ills. Serial. 1st part. 1800 w. Schweiz Bau—Oct. 3, 1908. No. 560 B.

Drying Plants.

Calculation of Air and Heat Requirements of Drying Plants (Die Berechnung des Luft- und Wärmebedarfs für Trockenanlagen in der Praxis). W. Franken. Gives a number of very elaborate tables. 8700 w. Gesundheits-Ing—Oct. 24, 1908. No. 588 D.

Gas Heating.

The Use of Coal Gas in Baking Ovens. Information on various applications of gas firing. 2000 w. Prac Engr—Nov. 6, 1908. No. 301 A.

Modern Methods of Heating. H. R. Basford. Read before the Pacific Coast Gas Assn. Gives a report of automatic gas water heating devices and their performances. Discussion. 4400 w. Pro Age—Nov. 16, 1908. No. 290.

Hot-Water Heating.

The Design of Low-Pressure Hot-Water Heating Systems (Calcul des Installations de Chauffage par l'Eau Chaude à Basse Pression). E. Mathieu. A mathematical discussion. Ills. Serial. 1st part. 1000 w. La Métal—Oct. 14, 1908. No. 531 D.

Pipe Bending.

How to Make Hardwood Forms for Bending Iron Pipe Cold. Illustrates and describes types and their making. 1200 w. Dom Engng—Nov. 7, 1908. No. 159.

HYDRAULIC MACHINERY.

Centrifugal Pumps.

Test of Four 35,000,000-Gal. Centrifugal Pumping Units at Pittsburg. Gives extracts from a report showing the results of duty tests. 1200 w. Eng News—Nov. 26, 1908. No. 637.

The Compounding of Centrifugal Pumps (Ueber die Schaltung von Schleuderpumpen). A. Laponche. A mathematical discussion of the two cases of compounding for pressure or for capacity. Ills. 3200 w. Die Turbine—Oct. 20, 1908. No. 567 D.

See also Fire Boats, under MARINE AND NAVAL ENGINEERING.

Penstocks.

A Diagram for Calculating Penstocks. Richard Muller. Gives diagram for calculating steel pipes of large size, with explanation of its use. 1600 w. Eng Rec—Nov. 14, 1908. No. 252.

Pipe Flow.

Flow of Water in Pipes and Flumes. Franklin Van Winkle. Discusses drop in pressure due to friction, giving charts for determining the size of pipe for a given flow. Ills. 4000 w. Power—Nov. 10, 1908. No. 162.

Pumping Engines.

New Pumping Engines for the Metropolitan Water Board. Illustrated description of the engines at Kempton Park Station. 2000 w. Engr, Lond—Oct. 23, 1908. No. 80 A.

Riveting Machines.

Some Notes on Hydraulic Plate Cutting and Riveting Machines. Norman S. Trustrum. Read before the Jun. Inst. of Engrs. Discusses materials, methods and related matters. Ills. 2000 w. Prac Engr—Nov. 13, 1908. Serial. 1st part. No. 427 A.

Turbines.

Oscillations in Pipe Lines and Their Influence on the Operation of Turbines (Schwingungen in Flüssigkeitsleitungen und ihr Einfluss auf den Gang von Kreiselrädern). H. Lorenz. Mathematical. Ills. Serial. 1st part. 3500 w. Zeitschr f d Gesamte Turbinenwesen—Oct. 10, 1908. No. 564 D.

MACHINE ELEMENTS AND DESIGN.

Clutches.

Clutches. Discussion of paper by Henry Souther. 2000 w. Jour Am Soc of Mech Engrs—Nov., 1908. No. 646 F.

Crushers.

Balancing a Rock Crusher—A Peculiar Problem. O. P. Hood. Presents the method of determining the unbalanced forces by graphical solution, and of reducing the vibration. 2500 w. Am Mach—Vol. 31. No. 48. No. 626.

Cylinders.

Distortions Symmetrical About the Axes of Thin-Walled Cylinders (Achsensymmetrische Verzerrungen in dünnwandigen Hohlzylindern). Rudolf Lorenz. Mathematical. Ills. 6500 w. Zeitschr d Ver Deutscher Ing—Oct. 24, 1908. No. 604 D.

Drafting.

Present Practice in Drafting-Room Conventions. John S Reid. Summary of answers to questions on methods. 3000 w. Am Mach—Vol. 31. No. 47. No. 362.

Gears.

Interchangeable Involute Gear Tooth Systems. Ralph E. Flanders. Discusses the effect of varying the pressure angle and addendum. 4500 w. Jour Am Soc of Mech Engrs—Mid-Nov., 1908. No. 654 F.

Spur Gearing on Heavy Railway Motor Equipments. Norman Litchfield. Gives facts gathered in a study of this subject. Ills. 1600 w. Jour Am Soc of Mech Engrs—Mid-Nov., 1908. No. 655 F.

Graphical Charts.

Isometric Plotting of Graphical Charts. Guido H. Marx. Explains the principle of isometric projection, illustrating by example. 1500 w. Am Mach—Vol. 31. No. 46. No. 220.

Joints.

A Note on Ball-and-Socket Joints. An investigation of the limiting proportions of such joints. 600 w. Engr, Lond—Nov. 13, 1908. No. 453 A.

Journals.

Friction and Bearing Pressures of Journals. W. H. Scott. A review of theories and experiments. 2500 w. Mech Wld—Oct. 23, 1908. No. 68 A.

Reducing Wheels.

The Practical Operation of Reducing Wheels. Hubert E. Collins. Illustrated explanation of parts of certain makes of wheel, with instructions for handling, etc. 2000 w. Power—Nov. 10, 1908. No. 161.

Screw Jacks.

The Design of a 20-Ton Screw Jack. Drawings and Calculations. 500 w. Prac Engr—Oct. 30, 1908. No. 180 A.

Stresses.

Stress Disturbance by Grooves (Ueber die Spannungsstörungen durch Kerben und Tellen und über die Spannungsverteilung in Verbundkörpern). Alfons Leon. A mathematical paper on the effects on stress distribution of various types of grooves. Ills. Serial. 1st part. 5500 w. Oest Wochenschr f d Oeffent Baudienst—Oct. 24, 1908. No. 578 D.

MACHINE WORKS AND FOUNDRIES.

Blacksmith Shops.

Tools for Increasing Production in Blacksmith Shops. James Cran. Illustrates and describes various useful appliances. 2000 w. Mach, N Y—Nov., 1908. No. 35 C.

Boring Machines.

A Large, Vertical, Cylinder Boring Machine. Philip Bellows. Describes a special design, equipped with friction drive. Ills. 3000 w. Am Mach—Vol. 31. No. 46. No. 219.

Brazing.

Brazing Cast Iron and Other Metals. F. N. Blake. Practical notes. 800 w. Prac Engr—Oct. 23, 1908. No. 66 A.

Castings.

Elementary Notes on Iron with a Few Side Lights on Malleable Castings. C. A. Swallow. 2000 w. Foundry—Nov., 1908. No. 59.

Casting Printing Press Cylinders. A. Manchester. Shows the manner of molding and casting. Ills. 1200 w. Am Mach—Vol. 31. No. 47. No. 363.

Figuring the Weight of Cast Steel. R. A. Bull. Explains a method of finding the weight of steel castings. 1200 w. Foundry—Nov., 1908. No. 56.

See also Cast Iron, under MATERIALS OF CONSTRUCTION.

Core Making.

Striking Up Cores in Loam. Walter J. May. Describes methods. Ills. 1000 w. Prac Engr—Oct. 23, 1908. No. 65 A.

Cores.

Method of Ascertaining the Lifting Pressure of Molten Metal on Cores. F. Webster. Experimental study. Ills. 1200 w. Foundry—Nov., 1908. No. 54.

Cupolas.

The Design of Cupolas (Die Berechnung der Kupolofenabmessungen). Bernhard Osann. Discusses principally air heating and the heating of the fore-hearth. Ills. Serial. 1st part. 4500 w. Stahl u Eisen—Oct. 7, 1908. No. 543 D.

Drilling.

Comparisons of Carbon and High-Speed Drills. Reports tests which show that the high-speed drills drilled 57 times as many holes as the carbon drills under the same conditions. 1800 w. Am Mach—Vol. 31. No. 46. No. 222.

Foundry Appliances.

The Improvements in Foundry Tools and Appliances. James F. Hobart. Reviews some of the improvements in tools and methods. 2200 w. Mech Wld—Nov. 6, 1908. No. 304 A.

Foundry Management.

See Accounting, and Management, under INDUSTRIAL ECONOMY.

Foundry Practice.

Method of Obtaining a Uniform Chill in Cast Iron Rolls. Thomas D. West. Read before the Am. Soc. for Test. Mat. Illustrates and describes devices used. 1200 w. Foundry—Nov., 1908. No. 57.

Chemical Analysis in Relation to Foundry Practice. The present number briefly considers oils, fuel, and water. 1200 w. Prac Engr—Oct. 23, 1908. Serial. 1st part. No. 67 A.

See also Castings, Molding Machines, Patterns, and Sand Blast, under MACHINE WORKS AND FOUNDRIES.

Furnaces.

Industrial Uses of Gas. Abstract of a paper by E. C. Riley, on applications made by the Great Western Ry. Co. at Swindon, England. Ills. 2000 w. Ir & Coal Trds Rev—Nov. 13, 1908. No. 455 A.

Galvanizing.

Modern Methods of Galvanizing. Illustrates and describes the electrolytic and sherardizing processes. 1000 w. Ir & Coal Trds Rev—Oct. 30, 1908. No. 203 A.

Gear Cutting.

An English Universal Gear Cutting Machine. Joseph Horner. Illustrated description of a 54-in. machine that cuts spurs and spirals with a hob or circular cutter and worm wheels with a taper hob or fly cutter. 2500 w. Am Mach—Vol. 31. No. 47. No. 361.

Grinding.

Grinding Threading Chasers for Brass Work. Ethan Viall. An illustrated article describing methods. 1500 w. Mach, N Y —Nov., 1908. No. 36 C.

Hydraulic Machines.

See Riveting Machines, under HYDRAULIC MACHINERY.

Lathes.

Improvements in Multiple Spindle Lathes and Like Machines. Illustrates and describes an invention patented by George Mellis for intermittently rotating the turret head, for stopping its rotation and locking it in various positions. 1500 w. Prac Engr—Nov 13, 1908. No. 428 A.

Machine Tools.

Some French Machine-Tools at the Franco-British Exhibition. Describes interesting examples of French practice. Ills. 1500 w. Engng—Oct. 30, 1908. Serial. 1st part. No. 190 A.

Milling.

Setting-Angles for Milling Angular Cutters and Taper Reamers. W. A. Knight. Diagrams and directions for calculations, with tables, and examples. 4000 w. Mach, N Y—Nov., 1908. No. 33 C.

Milling Cutters.

The Development of a High Speed Milling Cutter, with Inserted Blades for High Powered Milling Machines. Wilfred Lewis and William H. Taylor. Describes the cutter, discussing points considered in its construction, reporting tests. Ills. 2200 w. Jour Am Soc of Mech Engrs—Mid-Nov., 1908. No. 656 F.

Milling Machines.

Accurate Index Wheels and Milling Operations. Illustrated description of special machines for milling channels in type setter cylinders. 1500 w. Am Mach —Vol. 31. No. 45. No. 122.

Efficiency Tests of Milling Machines and Milling Cutters. A. L. De Leeuw. Deals with the efficiency problem only, showing results obtained rather than the means by which they were obtained. Ills. 6000 w. Jour Am Soc of Mech Engrs—Nov., 1908. No. 641 F.

Molding Machines.

A Difficult Molding Machine Job. Illustrates and describes the making of an automobile crank case mold. 1200 w. Foundry—Nov., 1908. No. 50.

Machine Molding for Large Castings. C. S. Bonsall. Read before the Nat. Found. Assn. Illustrated account of experience of an engine works. 2000 w. Ir Age—Nov. 26, 1908. No. 496.

Patterns.

Rapping Plates—A Discussion of the Proper Use and Abuse of Patterns. C. Neill. Ills. 2200 w. Foundry. Nov., 1908. No. 52.

Punching Machines.

Punching Machines (Ueber Durchstossmaschinen). E. Kühne. Discusses their design, operation, etc. Ills. 2700 w. Zeitschr f Werkzeug—Oct. 5, 1908. No. 569 D.

Sand Blast.

The Sand Blast in the Foundry. James M. Betton. The first of the series of articles on the use of the sand blast for cleaning castings. 2500 w. Foundry—Nov., 1908. Serial. 1st part. No. 53.

Shop Hygiene.

A Simple Method for the Detection of Gaseous Impurities in the Air of Factories (Vereinfachte Methoden zur Bestimmung der gasförmigen Verunreinigungen in der Fabrikluft). Martin Hahn. 4000 w. Gesundheits-Ing—Oct. 31, 1908. No. 589 D.

Shop Management.

See Management, under INDUSTRIAL ECONOMY.

Shop Photography.

Industrial Photography. S. Ashton Hand. An illustrated paper dealing with apparatus, preparation, focusing, copying, enlarging, etc. 3000 w. Jour Am Soc of Mech Engrs—Nov., 1908. No. 642 F.

Shop Practice.

Ways and Means of Producing Work in the Machine Shop. W. Burns. A summary of shop conditions contributing to efficiency with suggestions for improvements. 2000 w. Engineering Magazine—Dec., 1908. No. 675 B.

Making Pliers of Various Kinds and Sizes. Illustrates and describes novel methods and details of a new shop at Utica, N. Y. 2200 w. Am Mach—Vol. 31. No. 48. No. 627.

Machining the Casting for a Plain Milling Machine Column. B. R. Ashe. Prize paper. Illustrated description of the work. 1500 w. Mech Wld—Oct. 30, 1908. No. 179 A.

Shops.

The Windsor Machine Co.—Examples of Its Shop Practice. Illustrated description of these shops and selected operations. 3500 w. Mach, N Y—Nov., 1908. No. 34 C.

See also same title, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Straightening Presses.

Spindle Straightening Presses (Ueber Spindelrichtpressen). E. Kühne. A mathematical discussion. Ills. 2000 w. Zeitschr f Werkzeug—Oct. 5, 1908. No. 570 D.

Tempering.

Methods of Hardening Steel. E. R. Markham. Discusses methods best for various kinds of work. 2000 w. Mech Wld—Nov. 6, 1908. No. 305 A.

Tinning.

The Method of Tinning Cast-Iron. Illustrated description. 2500 w. Brass Wld—Nov., 1908. No. 479.

Tool Making.

Methods of Making Form Tools and Cutters. E. M. King. Diagrams and description of methods used. 1000 w. Am Mach—Vol. 31. No. 47. No. 360.

Tube Making.

Plant Used in the Manufacture of Tubes. W. H. A. Robertson. Read before the Inst. of Metals. Describes the more general methods of manufacture. 3000 w. Ir & Coal Trds Rev—Nov. 13, 1908. No. 458 A.

The Manufacture of Seamless Steel Tubing. From a lecture by George Lees. Illustrates and describes the processes of drawing tubes from solid steel billets and plates. 4000 w. Ir Trd Rev—Nov. 19, 1908. No. 364.

Welding.

Autogenous Welding by the Oxy-Acetylene Flame. Eugene Bournonville. Read before the Tech. Club of Syracuse, N. Y. Brief review of the process, describing the types of torches used. 1000 w. Ir Age—Nov. 26, 1908. No. 495.

Portable Oxy-Acetylene Welding Outfit. E. F. Lake. Illustrated description of the apparatus and its work. 1800 w. Am Mach—Vol. 31. No. 45. No. 124.

MATERIALS OF CONSTRUCTION.

Alloy Steels.

The Commercial Use of Vanadium. T. F. V. Curran. Information concerning its use and the results secured. 1500 w. Ir Trd Rev—Nov. 19, 1908. No. 365.

Vanadium and Its Estimation. George Auchy. Discusses whether or not vanadium is all that is claimed, the tests needed, and related matters. 3000 w. Ir Age—Nov. 12, 1908. No. 215.

Aluminium.

See same title, under MINING AND METALLURGY, MINOR MINERALS.

Bronze.

Notes on Phosphor Bronze. A. Philip. Read before the Inst. of Metals. A record of results of tests to obtain information in regard to chemical specification for this material. Also effect of treatment, etc. 3500 w. Ir & Coal Trds Rev—Nov. 13, 1908. No. 457 A.

Cast Iron.

Composition of Automobile Cylinders. Harry B. de Pont. Gives experience with various grades of iron. 2500 w. Foundry —Nov., 1908. No. 51.

Carbon and the Properties of Cast Iron. Henry M. Howe. The difference in the properties is considered to be due to the distribution of its carbon between the graphitic and combined states. 4000 w. Eng & Min Jour—Nov. 14, 1908. No. 256.

Cast Steel.

See Castings, under MACHINE WORKS AND FOUNDRIES.

Corrosion.

See same title, under ELECTRICAL ENGINEERING, ELECTRO-CHEMISTRY.

Metallography.

Metallographs, or Photographs of the Structure of Metal Specimens. J. F. Springer. An illustrated explanation of their value in the study of metals. 1700 w. Sci Am—Nov. 7, 1908. No. 106.

Alumina for Polishing (Alumine de Polisage). M. Robin. Discusses materials for polishing specimens for metallographic study. Ills. 2000 w. Rev de Métal—Oct., 1908. No. 514 E + F.

Researches on Tempering and Annealing Iron and Steel (Recherches sur la Trempe et le Revenu du Fer et de l'Acier). Ed. Maurer. An extensive study of changes in physical, chemical and metallographic properties in the heat treatment of iron and steel. Ills. 11000 w. Rev de Métal—Oct., 1908. No. 513 E + F.

A Contribution to the Metallographic Study of Tempered Steels (Contribution à l'Étude Métallographique des Aciers Trempés). M. Kourbatoff. Discusses the transformations of austenite and troostite. Ills. 2000 w. Rev de Métal—Oct., 1908. No. 512 E + F.

See also Testing Methods, under MEASUREMENT.

Steel.

Benefits Derived by Heat-Treating Steel. Thomas J. Fay. Aims to explain methods by which good steel may be fashioned into shape and then rendered hard or soft, ductile or dynamic, as the service may demand. 3300 w. Automobile—Nov. 26, 1908. Serial. 1st part. No. 621.

MEASUREMENT.

Brakes.

Prony Brakes for Practical Testing. G. Everett Quick. Illustrates and describes different forms of friction brakes and their application and operation. 3000 w. Power—Nov. 17, 1908. No. 291.

Hardness.

A Simplified Ball-Test Device and the Results Obtained (Vorrichtung zur vereinfachten Prüfung der Kugeldruckhärte und die damit erzielten Ergebnisse). A. Martens and E. Heyn. Illustrated description. 3300 w. Zeitschr d Ver Deutscher Ing—Oct. 24, 1908. No. 606 D.

See also Testing Methods, under MEASUREMENT.

Pressure.

See Pressure Indicators, under AUTOMOBILES.

Testing Methods.

Corrosion Tests of Iron and Steel (Essais des Fers et des Aciers par Corrosion). Ch. Frémont. An exhaustive discussion of the value of etching with various chemical reagents in the study and testing of iron and steel. Ills. 7000 w. Rev de Métal—Oct., 1908. No. 511 E + F.

The Ball Hardness Test as a Measure of the Strength of Materials (Die Kugeldruckhärte als Mass der Zerreissfestigkeit). Alfred Kurth. Mathematical. Ills. 2800 w. Zeitschr d Ver Deutscher Ing—Oct. 3, 1908. No. 599 D.

Thermometry.

Some New Measurements with the Gas Thermometer. Arthur L. Day and J. K. Clement. A study, giving detailed description of apparatus used, methods and results. Ills. 15800 w. Am Jour of Sci—Nov., 1908. No. 206 D.

Weight.

The Merrick Conveyor Weightometer. Detailed description of this appliance for weighing coal or other material while traveling in a continuous stream along the belt of a conveyor. Ills. 2500 w. Engng—Oct. 30, 1908. No. 192 A.

POWER AND TRANSMISSION.

Air Compressors.

A Complete Line of German Air Compressors. Newhaus W. Czenaison. Illustrates and describes types of the Borsig compressors. 2000 w. Am Mach—Vol. 31. No. 45. No. 123.

Operating Steam Driven Air Compressors. C. A. Dawley. Calls attention to points the engineer should understand. 2500 w. Power—Nov. 24, 1908. No. 471.

Controlling the Output of the Air Compressor. Frank Richards. Concerning a device for automatically varying the output of an air compressor. Ills. 2000 w. Eng News—Nov. 5, 1908. No. 100.

Notable Performances of Air Compressors (Bemerkungswerte Ausführungen von Luftkompressoren). Hans Wunderlich. Describes machines by various European makers and gives indicator cards. Ills. 3800 w. Zeitschr d Ver Deutscher Ing—Oct. 31, 1908. No. 607 D.

Belts.

Power Transmission by Endless Belts. W. Worby Beaumont. Discusses the efficiency of belts and the importance of high frictional adhesion. 1700 w. Elec Rev, Lond—Oct. 30, 1908. No. 183 A.

Electric Driving.

The Economy of the Individual Motor Drive for Machine Tools. Howard S. Knowlton. An illustrated article favoring individual rather than group driving and stating its advantages. 3500 w. Engineering Magazine—Dec., 1908. No. 670 B.

Electric Power.

See Industrial Plants, under ELECTRICAL ENGINEERING, DISTRIBUTION.

Gas Power.

Suction Gas Producer Power for Factories. L. P. Tolman. Claims that it saves from 1-2 to 3-4 of the coal required for steam power. Ills. 2000 w. Am Mach—Vol. 31. No. 45. No. 125.

Gearing.

See Gears, under MACHINE ELEMENTS AND DESIGN.

Lubricants.

Filtering Oil for Repeated Use. John M. Howland. Illustrated description of the Turner filter and its operation. 800 w. Power—Nov. 10, 1908. No. 164.

Lubrication.

The Lubrication of Bearings. A. L. Campbell. Briefly considers classes of lubricants, their quality, and the manner of applying to bearings. Ills. 3000 w. Engineering Magazine—Dec., 1908. No. 678 B.

Power Plants.

Power Plant of the New Plaza Hotel, New York. Plans and detailed description of a mechanical equipment of unusual size. 5000 w. Eng Rec—Nov. 21, 1908. No. 412.

See also Coal Bunkers, under CIVIL ENGINEERING, CONSTRUCTION.

STEAM ENGINEERING.

Boiler Design.

Influence of Strap on Lap Boiler Seams. S. F. Jeter. Government tests show that strap must always add some strength to the joint. 2000 w. Power—Nov. 24, 1908. No. 469

Boiler Draft.

Forced Draft for Steam Boilers. W. H. Wakeman. An illustrated article describing the advantages and disadvantages of forced draft, and suggestions relating to its use. 2000 w. Elec Wld—Nov. 7, 1908. Serial. 1st part. No 97.

Boiler Furnaces.

Principles of Furnace Design for Smokeless Combustion. C. H. McClure. Read before the Am. Chem. Soc. States the requirements of smokeless furnaces, discussing each. 2500 w. Eng Rec—Nov. 7, 1908. No. 142.

Boiler Inspection.

The Inspection of Steam Boilers. James F. Hobart. Remarks on necessary tools and clothes for the purpose, giving a list of questions, and practical instruction. 4500 w. Power—Nov. 24, 1908. No. 468.

Boilers.

New Developments in Boilers and Accessories (Neuerungen auf dem Gebiet des Dampfkesselwesens). Ernst Arnold. Illustrates and describes recent European types of boilers, superheaters, economizers, etc. Serial. 1st part 3300 w. Stahl u Eisen—Oct. 7, 1908. No. 544 D.

Boiler Scale.

Concerning Solid Deposits in Steam Boilers. Deals principally with scale formed from dissolved matter that cannot be removed by filtration. Ills. 13000 w. Locomotive—Oct., 1908. No. 493.

Boiler Waters.

Effect of Oil in Steam Boilers. J. E. Terman. Describes bags caused by oil, and matters relating to the subject. 1600 w. Power—Nov. 3, 1908. No. 43.

See also Feed-Water Heating, under STEAM ENGINEERING; Analysis, under CIVIL ENGINEERING, WATER SUPPLY; and Rand, under MINING AND METALLURGY, GOLD AND SILVER.

Condensers.

Condensers. S. K. Patterson. Considers the general theory of condensers, types, difficulties in design and operation, and related matters. 2500 w. Elec Rev, N Y—Nov. 28, 1908. No. 499.

See also same title, under MARINE AND NAVAL ENGINEERING.

Engine Efficiency.

See Steam Engines, under MARINE AND NAVAL ENGINEERING.

Engines.

Design of an English High-Speed Steam Engine. Philip Bellows. Discusses an engine of the semi-superposed type, calling attention to noteworthy features. Ills. 4500 w. Power—Nov. 3, 1908. No. 42.

Engine Tests.

Tests on a Wolf Superheated Steam Portable Engine (Versuche mit einer Heissdampf-lokomobile von R. Wolf). Herrn Gutermuth und Watzinger. Reports tests on a 100-140 horse power tandem engine. Ills. 3000 w. Zeitschr d Ver Deutscher Ing—Oct. 3, 1908. No. 598 D.

Entropy.

The Entropy Diagram and Its Application to Steam (Die Entropiefunktion und ihre Anwendung auf Wasserdampf). J. W. Haeussler. Refers particularly to the thermo-dynamics of the steam turbine. Serial. 1st part. 2000 w. Die Turbine—Oct. 20, 1908. No. 568 D.

Feed-Water Heating.

Means and Methods for Heating the Feed Water of Steam Boilers. Reginald Pelham Bolton. First of a series of three articles examining the economy of feed-water heating. Ills. 3000 w. Engineering Magazine—Dec., 1908. No. 672 B.

Fuels.

Fuel Economy Tests at a Large Oil Burning Electric Power Plant Having Steam Engine Prime Movers. C. R. Weymouth. Presents results of fuel economy tests at the Redondo Plant, near Los Angeles, Cal. 6500 w. Jour Am Soc of Mech Engrs—Mid-Nov., 1908. No. 653 F.

Heat Storage.

Heat Accumulation in Steam Engineering. L. A. Battu. Briefly reviews the development of thermal storage plants, describing special apparatus and explaining when it can be made useful. Ills. Also discussion. 10500 w. Pro N Y R R Club—Oct. 16, 1908. No. 205.

Oil Fuel.

See Fuels, under STEAM ENGINEERING; and Oil Fuel, under MARINE AND NAVAL ENGINEERING.

Steam Pipes.

See Pipe Bending, under HEATING AND COOLING.

Steam Properties.

The Total Heat of Saturated Steam. Dr. Harvey N. Davis. Proposes a new formula for the range from 212 to 400 deg. the accuracy of which is believed to be within about 0.1 per cent. 3500 w. Jour Am Soc of Mech Engrs—Nov., 1908. No. 644 F.

See also Superheated Steam, under STEAM ENGINEERING.

Stoking.

Firing Cheap Grades of Fuel. William Kavanagh. Briefly outlines methods of firing that will avoid smoke. 1000 w. Power—Nov. 17, 1908. No. 296.

The Training of Firemen in Central Stations (L'Education Professionnelle du Personnel Chauffeur dans les Stations Centrales). J. Izart. Discusses the essentials of good boiler firing and means of obtaining it. Ills. 3500 w. L'Elecn—Oct. 17, 1908. No. 529 D.

Superheated Steam.

Thermal Properties of Superheated Steam. Discussion of the paper by Prof. R. C. H. Heck. 1400 w. Jour Am Soc of Mech Engrs—Nov., 1908. No. 645 F.

See Engine Tests, under STEAM ENGINEERING.

Turbine Design.

The Design of Steam Turbines (Sul "Calcolo" delle Turbine a Vapore). G. B. Dall'Armi. A mathematical demonstration of the method employed. Ills. 7000 w. Riv Marit—Oct., 1908. No. 538 E + F.

Turbines.

The Development of the Small Steam Turbine. Charles A. Howard. Illustrates and describes features of design and construction of leading types of small capacity turbines used in the United States. 2500 w. Engineering Magazine—Dec., 1908. No. 673 B.

The Low Pressure Steam Turbine. Charles B. Burleigh. Abstract of a paper read before the Nat. Assn. of Cotton Mfrs. Discusses the uses to which it may be applied with advantage. 2500 w. Power—Nov. 17, 1908. No. 295.

The Curtis Horizontal Steam Turbine. H. E. Twombly. Directions for operating this type. Ills. 2500 w. Power—Nov. 10, 1908. No. 165.

Running a Parsons Turbine. H. M. MacSweeney. Suggestions for operation. 2000 w. Power—Nov. 24, 1908. No. 470.

The New Eyermann Steam Turbine. Dr. Alfred Gradenwitz. Illustrated description of a turbine showing decided departures from usual practice. 2500 w. Power—Nov. 24, 1908. No. 467.

The Attachment of Steam-Turbine Blades (Ueber die Befestigung von Dampfturbinen-schaufeln). Wilhelm Gentsch. Illustrated description of the practice of various makers. Serial. 1st part. 2000 w. Die Turbine—Oct. 5, 1908. No. 566 D.

The Turbine with Regenerator as a Heat Motor (Die Turbine mit Regenerator als Wärmemotor). J. Nadrowski. A study of the thermodynamics of the steam turbine. Ills. Serial. 1st part. 2800 w. Die Turbine—Oct. 5, 1908. No. 565 D.

See also Entropy, under STEAM ENGINEERING.

TRANSPORTING AND CONVEYING.

Cableways.

Short-Distance Transportation. Frank C. Perkins. Illustrated description of a modern freight conveying system. 1000 w. Sci Am Sup—Nov. 21, 1908. No. 334.

Coal Handling.

Storage Yard and Mechanical Handling and Loading Plant at the Rheinelbe III Mine (Lagerplatz und Vorrichtung zum mechanischen Stürzen und Rückladen von Kohlen auf der Schachtanlage Rheinelbe III). Wilhelm Schulte. Illustrated description. 3100 w. Glückauf—Oct. 17, 1908. No. 555 D.

See also Weight, under MEASUREMENT.

Conveyors.

The Use and Performance of Belt Conveyors. Werner Boecklin. A useful summary of general working principles tending to economical operation. Ills. 2500 w. Engineering Magazine—Dec., 1908. No. 676 B.

A Novel Belt Conveyor System. Illustrated description of the system used in concrete construction on the New York Barge Canal. 2000 w. Ir Age—Nov. 5, 1908. No. 86.

Recent Developments in Material Handling Devices (Ueber einige Neuerungen im Massentransport). M. Buhle. Describes recent European types of conveyors, bucket elevators, etc. Ills. Serial. 1st part. 2500 w. Zeitschr d Oest Ing u Arch Ver—Oct. 23, 1908. No. 582 D.

See also Weight, under MEASUREMENT.

Cranes.

Modern Handling Cranes Built by Adolf Bleichert & Co, Leipzig (Moderne Verladekrane gebaut von Adolf Bleichert & Co. in Leipzig-Gohlis). Georg von Hanffstengel. Illustrated description. Serial. 1st part. 3800 w. Zeitschr d Ver Deutscher Ing—Oct. 31, 1908. No. 608 D.

See also Floating Cranes, and Shipbuilding, under MARINE AND NAVAL ENGINEERING.

Transporter Bridges.

The Old Bizerte Transporter Bridge at the Brest Arsenal (Transport de l'Ancien Pont à Transbordeur de Bizerte dans l'Arsenal Maritime de Brest). G. Leinekugel Le Cocq. Illustrated description. 3500 w. Génie Civil—Oct. 31, 1908. No. 536 D.

Traveling Bridges.

A Large Material Handling Plant. Brief illustrated description of the use of traveling bridges in building a river lock. 1000 w. Ir Age—Nov. 19, 1908. No. 336.

MISCELLANY.

Aeronautics.

Longitudinal Stability of Aeroplanes. Henry T. Strong. Explains a method of keeping the line of thrust of propellers always horizontal. 1500 w. Sci Am Sup—Nov. 7, 1908. No. 107.

The Lift and Drift of Arched Surfaces. Matthew Bacon Sellers. A study of their behavior in a uniform current of air. 2500 w. Sci Am Sup—Nov. 14, 1908. No. 245.

The Laws of Flight. F. W. Lanchester. Read before the British Assn., at Dublin. Considers information obtained by observation and experiment, explaining the theory of flight developed by the author. 3000 w. Engr, Lond—Sept. 18, 1908. Serial. 1st part. No. 95414 A.

The Problem of Aerial Navigation. B. Baden-Powell. A reply to Prof. Simon Newcomb's paper in the September issue of the same magazine. 4000 w. Nineteenth Cent—Nov., 1908. No. 289 D.

Battles in the Sky. Major Goebel. Trans. from *Illus. Zeit.* Discusses the military utility of the airship. 2000 w. Sci Am Sup—Nov. 14, 1908. No. 246.

Progress in Aviation. G. H. Bryan. A review of progress. Ills. 4000 w. Nature—Oct. 29, 1908. No. 166 A.

Cross-Country the Aeroplane Now Travels. W. F. Bradley. Illustrated account of recent achievements. 1500 w. Automobile—Nov. 19, 1908. No. 371.

An Aeroplane Factory. Jacques Boyer. Illustrated description of the Vorsin factory at Billancourt, France. 900 w. Sci Am—Nov. 21, 1908. No. 333.

Carbonic Acid.

The Physical Properties of Carbonic Acid and the Conditions of Its Economic Storage for Transportation. Prof. T. Stewart. Gives tables and charts showing the physical properties, results of the author's experiments on commercial carbonic acid in steel cylinders, and a method of designing commercial carbonic acid cylinders. 13500 w. Jour Am Soc of Mech Engrs—Nov., 1908. No. 643 F.

Gyroscopes.

Recent Development in Gyroscope Design. Describes a new form for engineering use invented by Prof. Narciss Ach. 3000 w. Sci Am Sup—Nov. 21, 1908. No. 335.

MINING AND METALLURGY

COAL AND COKE.

Coke Ovens.

Levellers for Coke Ovens. A. Thau, in Glückauf. Illustrates and describes types of mechanical levellers. 1000 w. Col Guard—Nov. 6, 1908. No. 317 A.

Electric Power.

Development of Electric Power in Coal Mines. George E. Walsh. Remarks on the Applications, recent installations, etc. 2000 w. Eng & Min Jour—Nov. 21, 1908. No. 410.

Explosions.

The Prevention of Mine Explosions. Recommendations of a committee appointed to investigate coal mine explosions. 2500 w. Can Min Jour—Nov. 15, 1908. No. 464.

Norton Hill Colliery Explosion. Report by Joseph S. Martin, on the circumstances attending the explosion of April 9, 1908. 3500 w. Col Guard—Oct. 30, 1908. No. 187 A.

See also Mine Dust, under COAL AND COKE.

Explosives.

Safety Blasting Explosives. Arthur M. Carney. Discusses the classes and properties of different explosives, and the apparatus and methods used in testing. Ills. 3500 w. Mines & Min—Nov., 1908. No. 30 C.

Tests with Compressed Gunpowder, Nitroglycerin and Ammonium Nitrate Explosives in the Schwalbach Mine (Versuche mit komprimiertem Pulver, Nitroglyzerin- und Ammonsalpeter-Sprengstoffen im Schwalbach Flöz der Königl. Steinkohlengrube Schwalbach - Saar). Erich Seidl. Describes the tests and gives the results and conclusions drawn from them. Ills. 3100 w. Glückauf—Oct. 31, 1908. No. 558 D.

Handling.

See Coal Handling, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Illinois.

Studies of Illinois Coals. Gives results of investigations made by experts, with discussions of certain phases, with summary and conclusions. 22500 w. Bul Am Inst of Min Engrs—Nov., 1908. No. 688 E.

Mine Dust.

The Present Position of the Coal Dust Problem. James and John Ashworth. Read before the Can. Min. Inst. Discusses coal dust as connected with colliery explosions. 2000 w. Can Min Jour—Nov. 1, 1908. No. 45.

Mine Gas.

The Influence of Atmospheric Conditions on the Amount of Water and Gas in Mines (Der Einfluss der Luftdruckschwankungen auf den Wasserdrang und den Gasaustritt in Bergwerken). Chr. Mezger. A discussion based on extensive observations. Ills. Serial. 1st part. 5600 w. Glückauf—Oct. 24, 1908. No. 557 D.

Mining.

The Cost of Longwall in England. George R. Dixon. Gives details and dimensions of the system. 2000 w. Eng & Min Jour—Nov. 14, 1908. No. 260.

Advanced Methods of Mining Coal in Silesia. Lucius W. Mayer. Illustrates and describes a system in which filling is flushed into the workings and total extraction accomplished. 6000 w. Eng & Min Jour—Nov. 7, 1908. No. 145.

The Determination of the Net Contents of Loaded Cars (Die Ermittlung des Nettoinhaltes beladener Förderwagen). A. Weise. Describes methods for the purposes of miners' wage determination. Ills. 2500 w. Glückauf—Oct. 3, 1908. No. 553 D.

See also Eight-Hour Day, under INDUSTRIAL ECONOMY.

Mining Plants.

Re-Sinking and Re-Equipping the Great Western Colliery Company's Maritime Pit. Hugh Bramwell. Read before the S. Wales Inst. of Engrs. Illustrates and describes the work and methods. 5000 w. Ir & Coal Trds Rev—Oct. 23, 1908. No 81 A.

Storage.

See Coal Handling, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Washing.

Coal-Washing Jigs. E. J. Munby. Describes the Foust jig and its trial. Ills. 1500 w. Sci Am Sup—Nov. 14, 1908. No. 247.

COPPER.

Australia.

See same title, under GOLD AND SILVER.

Austria.

The Value of the Schneeberg Deposits (Die Bauwürdigkeit der Schneeberger Lagerstätten). B. Granigg. A discussion of the economy of further working of these zinc-lead-copper deposits in the Austrian Tyrol. Ills. Serial. 1st part. 4500 w. Oest Zeitschr f Berg u Hüttenwesen—Oct. 24, 1908. No. 551 D.

Electro-Metallurgy.

Improvements in the Construction and

Manufacture of Parabolic Reflectors. Sherard Cowper-Coles. Describes an electrolytic process for making metallic reflectors. Ills. 4500 w. Engng—Oct. 23, 1908. No. 78 A.

Idaho.

Snowstorm Copper Deposits. Abstract of Paper 62, U. S. Geol. Survey, by F. L. Ransome and F. C. Calkins. Describes the deposits of this productive mine in Idaho. 1000 w. Min & Sci Pr —Nov. 21, 1908. No. 623.

Mattes.

The Constitution of Copper-Iron and Copper-Lead-Iron Mattes. Charles H. Fulton and Ivan E. Goodner. Determines, by metallographic and chemical means, the constitution of the mattes named. Ills. 8500 w. Bul Am Inst of Min Engrs—Nov., 1908. No. 685 C.

Peru.

The Mineral Resources of the Department of Apurimac, Peru. A. Jochamowitz. Reports of various districts, where copper, silver and gold are found. 4500 w. Min Jour—Nov. 7, 1908. No. 321 A.

See also Smelting, under COPPER.

Reverberatory Furnaces.

Regenerative Reverberatory Copper Furnace. Fred A. Leas. Plans and description of an oil-burning furnace at the works of the Peyton Chemical Company. 2000 w. Eng & Min Jour—Nov. 7, 1908. No. 147.

Smelters.

Construction of 100-Ton Copper Smelting Plant. Charles C. Christensen. Illustrates and describes some of the essential features. 2000 w. Eng & Min Jour —Oct. 31, 1908. No. 16.

Smelting.

Salt Lake, Utah. A letter from Mr. Courtenay DeKalb, describing a recent invention for condensing smelter fume. 1100 w. Min & Sci Pr—Nov. 14, 1908. No. 359.

Smelting at Cerro de Pasco, Peru. Lester W. Strauss. Illustrates and describes the plant and methods used for these copper ores. 5800 w. Min & Sci Pr— Nov. 7, 1908. No. 382.

GOLD AND SILVER.

Alabama.

See Gold Milling, under ORE DRESSING AND CONCENTRATION.

Australia.

Cobar Gold and Copper Field, New South Wales. Gerard W. Williams. Oxidized gold ores at surface become refractory and copper-bearing with depth, presenting difficulties in treatment. Ills. 1200 w. Eng & Min Jour—Nov. 14, 1908. No. 259.

Bohemia.

The Silver Lead Mines of Przibram. H. L. Terry. Descriptive account of mines famous for their great depth, and where the galena has proved increasingly argentiferous with depth. 3000 w. Min Jour—Nov. 7, 1908. No. 320 A.

California.

The Eagle Shawmut Mine. S. E. Montgomery. A discussion of present day methods of mining low-grade ores. 2000 w. Cal Jour of Tech—Oct., 1908. No. 342.

Chlorination.

Chlorination in California. Wilton E. Darrow. Discusses the Plattner and Greenawalt processes and describes modern plants. 2000 w. Min & Sci Pr—Oct. 31, 1908. No. 114.

Cobalt.

The Present Position of Cobalt, Ontario. Harold P. Davis. Gives statistics of production and shipment. Ills. 800 w. Eng & Min Jour—Oct. 31, 1908. No. 17.

The Fortunes of the Temiskaming & Hudson's Bay Mining Company. Alex. Gray. An account of the origin and work of this company at Cobalt, Ontario. 2500 w. Min Jour—Oct. 24, 1908. No. 75 A.

See also Ore Deposits, under MISCELLANY.

Colorado.

The San Juan Region, Colorado. Thomas T. Read. Describes the latest phases of development, reviewing its history. Ills. 3000 w. Min & Sci Pr— Nov. 7, 1908. Serial. 1st part. No. 234.

The Portland Mine in Cripple Creek District. C. P. Scates. An account of the methods of mining and ore treatment in this gold mine. Ills. 1800 w. Min Wld—Nov. 7, 1908. No. 157.

Cyaniding.

Home-Made Cyanide Plant. W. F. Boericke and B. L. Eastman. Describes a plant for treating low-grade tailings at small cost. 600 w. Min & Sci Pr— Nov. 21, 1908. No. 625.

Newer Ore-Treatment and Metallurgical Processes and Their Machinery. Charles C. Christensen. Deals with the latest practice in a few of the recently developed processes for silver and copper ores, and the appliances used. Ills. 3500 w. Engineering Magazine—Dec., 1908. No. 679 B.

Cyanide Mills, Guanajuato Development Co. Charles T. Rice. The Nayal mill shows the possibilities of cyaniding silver ores on a small scale. The interesting features of other mills are described. Ills. 3000 w. Eng & Min Jour—Nov. 14, 1908. Serial. 1st part. No. 257.

Zinc Dust Precipitation at Cerro Prieto. Robert Linton. An account of a plant in Mexico successfully using zinc dust for precipitation. 2500 w. Jour Chem, Met, & Min Soc of S Africa—Sept., 1908. No. 175 E.

Dredging.

The Method and Cost of Gold Dredging by the Elevating Bucket. Describes its use, reporting costs. Ills. 2000 w. Engng-Con—Nov. 4, 1908. No. 120.

Hydraulic Mining.

See Yukon, under Gold and Silver.

Idaho.

The Coeur d'Alene Mining District, Idaho. J. P. Rowe. Reviews the history and describes the methods of mining. Ills. 1600 w. Min Wld—Nov. 14, 1908. Serial. 1st part. No. 278.

Mexico.

Las Chispas Mines, Sonora, Mexico. B. E. Russell. The mining and ore treatment of rich silver deposits. Ills. 2000 w. Eng & Min Jour—Nov. 21, 1908. No. 409.

Hinds Consolidated Mines, Mexico. S. F. Shaw. A report of the mines of this company which yield lead, gold, silver, and other economic minerals. Ills. 1000 w. Min & Sci Pr—Oct. 31, 1908. No. 111.

Hostotipaquillo and the Lerma River. Ezequiel Ordoñez. Map and illustrated description of this mining region where old mines are now being developed by improved methods. The most valuable mineral is silver sulphide. 2500 w. Min & Sci Pr—Nov. 21, 1908. No. 624.

Nevada.

Progress on the Comstock Lode. R. L. Herrick. Reviews the history and difficulties that caused the shutting down, and the events that led to the reopening. Ills. 7000 w. Mines & Min—Nov., 1908. No. 31 C.

Mining and Milling at Virginia City, Nevada. G. E. Walcott. Reminiscences of the camp where milling of silver ore was first practiced, and where the square-set system of timbering was invented. Ills. 3000 w. Min Wld—Nov. 21, 1908. No. 461.

New Mexico.

The New Gold Camp at Sylvanite, New Mexico. Charles A. Dinsmore. An account of the discovery, transportation facilities and work being done. 2000 w. Min Wld—Oct. 31, 1908. No. 38.

New Zealand.

The Gold Mines of Blackwater and Reefton Districts, New Zealand. Gives the history, geology, and development of the mines of these districts. 4000 w. Min Jour—Oct. 31, 1908. No. 186 A.

Peru.

See same title, under Copper.

Rand.

The Robinson Mine. J. B. Pritchford. A report of the most productive gold mine in the world at the present time. 2200 w. Min & Sci Pr—Oct. 31, 1908. No. 113.

Notes on Rand Mining. Tom Johnson. Reply to discussion of paper on this subject by the author. 13000 w. Jour Chem, Met & Min Soc of S Africa—Sept., 1908. No. 177 E.

Rand Mine Waters. F. W. Watson. Deals with waters for drinking and domestic uses, and for industrial purposes, especially for boiler feed supply. Also discussion. 7000 w. Jour S African Assn of Engrs—Sept., 1908. No. 60 F.

Rhodesia.

Small Mines of Rhodesia. B. I. Collings. Describes the nature of the ore bodies, the economic and industrial peculiarities of the country, and their effect on the methods of mining and milling adopted. 5000 w. Jour Chem, Met & Min Soc of S Africa—Sept., 1908. No. 176 E.

Tasmania.

The Lisle Goldfield, Tasmania. W. H. Twelvetrees. Specially considering the sources of the alluvial gold. 1600 w. Aust Min Stand—Oct. 14, 1908. No. 463 B.

Yukon.

Hydraulic Mining in the Yukon. R. E. W. Hagarty. Describes methods used. 4000 w. Can Engr—Nov. 6, 1908. No. 155.

IRON AND STEEL.

Alabama.

The Clinton Iron-Ore Deposits in Alabama. Ernest F. Burchard. Gives an outline of the geologic relations of the ores, describing particularly the ore of the Birmingham district, and discussing its relations and probable extent. Ills. 1600 w. Bul Am Inst of Min Engrs—Nov., 1908. No. 686 D.

Blast-Furnace Gas.

The Purification and Economic Utilization of Blast-Furnace Gas (Epuration et Utilisation Economique des Gaz de Hauts-Fourneaux). Louis Detrez. Discusses the problem, methods and cost of cleaning the gas and the economy of its use in gas engines. 5000 w. Bul Sci d l Assn d Elèves—June-Oct., 1908. No. 500 D.

Bosnia.

Iron Making in Bosnia (Eisenhüttenwesen in Bosnien). A general brief review of the industry. Ills. 2300 w. Stahl u Eisen—Oct. 28, 1908. No. 549 D.

Dry-Air Blast.

Experience with the Gayley Dry Blast at the Warwick Furnaces, Pottstown, Pa. Edward B. Cook. A brief illustrated description of the Warwick plant, with account of its very satisfactory working. 5000 w. Bul Am Inst of Min Engrs—Nov., 1908. No. 683 C.

Electro-Metallurgy.

Steel Making by the Girod Electrical

Process. Brief illustrated description of the Paul Girod electric steel-making furnace. 1000 w. Ir Trd Rev—Nov. 12, 1908. No. 233.

Ingot Iron from the Electric Furnace. Trans. of article by B. Osann, in *Stahl und Eisen.* Gives results obtained with the Stassano furnace. Ills. 3500 w. Ir & Coal Trds Rev—Nov. 6, 1908. No. 330 A.

The Development of Electric Steel Plants (Zur Entwicklung der Elektrostahlanlagen). A table giving details of the various electric steel plants in the world. 2000 w. Stahl u Eisen—Oct. 7, 1908. No. 545 D.

An Electric Furnace with One Electrode and with a Conducting Hearth (Sur un Four électrique à une seule Electrode et à Sole Conductrice). M. Durnuis. Researches on such a furnace. Ills. 1500 w. Rev de Métal—Oct., 1908. No. 515 E + F.

See also Lash Process, under IRON AND STEEL.

Lash Process.

The Lash Steel Process. F. A. J. FitzGerald. Abstract of paper and discussion, before the Am. Elec-Chem. Soc. Describes the process, discussing the possibility of its application to the electric furnace. Ills. 1500 w. Ir Age—Nov. 5, 1908. No. 85.

New York.

Clinton Iron Ores in New York State. Data from a report issued by the Educational Department of the State, concerning a recent investigation of their extent and character. 2500 w. Ir Age—Nov. 12, 1908. No. 218.

Pennsylvania.

The Clinton Iron-Ore Deposits of Stone Valley, Huntingdon Co., Pa. J. J. Rutledge. Describes the ores and associated rocks, discussing their origin. Ills. 10500 w. Bul Am Inst of Min Engrs—Nov., 1908. No. 687 C.

Rolling Mills.

Three-High Rolling-Mill at Mossend Steel Works. Drawings and brief description. Plate. 400 w. Engng—Nov. 13, 1908. No. 446 A

New Electric Rolling Mill Plant at the Works of Messrs. Dorman, Long & Company, Limited. Illustrated detailed description. 3000 w. Ir & Coal Trds Rev—Oct. 30, 1908. No. 201 A.

Hydraulic Machines in English Rolling Mills (Einige hydraulische Vorrichtungen englischer Walzwerke). K. Rummel. Illustrates and describes apparatus and machines for various purposes. 3000 w. Stahl u Eisen—Oct. 14, 1908. No. 546 D.

Steel Making.

See Lash Process, under IRON AND STEEL.

Trade.

The Flow of Steel Through Consumption. Editorial on the movement of products of the steel industry. 2000 w. Ir Age—Nov. 26, 1908. No. 497.

LEAD AND ZINC.

Australia.

See Lead Milling, under ORE DRESSING AND CONCENTRATION.

Austria.

See same title, under COPPER.

France.

The Mining and Milling of Silver, Lead and Zinc Ores at Pierrefitte Mines, France. William Waters Van Ness. Reviews the history of these mines, describing conditions, mining methods, etc., and giving costs. Ills. 7000 w. Bul Am Inst of Min Engrs—Nov., 1908. No. 684 C.

Mexico.

See same title, under GOLD AND SILVER.

Oklahoma.

Miami Lead and Zinc District in Oklahoma. Otto Ruhl. Describes the ore occurrence, difficulties in milling, and gives the capacity of some of the mills. Ills. 2000 w. Eng & Min Jour—Nov. 7, 1908. No. 150.

Zinc Smelting.

Zine Smelting for Pigment. Evans W. Buskett. Information concerning the manufacture of zinc pigment. Ills. 1200 w. Min & Sci Pr—Oct. 31, 1908. No. 112.

The Method of Extracting Zinc in Australia. John Plummer. Describes recovering zinc from the waste of Broken Hill silver-lead mines. Ills. 1200 w. Min Wld—Nov. 7, 1908. No. 158.

MINOR MINERALS.

Aluminium.

The Development of the Aluminium Corporation, Ltd. Illustrated description of plants for the production of aluminium by the electro-thermal process. 6500 w. Elec Rev. Lond—Nov. 6, 1908. No. 310 A.

Notes on Aluminium. Prof. A. Humboldt Sexton. Its properties, compounds, minerals, purification, etc., are discussed in the present number. 3300 w. Mech Engr—Nov. 13, 1908. Serial, 1st part. No. 430 A.

Aluminium and Some of Its Uses. J. T. W. Echevarri. Read before the Inst. of Metals. Its manufacture, properties, methods of working and its applications are considered. 4000 w. Min Jour—Nov. 14, 1908. Serial, 1st part. No. 439 A.

Antimony.

Notes on Antimony. Prof. A. Humboldt Sexton. Considers its physical and chemical properties, its compounds, minerals, treatment, etc. Ills. 4000 w. Mech Engr—Oct. 30, 1908. No. 182 A.

Cement.

Cement Raw Meal Mixer and Stores. Details and illustrations of the cement works at Cambridge, Eng. 1200 w. Engr, Lond—Nov. 13, 1908. No. 452 A.

A Design for a Portland Cement Plant with a Car System for Transporting Materials. C. J. Tomlinson. Plans and description of a departure from accepted designs for this work. 1200 w. Eng News—Nov. 19, 1908. No. 375.

Manganese.

See Alloys, under MISCELLANY.

Oil.

The Shale Oil Industry of Scotland. D. R. Steuart. An account of the nature, extent and origin of the industry; its history, geology and methods. Ills. 7000 w. Ec-Geol—Oct.-Nov., 1908. No. 480 D.

The Oil Fields of Argentina. Brief account of a recent discovery and reference to previous discoveries. Map. 600 w. Engng—Oct. 30, 1908. No. 188 A.

Platinum.

Platinum at the Cracker Jack Mine, Douglas County, Oregon. H. B. Pulsifer. On the treatment of platinum-bearing black sands. 1000 w . Eng & Min Jour—Nov. 21, 1908. No. 408.

Rare Metals.

The Rare Metals. I. Beryllium. Charles Baskerville. The present article considers some of the minerals of beryllium. 1000 w. Eng & Min Jour—Nov. 7, 1908. Serial, 1st part. No. 149.

Turquoise.

Turquoise Mining, Burro Mountains, New Mexico. Edward R. Zalinski. Notes on how turquoise is mined, and a review of the geological features. Ills. 3500 w. Eng & Min Jour—Oct. 31, 1908. No. 15.

MINING.

Boring.

See same title, under CIVIL ENGINEERING, CONSTRUCTION.

Electric Power.

Switchboards for Mine Power Plants. W. B. Clarke. Considers the equipment desirable and the reasons for certain arrangements. 3000 w. Mines & Min—Nov., 1908. No. 32 C.

See also Exhibitions, under MINING.

Engineering Ethics.

Professional Ethics. John Hays Hammond. The relation of the mining engineer to employers, to the public, and to personal interest. 3000 w. Bul Am Inst of Min Engrs—Nov., 1908. No. 690 C.

Exhibitions.

Manchester Electrical Exhibition. The first of a series of illustrated articles describing especially the exhibits dealing with mining and quarrying. 3000 w. Col Guard—Nov. 6, 1908. Serial, 1st part. No. 318 A.

Explosives.

See same title, under COAL AND COKE.

Finance.

The Better Protection of Mine Investors. H. S. Munroe. Briefly considers prospecting, development and working, and the information that a company report should contain. 1500 w. Min Wld—Nov. 14, 1908. Serial, 1st part, No. 279.

Haulage.

An Electric Colliery Railway. Illustrated description of an installation at Chopwell Colliery, England. 1700 w. Elec Engng—Oct. 22, 1908. No. 70 A.

Some Economies in Underground Ore Haulage. G. E. Walcott. Discusses how to lay tracks, how to run a drift, switching devices, etc. Diagrams. 3000 w. Min Wld—Oct. 31, 1908. No. 37.

Hoisting.

The Influence of the Use of Back Steam for Shortening Hoisting Time on the Steam Consumption of Hoisting Engines (Der Einfluss der Fahrt mit Gegendampf zur Verkürzung der Fahrzeit auf den Dampfverbrauch von Fördermaschinen). Herr Moritz. Discusses an actual experience. Ills. 2000 w. Glückauf—Oct. 10, 1908. No. 554 D.

Labor.

The Kaffir Mine Laborer. Thomas Lane Carter. An account of conditions in South Africa, the mental and physical capabilities of the natives, their customs and their economic value as laborers. Ills. 10800 w. Bul Am Inst of Min Engrs—Nov., 1908. No. 681 C.

Mine Waters.

A Method of Determining Ground-Water Flow during Shaft Sinking. (Ueber eine Methode zur Ermittlung der zur wältigenden Wasserzuflüsse beim Uebergang vom Schachtabteufen in totem Wasser zur Abteufarbeit auf der Sohle). Dr. Münster. Description and mathematical demonstration. Ills. 2800 w. Glückauf—Oct. 24, 1908. No. 556 D.

Shaft Sinking.

A Difficult Shaft Sinking Operation at Durwood, Minn. An account of methods used. 1000 w. Ir Trd Rev—Nov. 5, 1908. No. 108.

Note on a Problem During Shaft Sinking. Charles B. Saner. An account of methods of accomplishing difficult work in the shaft of the Turf Mines, Ltd., on the Rand. 2500 w. Jour Chem, Met & Min Soc of S Africa—Sept., 1908. No. 174 E.

Shaft Tubbing.

Tubbing for Modern Collieries. J. S. Barnes. Discusses the scientific design of tubbing. Diagrams. 3000 w. Engr, Lond—Oct. 23, 1908. No. 79 A.

Subsidence.
The Law of Subsidence. Discusses British law and recent decisions. 1500 w. Col Guard—Nov. 13, 1908. No. 440 A.

Surveying.
A Few Suggestions on How to Survey a Mine. Charles W. Helmick. Briefly considers three methods, explaining the determination of a meridian, etc. 1500 w. Min Wld—Oct. 31, 1908. No. 39.

Tunnel Lining.
See same title, under CIVIL ENGINEERING, CONSTRUCTION.

ORE DRESSING AND CONCENTRATION.

Crushers.
See same title, under MECHANICAL ENGINEERING, MACHINE ELEMENTS AND DESIGN.

Flotation Process.
Ore Dressing by Adhesion of Liquid Films. R. Stören. Reviews the principles of the Elmore process and other systems based upon similar principles. 4000 w. Eng & Min Jour—Oct. 31, 1908. No. 14.

Gold Milling.
How to Clean and Dress Amalgamating Plates. Justin H. Haynes. Useful hints and suggestions. 1500 w. Min Wld—Nov. 21, 1908. No. 462.

The St. George Treatment Plant (W. A.). Percy Ifould. A brief description of a modern plant. 1200 w. Aust Min Stand—Sept. 30, 1908. No. 178 B.

The Treatment of the Gold Ores of Hog Mountain, Alabama. T. H. Aldrich, Jr. An account of experiments made, and conclusions reached, concerning the treatment of certain refractory low-grade gold-ores. 2500 w. Bul Am Inst of Min Engrs—Nov., 1908. No. 682 C.

See also Colorado, Cyaniding, and Rhodesia, under GOLD AND SILVER.

Iron Ores.
See Magnetic Concentration, under ORE DRESSING AND CONCENTRATION.

Lead Milling.
Metallurgy of Broken Hill, New South Wales. Gerard W. Williams. Describes concentration methods. 6000 w. Eng & Min Jour—Nov. 7, 1908. No. 146.

See also France and Oklahoma, under LEAD AND ZINC.

Jigs.
See Washing, under COAL AND COKE.

Magnetic Concentration.
Notes on Some Recent Swedish Plants and Methods for Concentrating and Briquetting Iron Ores (Mitteilungen über einige neuere schwedische Anlagen und Verfahren für Aufbereitung und Brikettierung von Eisenerzen und Kiesabbränden). G. Franke. Illustrated description of latest developments in the Gröndal process. Serial, 1st part. 4800 w. Glückauf—Oct. 3, 1908. No. 552 D.

Sampling.
Principles of Machine Sampling. John A. Church. Discusses the controlling elements and the possible methods of remedying their faults. 2500 w. Eng & Min Jour—Nov. 14, 1908. No. 258.

Silver Milling.
Metallurgical Practice at Hacienda de la Union. Francisco Narvaez. Illustrated description of the present system of treatment at Pachuca, Mexico. 3000 w. Eng & Min Jour—Nov. 21, 1908. No. 406.

Stamp Mills.
Some Notes on the Gravitation Stamp Mill. R. C. Robinson. Describes the general design and construction and some details. 4000 w. Queens Gov Min Jour—Oct. 15, 1908. No. 460 B.

Wilfley Tables.
Experimental Work in Ore Concentration. John Allen Davis. Reports investigations made to determine the conditions of greatest efficiency in concentrating a classified product on tables. 1800 w. Eng & Min Jour—Nov. 7, 1908. No. 148.

Zinc Milling.
Improvements at the Oronogo Circle Mill No. 5. Otta Ruhl. Illustrates and describes equipment for setting and treating fine material. 1800 w. Eng & Min Jour—Nov. 21, 1908. No. 407.

MISCELLANY.

Alloys.
The Alloys of Manganese (Les Alliages de Manganèse). A. Portevin. Summarizes the results of Prof. Tammann's researches on the alloys of manganese with nickel, lead, phosphorus, antimony, silicon, and tin. Also alloys of magnesium with bismuth, cadmium, potassium, sodium, nickel, lead, antimony, tin, thallium, and zinc. Ills. 500 w. Rev de Mètal—Oct., 1908. No. 516 E + F.

British Columbia.
Mining in British Columbia. A general review of the industry. Ills. 9000 w. B C Min Rec—Aug., 1908. No. 82 B.

Canada.
The Taxation of Mineral Resources in Canada. O. D. Skelton. Reviews the measures adopted, with comments. 3500 w. Can Min Jour—Nov. 1, 1908. No. 44.

Mineral Springs.
The Hot Mineral Springs of Savoie (Les Sources Thermo-Minérales de la Savoie). J. Révil. A discussion of their origin. Ills. 6000 w. Rev Gen d Sci—Oct. 30, 1908. No. 524 D.

Ore Deposits.
Origin of Cobalt Silver Ores of Northern Ontario. Reginald E. Hore. Gives results of study in field and laboratory, and conclusions. 4000 w. Ec-Geol—Oct.-Nov., 1908. No. 481 D.

The Relation of Copper to Pyrite in

the Lean Copper Ores of Butte. James F. Simpson. Gives results of investigations. Ills. 1800 w. Ec-Geol—Oct.-Nov., 1908. No. 483 D.

A Genetic Classification of Minerals. William H. Emmons. Indicates briefly the principal conditions under which the most important minerals are formed, giving tables and explanatory notes. 4500 w. Ec-Geol—Oct.-Nov., 1908. No. 482 D.

The Localization of Values in Ore Bodies and the Occurrence of Shoots in Metalliferous Deposits. Hjalmar Sjögren. Notes concerning the Scandinavian copper and lead-silver mines. 2500 w. Ec-Geol—Oct.-Nov., 1908. No. 484 D.

A New Theory of the Genesis of Brown Hematite Ores; and a New Source of Sulphur Supply. Charles Catlett's discussion of the paper by H. M. Chance. 1500 w. Bul Am Inst of Min Engrs—Nov., 1908. No. 689 C.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Communication.

Telegraph Service on Railways (Etude du Service Télégraphique dans les Chemins de Fer). M. Pellarin. Report of a commission appointed to study conditions in Belgium, Italy, Switzerland, and Holland. 4000 w. Ann d Ponts et Chaussées—1908-III. No. 505 E + F.

Signalling.

The State of the Art of Railway Signalling. J. P. Simmen. A general review, with a description of the Simmen system. 4500 w. Can Engr—Nov. 20, 1908. No. 405.

Railway Signalling: Its Defects, and Suggestions for Removing Them. A. Gardiner. Abstract of paper before Leeds Loc. Soc. of Inst. of Elec. Engrs. Describes the author's system of train working with engine cab signals. 2000 w. Elect'n, Lond—Nov. 6. 1908. No. 313 A.

Controlled Manual Block Signaling. A. D. Cloud. Describes this system as used on some of the western roads. 3000 w. Sig Engr—Nov., 1908. No. 281.

Safety Appliances on the Java Railways (Dutch Indies). L. Dufour. Describes the appliances adapted for interlocking the signals and switches on lines carrying but little traffic. Ills. 2200 w. Bul Int Ry Cong—Oct., 1908. No. 169 G.

See also Drawbridges, under CIVIL ENGINEERING, Bridges.

Train Operation.

Extension of the "A. B. C." Rules on Northern Pacific. An explanation of this system of train operation and the instructions for the change. 1500 w. R R Age Gaz—Nov. 6, 1908. No. 128.

MOTIVE POWER AND EQUIPMENT.

Air Pumps.

Care of the Air Pump. G. W. Kiehm. Suggestions for repairs and care. 1500 w. Ry & Loc Engng—Nov., 1908. No. 9 C.

Electrification.

Inaugural Address to the Leeds Local Section of the Institution of Electrical Engineers. H. E. Yerbury. (Abstract.) Reviews the progress made in the electrification of tramways and railways, discussing probable future developments. 1200 w. Elect'n, Lond—Nov. 6, 1908. No. 312 A.

Report of the Swiss Commission on Electrification (Mitteilungen der Schweizerischen Studienkommission für elektrischen Bahnbetrieb). W. Wyssling. Results of an investigation of the possibilities of electric traction on Swiss railways. Ills. Serial, 1st part. 3000 w. Schweiz Bau—Oct. 17, 1908. No. 561 B.

See also Trunk Lines, under STREET AND ELECTRIC RAILWAYS.

Freight Cars.

A General Service Freight Equipment Car. Detailed description of a car of the convertible type. Ills. 900 w. Am Engr & R R Jour—Nov., 1908. No. 91 C.

Standard Fifty-Ton Gondola Coal Car. Illustrated detailed description of cars for the Virginian Railway. 1200 w. Am Engr & R R Jour—Nov., 1908. No. 88 C.

The Construction of Large Railway Wagons. From the presidential address of Jas. Hewlett before the Midland Jun. Gas Engng. Assn. Compares flat and hopper wagons, and ten and twenty-ton wagons. 2500 w. Ir & Coal Trds Rev—Oct 30, 1908. No. 202 A.

Locomotive Design.

The Efficiency of Locomotives and Its Relation with Their Chief Dimensions and the Speed. Albert Frank, in *Ann. für Gewerbe und Bauwesen.* Gives calculations of value in designing locomotives for special purposes. 9800 w. Bul Int Ry Cong—Oct., 1908. No. 170 G.

Design of a Four-Cylinder Compound Locomotive (Calcul d'une Locomotive Compound à Quatre Cylindres). Marcel Ubaghs. Illustrated description of the method of obtaining the principal dimensions. 3500 w. All Indus—Oct., 1908. No. 527 D.

Locomotive Economy.

Locomotive Characteristics. Lawford

H. Fry. Gives chart for the operation of single expansion locomotives, with explanatory notes. 1800 w. Am. Engr & R R Jour—Nov., 1908. No. 89 C.

Locomotives.

Details of DeGlehn Compound Locomotives. Drawings and description of the cylinders and of a novel boiler fitted to these locomotives. 1400 w. Am Engr & R R Jour—Nov., 1908. No. 90 C.

New Standardized Locomotives, Harriman Lines Illustrates and describes types, giving specifications for the mogul type. 1500 w. Ry & Engng Rev—Oct. 31, 1908. No. 40.

Goods Locomotive for the Caledonia Railway. View, outline, sketch, and description of a new engine. 500 w. Engng —Oct. 23, 1908. No. 77 A.

Mogul for the Iowa Central. Illustration, with description of a 2-6-0 type for freight service. 700 w. Ry & Loc Engng —Nov., 1908. No. 8 C.

Ten-Wheeler for the Lackawanna. Illustration and description of recent engines for passenger service, weighing 217000 lbs. 900 w. Ry & Loc Engng—Nov., 1908. No. 11 C.

"Pacific" Type Compound Locomotive for the Paris-Orleans Railway. Illustrated detailed description of a 4-6-2 type of engine. 600 w. Engr, Lond—Oct. 30, 1908. No. 200 A.

Mallet Articulated Compound Locomotives for Santo Domingo. Illustrated detailed description. 700 w. R R Age Gaz—Nov. 27, 1908. No. 630.

Twelve-Wheel Articulated Compound Freight Locomotive of the Hedschas Railway (Sechsachsige kurvenbewegliche Güterzug-Verbundlokomotive der Hedschasbahn). H. Keller. Detailed description. Ills. 2700 w. Zeitschr d Ver Deutscher Ing—Oct. 10, 1908. No. 601 D.

Locomotive Speed.

See Speed, under ELECTRICAL ENGINEERING, MEASUREMENT.

Locomotive Superheating.

The Application of Superheated Steam to Locomotives (Note sur l'Application de la Vapeur Surchauffée aux Locomotives). Maurice Demonlin. Deals with the results obtained on the Italian State Railways and the Western Railway of France. Ills. 10000 w. Rev Gen d Chemins d Fer—Oct., 1908. No. 521 G.

Locomotive Trucks.

The Mechanics of the Locomotive Truck. L. S. Randolph. A discussion of the principles governing the three types of truck developed. Mathematical. 3000 w. Stevens Ind—Oct., 1908. No. 486 D.

Locomotive Valve Gears.

Young Rotary Valve and Gear for Locomotives. Illustrated detailed description of the recent improvements in this valve gear. 1000 w. R R Age Gaz—Nov. 13, 1908. No. 244.

Setting Walschaert Valve Gear. R. S. Mounce. Rules for a specific case, but of general use. Diagrams. 900 w. Am Engr & R R Jour—Nov., 1908. No. 92 C.

Motor Cars.

Accumulator Cars of the Prussian State Railways (Akkumulatoren Doppelwagen der Preussischen Staatsbahnen). Illustrated description and details of performance. 2000 w. Elektrotech Zeitschr—Oct. 29, 1908. No. 615 B.

Gasoline and Oil Engines for Railway Motor Cars (Motore a Petrolio e ad Oli Pasanti, a Combustione senza Accensore, per Automotrici Ferroviarie, Moderabile, Invertibile e ad Azione Diretta sull' Asse del Veicolo). Enrico Mariotti. Ills. Serial. 1st part. 3000 w. Ing Ferro—Oct. 16, 1908. No. 542 D.

Refrigeration.

The Transportation of Perishable Freight in Refrigerator Cars (Le Transport des Denrées Alimentaires par Wagons Frigorifiques). L. Piaud. Describes recent French practice. Ills. 3000 w. Génie Civil—Oct. 3, 1908. No. 533 D.

Shops.

Improvements at the Works of the Kingston Locomotive Company, Kingston, Ontario, Canada Henry Goldmark. Describes the enlargement and modernizing of these works. Ills. 3500 w. Can Soc of Civ Engrs—Oct. 29, 1908. No. 284 N.

A Modern Steel Car Plant. Horace H. Lane. Describes the Detroit shops of the American Car & Foundry Co. 3500 w. Ir Age—Nov. 12, 1908. No. 216.

Modern Plants for Building Steel Cars. Horace H. Lane. An illustrated study of modern plants, their equipment and methods. 5000 w. Jour Assn of Engng Socs —Sept., 1908. No. 351 C.

The J. J. Beijnes Car Shops at Haarlem (De Koninklijke Fabriek van Rijtuigen en Spoorwagens, firma J. J. Beijnes te Haarlem). J. J. Beijnes. Description of this plant in Holland. Plate. 6500 w. De Ingenieur—Oct. 10, 1908. No. 616 D.

NEW PROJECTS.

Erie.

The Guymard Cut-Off. Illustrates and describes the short cut on the Erie R. R. between Guymard, N. Y., and Newburgh Junction. 1200 w. R R Age Gaz—Nov. 6, 1908. No. 130.

PERMANENT WAY AND BUILDINGS.

Crossings.

The Kinsman Road Improvement in Cleveland, Ohio. D. M. Taylor. An illustrated description of extensive grade crossing elimination. 1500 w. Ry & Engng Rev—Nov. 21, 1908. No. 465.

Railroad Crossings. W. C. Sparks. Read before the Cent. Elec. Ry. Assn. Discusses construction, maintenance, etc. 1500 w. Elec Ry Jour—Nov. 21, 1908. No. 368.

Curves.

See Rail Stresses, under PERMANENT WAY AND BUILDINGS.

Elevated Railways.

Some Features of Construction of the South Side Elevated Railroad. J. N. Darling. Describes improvements on this Chicago line, to meet the transportation requirements of rapid transit. Ills. Discussion. 8500 w. Jour W Soc of Engrs —Oct., 1908. No. 354 D.

The Experimental Section of Suspension Railway at the Rosenthal Tor in Berlin. Translated from *Zeit. des Ver. Deut. Eisenbahnverwaltungen.* An illustrated account of the structure and of its influence on the traffic. 2300 w. Bul Int Ry Cong—Oct., 1908. No. 171 G.

Rail Joints.

Wheel-Carrying Rail-Joints and Tie Preservation. Max Barschall. Discusses the construction and trials. Ills. 900 w. Bul Int Ry Cong—Oct., 1908. No. 168 G.

A Study of Rail Joints (Etude des Joints des Rails). M. Pellarin. Report of a Commission appointed to make investigations in Belgium, Italy, Holland and Switzerland. Ills. 8000 w. Ann d Ponts et Chaussées—1908-III. No. 504 E + F.

Rails.

The Hardness and Wear of Steel Rails. Editorial on the service of rails and the improved methods of testing for hardness. 1700 w. R R Age Gaz—Nov. 27, 1908. No. 628.

Method of Reporting and Studying Rail Failures on the Harriman Lines. Taken from a paper by J. D. Isaacs, read before the Am. Main. of Way Assn. Outlines the methods of studying the statistics of rail failures. 2500 w. R R Age Gaz—Nov. 13, 1908. No. 243.

Rail Stresses.

A Study of Rail Pressures and Stresses in Track Produced by Different Types of Steam Locomotives on Curves. E. E. Stetson. From Bul. No. 104, of the Am. Ry. Engng. & Main. of Way Assn. Preface by W. C. Cushing. 5000 w. Eng News—Nov. 26, 1908. No. 640.

Roundhouses.

Wabash Locomotive Terminal at Decatur, Ill. Illustrated description of interesting features. 2000 w. R R Age Gaz —Nov. 6, 1908. No. 133.

Stations.

New Lackawanna Station at Scranton. Illustrated description. 1000 w. R R Age Gaz—Nov. 13, 1908. No. 242.

The Manhattan Terminal of the Central Railroad of New Jersey. Illustrated detailed description, confined principally to the passenger station. 1700 w. R R Age Gaz—Nov. 6, 1908. No. 129.

The New Chicago Terminal for the Chicago and Northwestern Railway. Alfred Hoyt Granger. A statement of conditions at Chicago and brief illustrated description of this fine building and its arrangements. 2500 w. Archt Rec—Dec., 1908. No. 494 C.

Ties.

Steel Tie and Concrete Tie Construction. Charles H. Clark. Abstract of paper read before the St. Ry. Assn. of the State of N. Y. Information concerning these ties, comparing their cost with oak tie construction. 2000 w. Elec Ry Jour—Nov. 14, 1908. No. 236.

See also Rail Joints, under PERMANENT WAY AND BUILDINGS.

Track Construction.

Track Superstructure in Tunnels. Brief illustrated description of the type being considered by the Pennsylvania R. R. Also editorial. 1700 w. R R Age Gaz—Nov. 6, 1908. No. 135.

The Detailed Cost of Laying Side Tracks and Switches, Including Labor and Materials. Gives eight examples of the actual cost of this sort of work on a western railway. 1200 w. Engng-Con—Nov. 4, 1908. No. 121.

Track Depression.

Track Depression of the Seaboard Air Line Railway at Birmingham, Ala. Philip Aylett. Illustrated detailed description of the general features, construction, and requirements. 3500 w. Eng News—Oct. 1, 1908. No. 210.

Track Maintenance.

Railway Maintenance of Way. E. E. R. Tratman. From a paper read before the Road. & Main. of Way Assn. Discusses problems in track construction and maintenance. 2500 w. Ry & Engng Rev—Nov. 21, 1908. No. 466.

Tunnels.

See Track Construction, under PERMANENT WAY AND BUILDINGS; and Tunnels, under CIVIL ENGINEERING, CONSTRUCTION.

Yards.

The Gardenville Yard of the New York Central Lines. Plan and description of this freight terminal near Buffalo, N. Y. 2500 w. Eng Rec—Nov. 7, 1908. No. 137.

TRAFFIC.

Car Carding.

Carding of Cars. J. E. Stumpf. Read before the Cent. Assn. of R. R. Officers. Discusses the form of cards to be used, their color, etc. 800 w. R R Age Gaz—Nov. 6, 1908. No. 134.

Car Distribution.

Car Distribution and Car Shortage. Report of Franklin K. Lane before the Nat. Assn. of Ry. Com. Discusses remedies for car shortage, etc. 3000 w. Ry & Engng Rev—Nov. 7, 1908. No. 160.

STREET AND ELECTRIC RAILWAYS

Austria.

The Rittner Railway in the Tyrol (Die Rittnerbahn, Tirol). Egon E. Seefehlner. Illustrated detailed description. Serial. 1st part. 2800 w. Elek Kraft u Bahnen—Oct. 14, 1908. No. 591 D.

Brakes.

Report of the Tramways and Light Railways Association Committee on "Braking Arrangements and Sanding Gear on Tram Cars." 5000 w. Elect'n, Lond—Nov. 13, 1908. Serial. 1st part. No. 438 A.

Car Barns.

See Fire Protection, under CIVIL ENGINEERING, WATER SUPPLY.

Cars.

New Cars of the Chicago Railways Company. Illustrated description of the new pay-as-you-enter cars. 2500 w. Elec Ry Jour—Nov. 7, 1908. No. 110.

Pay-as-You-Enter Cars for the Third Avenue Railroad Company, New York. Illustrated description. 2000 w. Elec Ry Jour—Nov. 21, 1908. No. 367.

Conductors.

Location of Conductors Other Than Third Rail. Report of the Committee on Standard Location for Conductors, Am. Ry. Assn. 800 w. R R Age Gaz—Nov. 27, 1908. No. 631.

Hamburg.

The Blankanese-Ohlsdorf City and Suburban Railway (Die Stadt- und Vorortbahn Blankanese-Ohlsdorf). H. v. Glinski. A detailed description of this railway at Hamburg-Altona. Ills. Serial. 1st part. 2700 w. Zeitschr d Ver Deutscher Ing—Oct. 3, 1908. No. 597 D.

Interurban.

Electric Railways in the Ohio Valley Between Steubenville, Ohio, and Vanport, Pennsylvania. George B. Francis. Illustrated description of a high-grade interurban road. 5500 w. Pro Am Soc of Civ Engrs—Nov., 1908. No. 648 E.

Locomotives.

New Locomotives of the Chicago City Railway. Illustrated description of 40-ton electric locomotives for switching purposes. 1000 w. Elec Ry Jour—Nov. 21, 1908. No. 366.

Motors.

See Railway Motors, under ELECTRICAL ENGINEERING, DYNAMOS AND MOTORS.

Power Losses.

Economy in Current Consumption. C. J. Spencer. Discusses the sources of loss and the remedies on tramways. 2500 w. Tram & Ry Wld—Nov. 5, 1908. No. 432 A.

Power Stations.

See Central Stations, and Hydro-Electric, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Railroad Crossings.

See Crossings, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

Rails.

T-Rail in Paved Streets. R. A. Dyer, Jr. Read before the St. Ry. Assn. of the State of N. Y. Information concerning their use, construction and service. 1200 w. Elec Ry Jour—Nov. 14, 1908. No. 237.

Sanding Gears.

See Brakes, under STREET AND ELECTRIC RAILWAYS.

Single-Phase.

Constants of Single-Phase Railway Circuits. A. W. Copley. Report of tests giving data of interest. 2500 w. Elec Jour—Nov., 1908. No. 208.

St. Clair Tunnel.

Electrification of the St. Clair Tunnel. Illustrated detailed description of the tunnel, equipment, etc. 6000 w. Elec Ry Jour—Nov. 14, 1908. No. 235.

Subways.

Washington Street Subway. Brief illustrated description of the new tunnel built by the Boston Transit Commission. 2000 w. Elec Ry Jour—Nov. 28, 1908. No. 498.

Washington Street Tunnel, Boston. John S. Hodgson. Illustrated description of this recently opened tunnel for the Boston Rapid Transit System. 3000 w. R R Age Gaz—Nov. 27, 1908. No. 629.

Ties.

See same title, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

Track Construction.

Method of Constructing Concrete Foundation for Street Railway Track Using a Special Mixer Mounted on a Car. Illustrated description. 700 w. Engng-Con—Nov. 4, 1908. No. 119.

Trunk Lines.

The Introduction of Electric Traction on Trunk Lines (Ueber die Einführung des elektrischen Zugbetriebes auf Vollbahnen). E. Frischmuth. A general review of progress in Europe and America. Ills. 8000 w. Elek Kraft u Bahnen—Oct. 24, 1908. No. 592 D.

Wire Suspension.

Catenary Trolley Construction. Discussion of a paper by Oliver S. Lyford. Ills. 8000 w. Pro Am Soc of Civ Engrs—Oct. and Nov., 1908. No. 649 each E.

We supply copies of these articles. See page 747.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated: W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.

Consular Reports. *m.* Washington.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *w.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *m.* Milan.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *w.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *b-m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Age Gazette. *w.* New York.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Signal Engineer. *m.* Chicago.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Surveyor. *w.* London.
Technology Quarterly. *qr.* Boston, U. S. A.
Technik und Wirtschaft. *m.* Berlin.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagon Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

THE ENGINEERING MAGAZINE
"THE WORLD IS ITS FIELD"

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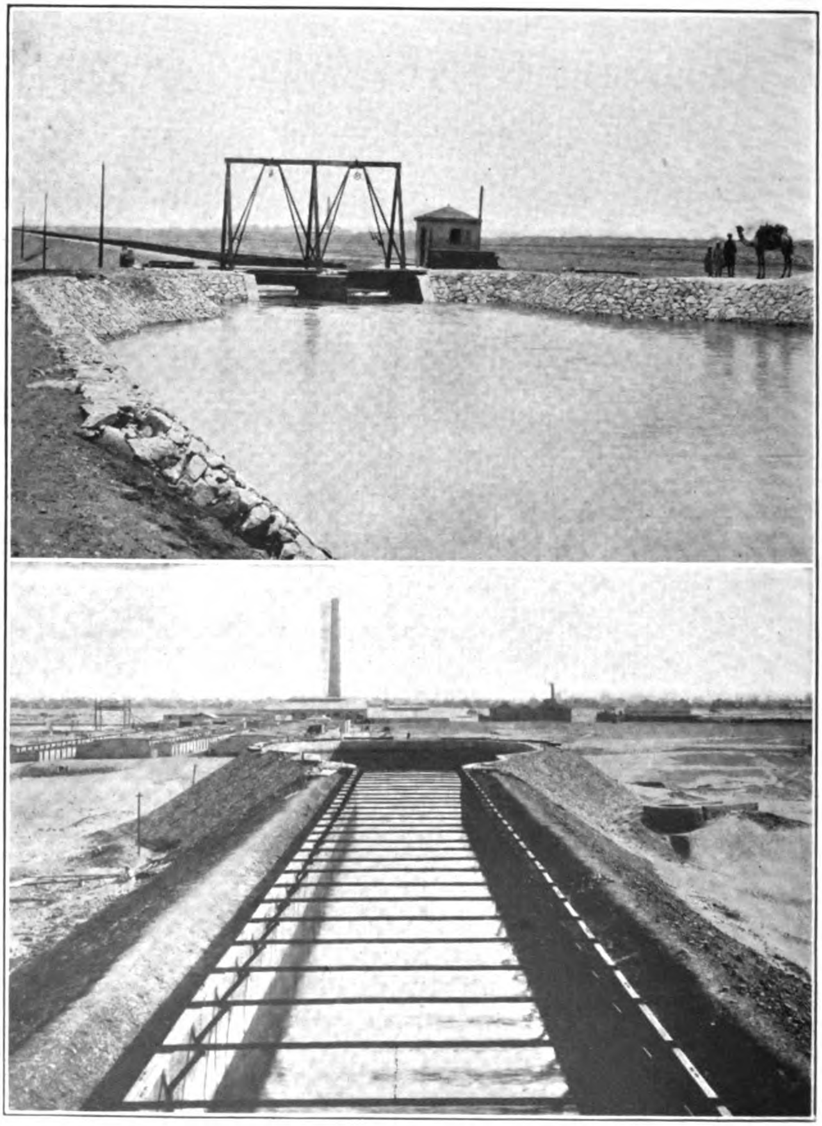
MECHANICAL IRRIGATION STATIONS ON THE NILE.

By J. B. Van Brussel.

The work described in the following pages is interesting on account of its location and the circumstances surrounding the construction, on account of its effect in restoring to fertility and production a long barren region of the globe, and on account of the confident use made of machinery to solve difficulties imposed by the natural topography of the land.—THE EDITORS.

EGYPT has been known as one of the most fertile countries in the world, its large fertility being dependent upon the Nile. This river, during its annual floods, not only supplies the necessary moisture to the ground, but by its deposited silt furnishes an excellent fertilizer. The soil which is not within the area of the annual floods is dry and parched, and is supposed to have received no water for the last 4,000 or 5,000 years. It is, moreover, saline, and for this reason it is necessary to wash the ground for from three to four weeks, before any crops can be grown upon it. Long before the beginning of the Christian era, the Egyptian cultivators endeavored to utilize the fertilizing power of the Nile on desert portions of the country, and large networks of canals and innumerable scoop-wheels worked by men or animals served this purpose. Serious improvements in the irrigation systems were not made for thousands of years, and it is only at the end of the nineteenth century and in the beginning of the twentieth that the problem of irrigation has been solved in a satisfactory way.

The centrifugal pump, which had long been treated more or less contemptuously, but which in the last few decades has been so carefully developed that today it successfully competes with the piston



SLUICE GATES, SERVICE RESERVOIR, AND PART OF THE STEEL CANAL, WADI KÔM-OMBO IRRIGATION SCHEME.

pump in many forms of service, has fulfilled admirably the requirements at the Nile. Apart from the fact that piston pumps are not well adapted to lift large quantities of water to small heights, the quality of the Nile water, with its large amount of silt, almost completely precludes the use of the piston pump, while the centrifugal pump is practically unaffected thereby.

One of the most important irrigation schemes carried out during recent years, and one of the most interesting from the engineering point, is that of Wadi Kôm-Ombo, in Upper Egypt; it utilizes a portion of the additional Nile water supply stored up by the Assuan Barrage. Kôm-Ombo is the site of an ancient town, and also of a famous temple, the ruins of which still exist. The irrigation estate, which covers nearly 150,000 acres, is bounded on the west by the Nile. The Egyptian State Railway's main line from Luxor to Assuân runs through the property, and to the eastward lies the desert.

The east bank of the Nile at Kôm-Ombo is too high to allow of the land being irrigated at flood time in the usual manner, and in order to obtain an adequate supply of water for the continual watering of this large tract of land, it was necessary to put down sets of powerful and specially designed pumps. These pumps lift the water through suction mains 2 metres in diameter, and discharge it into riveted steel rising mains 2 metres in diameter, which in their turn deliver the water into a service reservoir. A large steel canal starts from this service reservoir and delivers the water into distributing earth canals or culverts, from which it flows over the land.

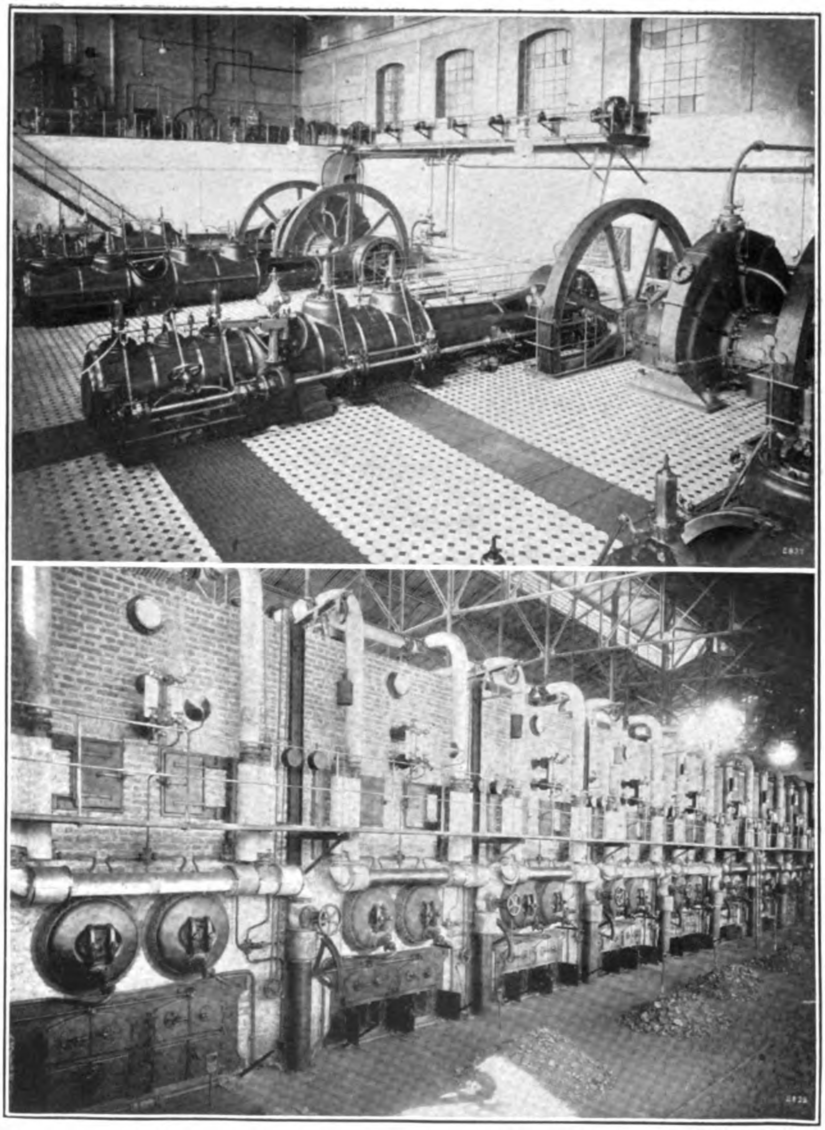
The pumps are placed as near to the Nile as the condition of the ground, which is often very bad, permitted. As the entire area to be irrigated is situated at such a level that even during the period of floods the water does not reach it, the pumping plants must operate continuously during the entire year. A breakdown in any one of the plants might result in the destruction of part of the crop. The first point to demand consideration was therefore absolute reliability of working. Another was to work with the lowest possible consumption of coal per unit of water lifted. The entire area is divided into three zones, 325 feet, 330 feet and 335 feet above sea level respectively, which are irrigated alternately. As the water level of the Nile varies about 23 feet to 26½ feet during the year, the pumps have naturally to work at variable heads.

The three pumping plants work under the same conditions. These working conditions are shown in the table on the following page:

Level of Nile.	I. Low	I. High	II. Low	II. High	III. Low	III. High
Manometric lift	19.4	12.0	20.9	13.5	22.4	15.0
Delivery in litres per second	3,000	3,000	3,000	3,000	3,000	3,000
Theoretical output in horse-power	776	480	838	540	895	600
Indicated output of the steam engine	1,195	860	1,290	950	1,355	1,000
Number of revolutions of engine	103	82	106	86	110	91
Cut-off in the high-pressure cylinder per cent	30	25	32	28	33	31
Coal consumption per 1,000 cubic metres of water lifted (kilogrammes)	55.0	40.0	59.5	44.0	68.0	47.0

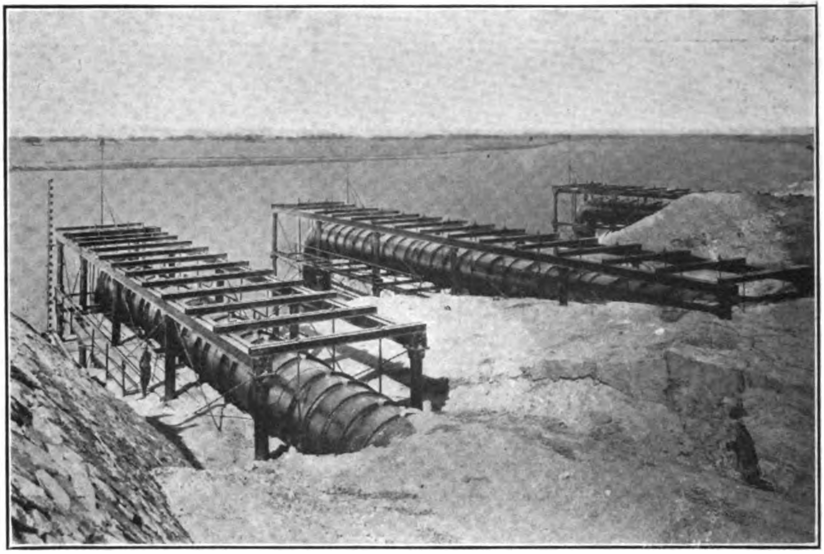
In the case of the first two plants the pumps, which were coupled direct to the steam engines, were placed 20 feet above the low-water line of the Nile. The entire engine room thus lies below the high-water level, and has therefore to stand great pressure, especially on the floor surface. The steam for both engines of these plants is generated by a plant of ten boilers. They have a heating surface of 2,152 square feet. A special arrangement of the grates was necessary, as during a part of the year the boilers are fed by waste material, such as straw, cotton-plant shrub, &c. Two grates had therefore to be provided, the top one of 35.5 square feet being used for coal firing. This can be removed so that the straw, shrubs, &c., can be burnt over a step grate below. The working boiler pressure is 185 pounds per square inch. On either side of the main drum superheater coils are arranged. In these the steam is raised to a temperature of 482 degrees F. The heating surface of each superheater is 376 square feet. Before entering the chimney the gases heat a Green economizer with 320 tubes provided with mechanical scrapers. These mechanical scrapers are run by two small steam engines. The thermal efficiency of the steam plant is increased by 5 per cent through the use of the economizer.

The steam engines are horizontal four-cylinder triple-expansion Sulzer valve-gear engines. The high-pressure cylinder with a diameter of 19⅝ inches and one low-pressure cylinder with a diameter of 34½ inches are arranged tandem on one side of the crank shaft, and the intermediate pressure cylinder of 34½ inches diameter on the other side, with the low-pressure cylinder, 34½ inches diameter, behind it. The cranks are set at an angle of 90 degrees, the common stroke being 51 inches. All cylinders are provided with steam jackets. Two fly-wheels of 18.7 feet diameter are arranged on one shaft. The machines are started by means of a steam barring gear. The condenser is arranged in the pit below the low-pressure cylinders.



ENGINE AND BOILER INSTALLATIONS OF THE FIRST TWO PUMPING PLANTS.

Horizontal four-cylinder triple-expansion engines, 19⅝, 34½, 84½ and 84½ by 51 inches.
Ten boilers, with double grates for burning waste, etc. Superheaters and economizers.
Sulzer Bros., Winterthur.

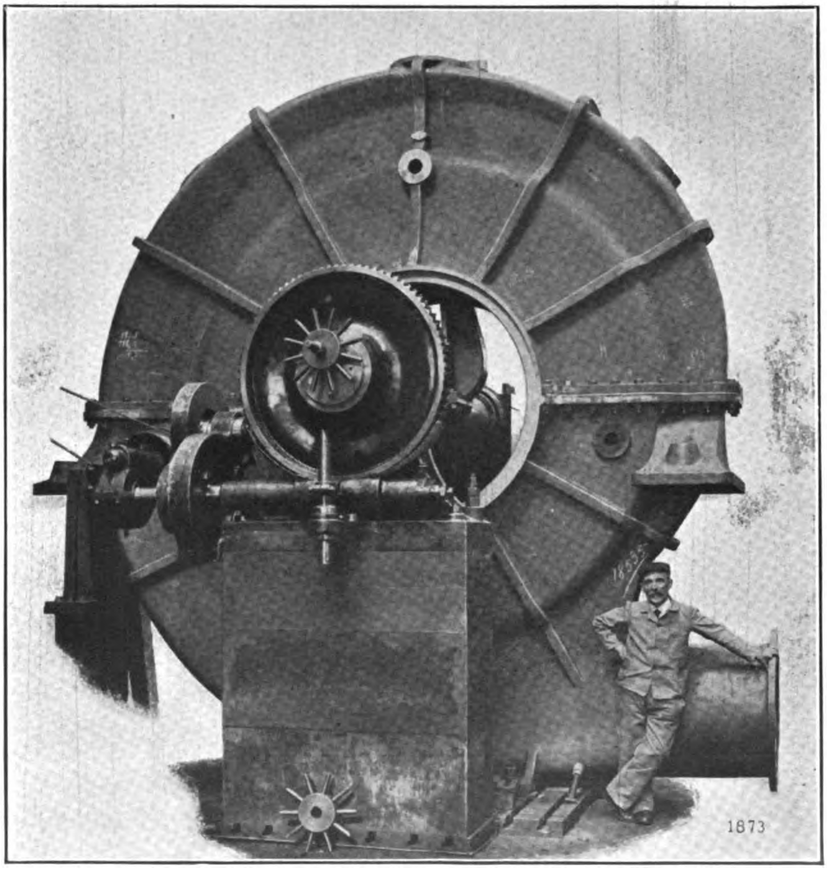


THE SUCTION PIPES AT THE RIVER NILE.

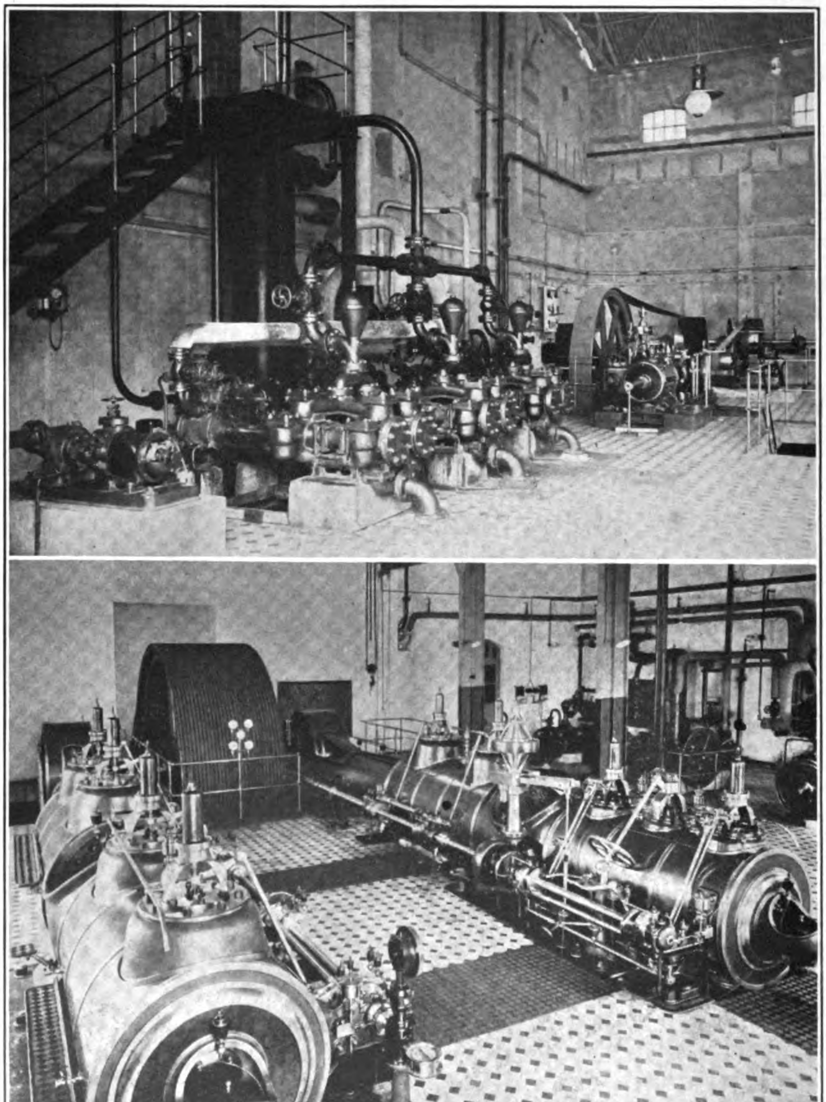
These condensers are driven from the crank pin of the engine. The injection water is taken from the suction pipe of the pump. The overflow from the condensers is led into two communicating reservoirs. A pipe dipping into one reservoir leads to the suction pipe of the pump, so that the overflow water from both reservoirs is drawn away. During high water, however, when the suction pipe also is under pressure, the overflow must be delivered into the large suction pipe of the pump against this pressure by means of a small centrifugal pump. The casings of the large centrifugal pumps are of spiral form. They are cast in two parts and provided with strengthening ribs. The diameter of each impeller is 10.7 feet.

An independent suction pipe 302 feet in length and 78½ inches in diameter is provided for each of the centrifugal pumps. This pipe is carried on a heavy iron trestle over the bank of the river. The suction bell at the end of each suction pipe has an inside diameter of 118 inches. Each of these suction pipes enters into a large sheet iron distributing tank provided with an air chamber. From this the water is drawn through two suction pipes of 39⅜ inches diameter. After passing through the sluice valves, it enters both sides of the pump. The delivery opening of the pump is 31½ inches diameter, but the delivery pipe increases to a diameter of 78½ inches at the throttle valve. To exhaust the air from both the pumps as well as from the suction piping, a steam vacuum pump is provided, with a piston of 4 inches diameter and a stroke of 12 inches. This pump runs at 160 revolutions per minute. The water draining from the stuffing-boxes of the centrifugal pump is led to small tanks, from which it is removed by ejectors.

The feed-water is taken from the Nile by a vertically driven high-lift centrifugal pump, and forced through two Reisert filters into a feed-water tank in the foundation of the engine-room pit. Two steam feed-pumps deliver the filtered water from the reservoir through the feed-water heater and economizer into the boilers. The feed-water heater receives the exhaust steam from the feed pump and vacuum pump.



ONE OF THE CENTRIFUGAL PUMPS.



PORTIONS OF THE MECHANICAL INSTALLATION.

Above, the feed pumps and lighting unit; below, the engine room of the third pumping plant.

In the main engine room there is also a small horizontal single-cylinder condensing slide-valve engine, with a cylinder of 9 inches and 21¼ inches stroke. It works with an initial steam pressure of 156 pounds per square inch and a speed of 130 revolutions per minute. A belt fly-wheel of 9.2 feet diameter transmits 55-60 horse power to a main shaft in the engine room. A continuous-current generator working at 230 volts running at 700 revolutions per minute and taking 30-35 horse power is driven from the main shaft. When the water is high this main countershaft also drives the pumps which deliver the overflow water from the main engines. The generator supplies current for lighting the entire plant, as well as for a motor in the adjoining building. This building contains a small ice-making plant and workshop, both driven from this motor, which, when running at 1,050 revolutions per minute at 230 volts, develops 25 horse power. The ice plant requires 4-5 horse power. The cooling water for the condensers is provided from the Nile by a small electrically driven centrifugal pump. An adjoining building contains a 35 horse-power Diesel engine as a spare, and this can drive the workshop independently of the boiler plant.

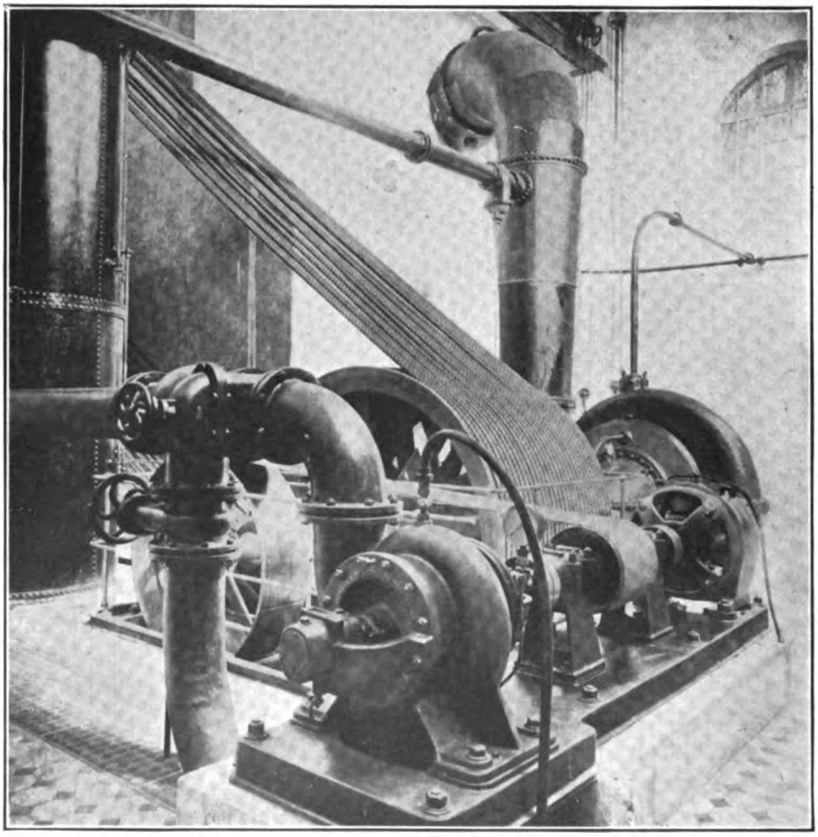
The many difficulties met with in building the engine-rooms of the first two plants were the cause of the buildings for the third plant being designed slightly differently. Such a simplification was possible by placing the steam engine above the reach of high water. The pump, on account of the suction lift, could not be placed higher. For this reason the advantage of direct coupling of pump and engine had to be abandoned and rope drive adopted.

The boiler room contains four water-tube boilers. The main drum has a length of 24.6 feet and a diameter of 4.3 feet. Together with the 129 water tubes of ⅞ inch outer diameter and 15.7 feet length, and with the headers, the total heating surface of each boiler is 2,152 square feet. Between the main drum and the tubes a superheater with 752 square feet of heating surface is provided. The arrangement of the grates is the same as that in the first two plants.

As there would have been difficulties, on account of the bad soil, in building a brick chimney, one of sheet iron only 99 feet high, with artificial draught, has been provided. The combustion gases first pass through a Green economizer having 400 tubes, and from there they are drawn by an electrically driven fan into the chimney. A second fan serves as spare. One fan is capable of delivering about 212 cubic feet of gases per second, giving a vacuum of ¾ inch to 1.2

inches water column when running at 275 revolutions per minute. The power required for one fan is 4 horse power.

The same type of engine as in the first two plants has been adopted, viz., a four-cylinder triple-expansion engine with Sulzer valve gear. A rope fly-wheel with thirty ropes drives the pump. The diameter of the impeller of the pump is 78½ inches, the design of the pump being otherwise the same as that of the other two pumps. At one end of the pump shaft of the delivery pump is mounted a belt pulley driving a centrifugal pump and a small dynamo. The pump and dynamo are erected on a common base-plate, and their shafts are coupled together. The pump sucks water from the main suction pipe, and delivers it into a reservoir, from which the condensers of the main engine draw the water. At times of flood, when the suction



AUXILIARY PUMP AND DYNAMO AT THE THIRD PUMPING PLANT.

pipe is under pressure, this small pump is not needed for the water then flows of its own accord through a by-pass around the small pump into the injection reservoir. In case through any cause the small pump is stopped, the injection reservoir can also be filled from the large delivery pipe, but this method will only be resorted to in case of emergency as loss of pressure is caused.

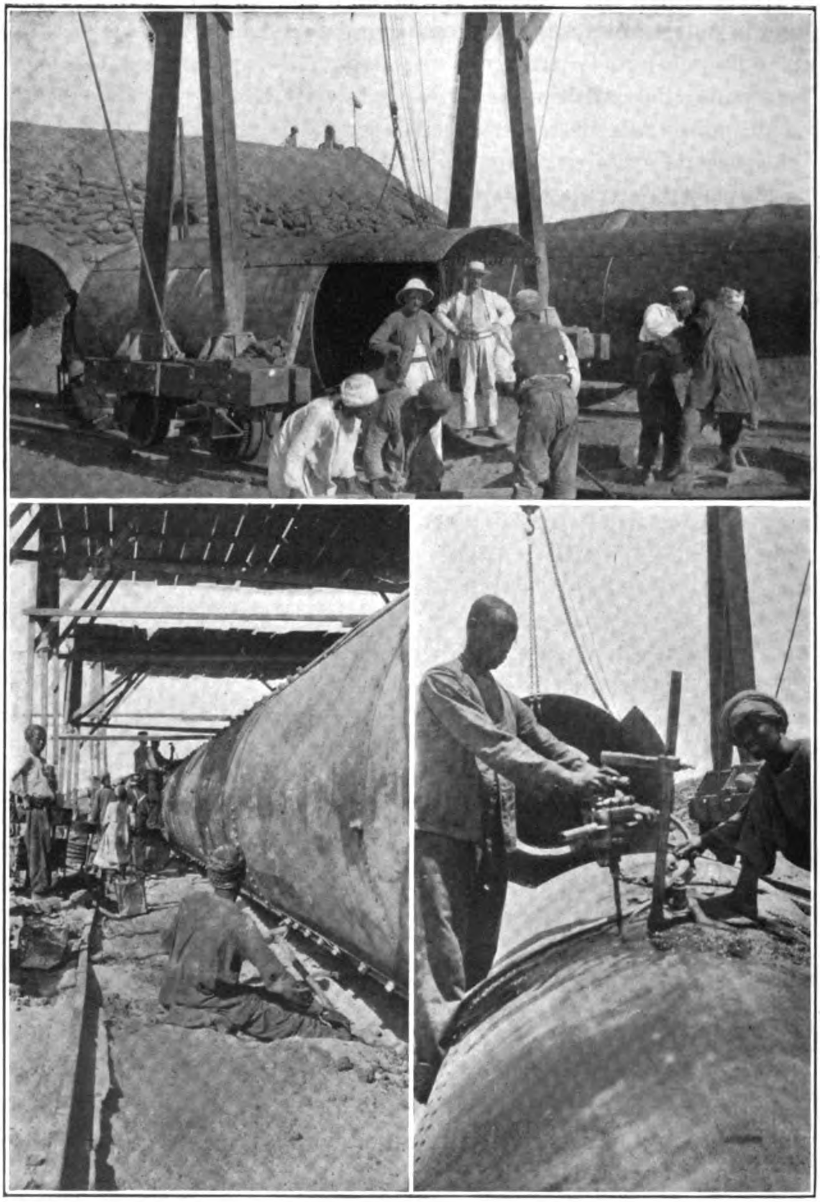
The feed water which is taken from the large delivery pipe is led through the filters and then flows into the feed-water tank. Two electrically-driven high-lift centrifugal pumps force it through two filters to make it clean. Part of this purified water is used for cooling purposes, the remainder flowing through a float valve into a second tank. From this two steam pumps take the water and force it through the feed-water heater, a water meter, and then through the economizer to the boilers. The feed-water heater gets its steam from the exhaust of the steam pumps and from the vacuum pump, which is used to exhaust the air from the large centrifugal pumps and piping. The exhaust steam of a small vertical piston-valve engine can also be used for heating. This engine, which works non-condensing, has a cylinder diameter of 7½ inches, a stroke of 8 inches, and develops 30 horse power when running at 325 revolutions per minute. It is coupled direct to a continuous-current dynamo working at 230 volts, and having an output of 20 kilowatts. This dynamo supplies current for lighting and for fan motors. The dynamo previously referred to supplies current to the motors for the centrifugal feed pumps.

The engine room is provided with a traveling crane of 38-feet span and 9-tons capacity, while the pump chamber is served with a smaller crane of 28-feet span and 6-tons capacity.

The machinery was all supplied and erected by Messrs. Sulzer Bros., Winterthur.

Two rising mains, each 2 metres in inside diameter, are taken away from the pumping stations to a basin distant 460 feet, and situated at a level of 350 feet. This basin or service reservoir is made of reinforced concrete. The plates of the raising mains are 9 millimetres thick and are riveted together with ¾ inch panhead rivets. The mains are made with four plates to the circumference, the circumferential seams breaking joint.

The steel canal which starts from the service reservoir has a total length of over 5,200 feet. It is nearly semicircular and composed of riveted steel, the plates being 6 millimetres thick. The diameter of



CONSTRUCTION OF THE 2-METRE RISING MAINS.

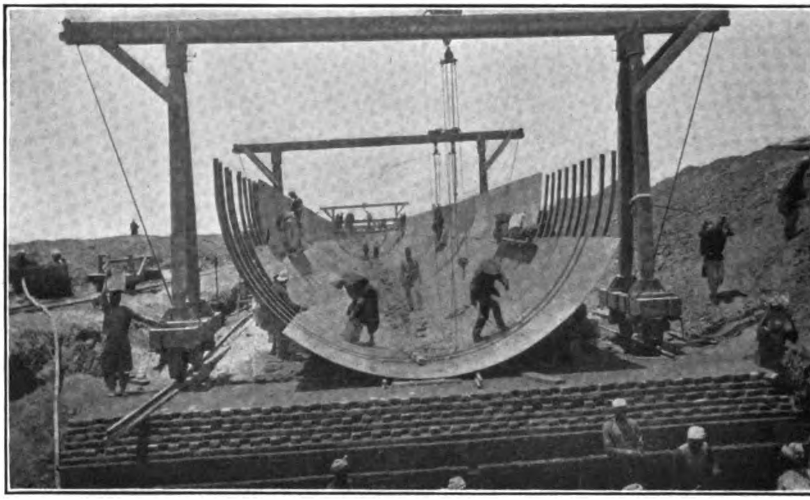
Above, plating at the reservoir end. Below, on the left, riveting; on the right, pneumatic drilling.

this canal is 20 feet, its depth nearly 12 feet. It is built up of seven plates round the circumference, the plates being connected together by ½-inch snaphead rivets.

The circumferential seams break joint. External F-iron stiffeners, 5 inches by 3 inches by ⅜ inch, are riveted on at 2 feet 6 inch centres. There is also a top bracing of cross angles, and flat bars bolted on to 3 inch by 2½ inch by ⅜ inch curb-angles.

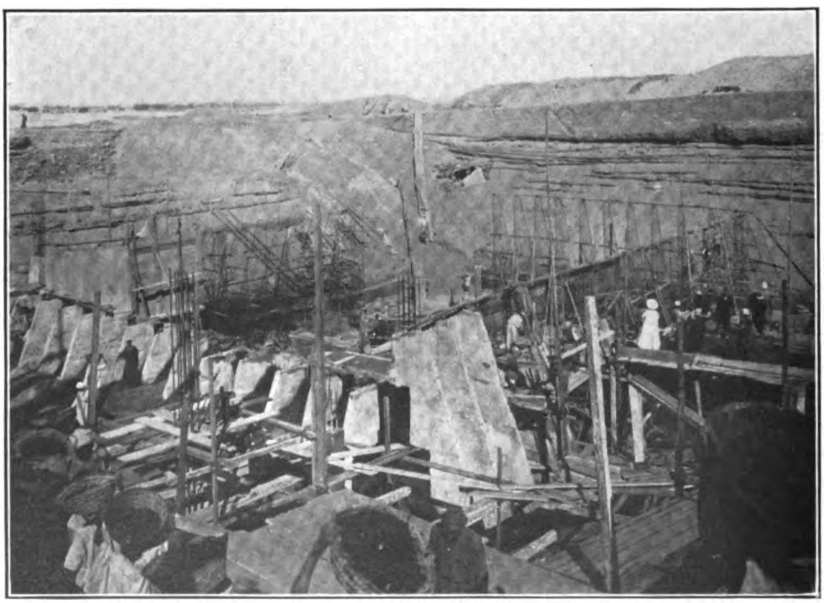
To allow for expansion and contraction the canal is subdivided into seventeen sections, averaging nearly 310 feet each. These are connected together by masonry basins and packed expansion joints. At the end of each section of canal as it enters the masonry basin a stiffening band, 3 feet 4 inches, is riveted on, the external rivet heads being countersunk flush. This band is made to slide in and out of the basin on short sections of rail let into the masonry. The joint is kept tight by means of tarred or tallowed rope packing enclosed between two high and semicircular angles placed back to back with bolts passing through them. The weight of the water flowing through keeps the canal floating on the packing, and each section can therefore expand or contract, according to temperature. In practice, we understand that it has been found that the movement is very small when the canal is running full. The recess containing the angles and the rope packing is slightly tapered, the smaller diameter being outside, so as to prevent the packing from being blown out by the pressure of the water.

RIVETERS AT WORK IN THE INTERIOR OF THE STEEL CANAL.



ERECTION OF THE LAST SECTION OF THE STEEL CANAL.

As it was impossible to make the riveters efficient with pneumatic tools, nearly all the rivets were put in by hand. For doing this work, Arabs from Cairo and Alexandria, and natives—*fellaheen*—from



FOUNDATION WORK FOR THE WADI KÔM-OMBO IRRIGATION PLANT.

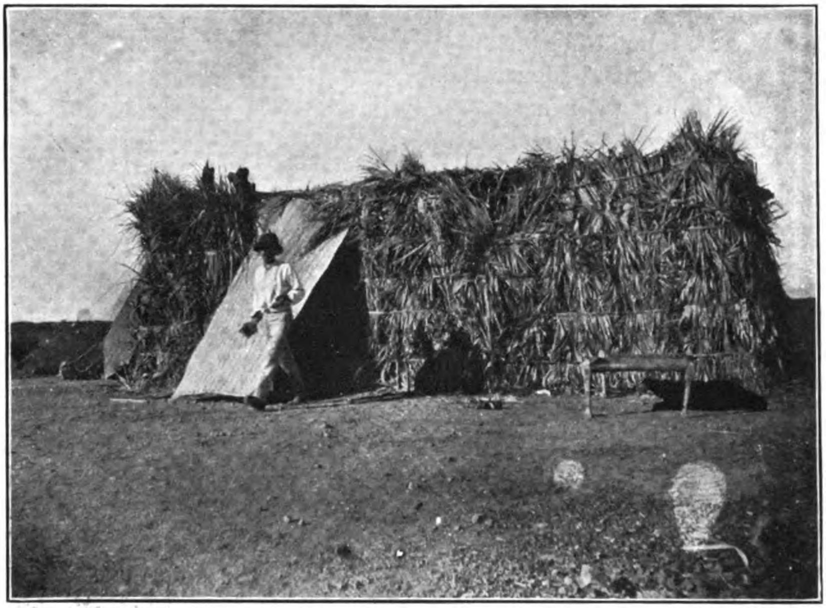
the little villages round Kôm-Ombo were engaged. The latter, on the whole were found to be much better and more reliable than the workmen from Cairo and Alexandria.

For leveling the canal the following method was used:

During the plating and riveting of the plates timber cradles were used to keep the bottom level, and props to prevent the sides from dropping out of shape. The cradles were placed about 30 feet apart. The props were placed under the top curb, and shorter ones were fixed under angle cleats bolted to the first longitudinal seam from the top. As each 310-foot section was completed, together with the masonry basin by which it was connected to the next section, the canal was adjusted to its proper level by means of Haley jacks which were placed along each side of the section, and before the jacks were removed earth was banked up on each side of the canal. To ensure the banks so formed being solid the earth was well watered and rammed tight against the steel work. The amount of fall given to the canal was about 1 centimetre per section of about 310 feet. One great difficulty experienced in keeping the steel canal level during construction was due to the action of the wind, especially during sandstorms on the dry sand which formed the foundation. The wind was able to pass under the canal through the spaces where the sand had been removed to allow room for riveting the cross seams on the bottom plates. This caused the sand to drift and the wood cradles to sink. A 310-foot section would often sink several inches, on this account, during one night.

STAFF SLEEPING QUARTERS.

Another difficulty was due to the unequal expansion of the steel plates owing to the sun's rays affecting the sides of the canal nearest



CHIEF ENGINEER'S QUARTERS DURING BUILDING OF THE INSTALLATION.

to it more than the other side. In some sections the end moved out of centre as much as 4 inches, sometimes one way and sometimes the other. This movement was not arrested entirely until the canal was banked up with earth, and had the water running through it. The canal was painted with two coats of a spirit paint with an asphalt or bitumen base. It is applied cold and dries quickly, and so far experience has proved it to be a very satisfactory coating for this class of work. The total weight of the steel work was 1,250 tons.

The steel canal and mains were carried out by Messrs. Thomas Piggott & Co., of Birmingham. Nearly 1,000 men were employed for erecting the whole plant. An enclosed camp was made close to the site for Europeans, the natives being housed some in tents and some in stone houses called *esbahs*. A chief trouble with these natives was that the different tribes did not get on well together, and fought with sticks and knives on the smallest provocation.

The mean shade temperature during the work was about 117 degrees F., and light wooden screens had to be erected for protecting the workpeople from the sun.

SYSTEMATIC FOUNDRY OPERATION AND FOUNDRY COSTS.

By C. E. Knoeppel.

V. APPORTIONING COSTS TO PRODUCTION IN VARIOUS CLASSES OF FOUNDRIES.

Mr. Knoeppel's series began in our issue for October, 1908, and preceding parts have dealt with the elements of the problems of foundry costing, the importance of correct burden apportionment, and the classification and apportionment of costs.—The Editors.

A MANUFACTURER, whether making castings or candy, is generally inclined to the belief that he can derive no direct benefit from a discussion of proposed betterments, because of his "peculiar" or "complex" conditions, which according to his way of thinking call for specific treatment—if any betterment is necessary.

There is of course no denying the fact that there are many cases where Jones puts into operation methods that are successful in the plant of Smith, and after a heart-breaking attempt to get things to run smoothly under the new arrangement, finally discards them for his old methods with the result that any new innovations thereafter are frowned upon. As a matter of fact, no betterments can be introduced into any business, no matter how correct they may be in principle, if little attention is given to the matter of their application to the existing conditions; and to this one defect of inapplicability—a serious one indeed—can be laid the failure of many a system that was no doubt correct as far as the principle was concerned. An improvement involves a change, although a change does not always imply an improvement; therefore before a manufacturer plans any changes, he wants to feel sure that they are going to better his results and still cover his conditions—he wants them right both in principle and application.

After a consideration of the reasons why methods sometimes fail to accomplish the results that are anticipated, it seems that an analysis of any proposed improvement would materially assist in demonstrating its value or its unfitness, and in doing this, three things are necessary to consider—First, what should be done, second why it should be done, third, how it should be done.

If a proposed method gets through this triple analysis and still appeals to the manufacturer as being valuable, the chances are that it will bring about the desired results. A manufacturer might decide on what should be done and feel satisfied as to why it should be done, and then stop his investigation and put the method into operation with unsatisfactory results due to a failure to plan out the "how;" or he might plan out a method by deciding on what he wanted to do and how it should be done, and unless he had satisfied himself as to the "why" of it, the method after being in operation for a time might be a failure. If he had first decided on what he wanted to do, then why he wanted to do it that way, and finally planned out with care as to how it should be handled, he would be able to supply himself with about all the arguments for and against the method, to decide him as to the course to pursue—the "why" testing the correctness of the principle; the "how" the logic of the application.

The preceding papers have dwelt upon correct burden apportionment; the elements entering into the burden; their apportionment to production and the necessity for analysis—the "what" and the "why" receiving the most attention. The suggested burden apportionment took into consideration the fact that some of the items were proportionate to direct labor, others to the tonnage produced; that it was advisable to divide the burden into the elements necessary to give the executive an intelligent grasp of all of the pertinent details of his business; and although the suggested division might impress a manufacturer as being "too much detail," the fact remains that we must know *where* to concentrate our attention before we can better results, and that compilations cannot anticipate whether information is going to be valuable or absolutely worthless. Therefore it would be better to divide into three parts an item which could be carried under one heading, if by so doing there is any possibility that one of these subdivisions may point out the way, through analysis, to greater efficiency—the conditions to be covered largely governing the kind and number of accounts. Finally, we saw that analysis of "comparative elements" was an absolute necessity because it took into consideration the fact that first impressions are usually lasting, whether correct or incorrect, and that it is an unwise policy to jump at conclusions unless we can see the conclusions.

Granting the importance of analysis—the correctness of a burden apportionment part to labor and part to tonnage—and the necessity for a detailed division of what is expended, the next feature a foundryman is concerned with is the consideration as to *how* his costs are to be absorbed by his production. In order to treat this phase of the subject as intelligently as possible, it is necessary to divide the foundry industry into different classes as follows:

1. Jobbing Foundries—Foundries selling all their production to outside manufacturing enterprises.
2. Specialty Foundries—Foundries selling all their production to the business of which they are a part.
3. Specialty Foundries Doing a Jobbing Business—Foundries selling part of their production to outside manufacturing enterprises and the balance to the business of which they are a part.

There seems to be little uniformity in foundries in the above classes when the matter of the division of the production is considered. Some foundrymen want it divided one way, while others have some other method of ascertaining the cost of different kinds of production; in fact, a half-dozen foundries in the same locality may have as many different ways of figuring. The following are the principal divisions of the several ways possible for a foundryman to treat his production, applicable to the three classes of foundries specified above:

(*a*) Cases where a foundryman is satisfied with simply the ***weight*** and cost of his production ***in total.***

(*b*) Cases where the production is ***classified*** according to ***weight*** and is divided into—

Total weight and cost of "light" work.
Total weight and cost of "heavy" work.

(*c*) Cases where the production is classified according to the principal ***methods of moulding,*** being divided into—

Total weight and cost of loam work.
Total weight and cost of dry sand work.
Total weight and cost of green sand work.

(*d*) Cases where the production is classified according to the ***use*** of the castings produced, being divided as follows (if we assume for example, a concern manufacturing engines and boilers)—

Total weight and cost of engine castings.
Total weight and cost of boiler castings.

Or if the output consists of a varying line such as the manufacture of steam and gas engines, boilers, and a special line of work such as laundry machinery, we can divide—

Total weight and cost of steam-engine castings.
Total weight and cost of gas-engine castings.
Total weight and cost of boiler castings.
Total weight and cost of laundry-machinery castings.

Or we can still further classify by taking the production of the steam-engine castings according to—

Total weight and costs of beds.
Total weight and cost of frames.
Total weight and cost of wheels.
Total weight and cost of cylinders.
Total weight and cost of all other steam-engine castings.

(*e*) Cases where the production is classified according to the *way the castings are made,* being divided into—
Total weight and cost of machine-made castings.
Total weight and cost of hand-made castings.

(*f*) Cases where the production is classified according to the weight and cost of *each separate casting.*

(*g*) Cases where the production is classified according to the total weight and cost of *each customer's work.*

(*h*) Cases where the production is classified according to the *departments* in which they are made, as for example—
Total weight and cost of bench work castings.
Total weight and cost of side-floor work.
Total weight and cost of main-floor work.

(*i*) Cases where the production is classified according to the various *classes of weights,* as for instance all castings weighing from 200-400 pounds being treated as in a class by themselves.

(*j*) Cases where the production is classified according to the *disposition,* being divided into—
Total weight and cost of castings made for our own consumption.
Total weight and cost of castings made for sale to the trade.

If space permitted, various combinations of the cases shown could be cited as for instance *j* and *b* could be combined, the castings made for sale and consumption being in turn divided into the weight and cost of the light and heavy work. Care should be exercised before deciding on what case or combination of cases to use, as conditions (and conditions only) must govern the plan to follow.

The following rules have been worked out in order that the calculations entering into the apportionment of costs to production, may be more clearly understood, our known elements being—

1. Weight of castings produced.
2. Total cost of Direct Material.
3. Total cost of Direct Labor.
4. Total cost of Foundry Charge.
5. Total cost of Tonnage Charge.
6. Total cost of Commercial Cost.

Rules for Rate Determination.

1.—To find the rate per 1,000 pounds of Direct Material, divide the cost in total of Direct Material by the tonnage produced.
2.—To find the rate in per cent of Foundry Charge, divide the cost in total of Foundry Charge by the cost in total of Direct Labor.
3.—To find the rate per 1,000 pounds of Tonnage Charge, divide the cost in total of Tonnage Charge by the tonnage produced.
4.—To find rate in per cent of Commercial Cost, divide the cost in total of Commercial Cost by the cost in total of Direct Labor.
5.—To find the rate per 1,000 pounds of Total Cost, divide the total cost by the tonnage produced.

Apportionments.

6.—To ascertain the cost of Direct Material, multiply the tonnage produced by the rate from Rule 1.
7.—To ascertain the cost of Direct Labor, charge the proper amount direct.
8.—To ascertain the Foundry Charge, multiply the Direct Labor by the rate from Rule 2.
9.—To ascertain the Tonnage Charge, multiply the tonnage produced by the rate from Rule 3.
10.—To ascertain the Commercial Cost, multiply the Direct Labor by the rate from Rule 4.

After the rates have been determined, the following rules can be used for enabling the foundryman to cost correctly any classified production:

Rules for the Treatment of the Various Cases.

11.—Select from list previously shown—cases *a-j,* the division desired.
12.—Classify the production according to the division selected.
13.—Ascertain the Direct Material cost by using Rule 6 for each classification.
14.—Post to each classification the correct amount of Direct Labor.
15.—Apportion Foundry Charge by using Rule 8.
16.—Apportion Tonnage Charge by using Rule 9.
17.—Apportion Commercial Cost by using Rule 10.
18.—Add 13-17 inclusive.
19.—For rate per 1,000 pounds of Total Cost, use Rule 5.
Rules 15-19 inclusive apply to each classification separately.

Illustration.

Values.	Apportionment.	
Tonnage—3,050 lbs.	Tonnage—$3,050 lbs.	
Direct Material—$10.00 per 1,000 lbs.	Direct Material..............	$30.50
Direct Labor—$20.00.	Direct Labor................	20.00
Foundry Charge—125 per cent.	Foundry Charge.............	25.00
Tonnage Charge—$2.50 per 1,000 lbs.	Tonnage Charge.............	7.63
Commercial Cost—35 per cent.		
	Shop Cost..................	83.13
	Commercial Cost............	7.00
	Total Cost.................	90.13
	Per 1,000 lbs..............	29.55

Through the use of the above rules, a foundryman is in a position to determine the costs of his production, in total as in Case *a,* as one extreme (hardly to be recommended, however), or by each individual casting as in Case *f,* as the other extreme. He would have in any case other than Case *a* a classified cost of his production, the amount of detail work necessary to secure the costs depending upon the selection from the list of cases; and as outlined, the costing would take into consideration the fact that the production, though classified, was the output of a single department.

If, however, the foundryman found it necessary, because of his conditions, to obtain *all* the information possible to secure, it would then be necessary to divide the foundry into certain departments. Take for instance a foundry where a number of machines are in use; where a considerable amount of bench work is done, but where the bulk of the work is light and heavy floor work. It would then be well to divide the foundry into Machine, Bench and Floor departments, and each in turn could have its production classified according to one or more of the cases previously shown. To treat the foundry as made up of these three departments, it would be necessary to make a number of separations in the figures. The cost of Direct Material and Labor would be separated into the costs for the three departments, by divisions decided upon, while the other three items—Foundry Charge, Tonnage Charge, and the Commercial Cost, would have to be separated as far as possible into—First, the costs which could be charged direct to the three departments, and second, the costs of a general nature which would have to be apportioned to the production of each department.

A brief analysis of the cost accounts which appeared in the third paper will show that there are several elements which could be charged direct to the departments; others could be charged part to the departments and part to the "general" section, while still others would have to be included in the "general" section. Each individual case would of course determine the divisions, but in a general way the apportionment shown on page 771 would be a representative illustration of the items which would appear as direct, direct-general, and general charges.

After the costing has been done along the lines suggested, it will be found that the departments are charged with the proper amount of Direct Material, Direct Labor, and a portion of the Foundry Charge, Tonnage Charge, and Commercial Cost, and in order that the production of the departments may absorb all the expenses, it will be necessary to distribute the remaining portion of the three latter elements in the "general" section, in such a manner as shall give to each department an equitable amount. To do this Direct Labor can be used as the basis for distributing the Foundry Charge and Commercial Cost items, while the Tonnage Charge items are distributed on the basis of tonnage produced. This seems to be fair, as the department having the largest amount of Direct Labor and tonnage would have to stand the largest amount of these expenses apportionable to labor and tonnage which could not be charged direct.

FOUNDRY CHARGE.

Direct to departments—
Power Plant, Shipping, Rigging, Taxes and Insurance.
Part direct to departments and the balance to "general"—
Cleaning Labor, Chipping, Shop Supervision and Clerical, Foundry, General and Cleaning Room Supplies.
General—
Maintenance of Buildings, Plant Equipment, Power and Transmission Machinery and Cast Equipment; Stable, Pattern Shop, Machine Shop, Carpenter Shop, Blacksmith Shop, Pattern Storage and Depreciation.

TONNAGE CHARGE.

Direct to departments—
Replace Labor, Night Gang, Foundry Supplies, Core Room Supplies on the basis of the Core Labor in each department and Maintenance of Patterns.
Part direct to departments and the balance to "general"—
Maintenance of Flasks.
General—
Cupola Labor, Handling Materials, Yard Labor, Cupola Supplies, Power Plant and Analysis Expense.

COMMERCIAL COST.

All of the Administrative to "general."
All of the Selling direct to the departments where possible and the balance to "general."

The following rules can be used for distributing to the departments, the Foundry Charge, Tonnage Charge, and the Commercial Cost items in the "general" section:

1.—For Foundry Charge and Commercial Cost—
A—Direct Labor in the Machine Department.
B— " " " " Bench Department.
C— " " " " Floor Department.
D—Total Direct Labor (A + B + C).

$\frac{A}{D}\ \frac{B}{D}\ \frac{C}{D}$ = Departmental rates in per cent.

Distribute to each department, using the rates ascertained, the proper proportion of the Foundry Charge and Commercial Cost, treating each expense element separately.

2.—For Tonnage Charge—
E—Tonnage in Machine Department.
F— " " Bench Department.
G— " " Floor Department.
H—Total tonnage produced (E + F + G).

$\frac{E}{H}\ \frac{F}{H}\ \frac{G}{H}$ = Departmental rates in per cent.

Distribute to each department, using the rates ascertained, the proper proportion of the Tonnage Charge, treating each expense element separately.

3.—For each department, add the amounts charged direct and distributed, according to the following classes—Direct Material, Direct Labor, Foundry Charge, Tonnage Charge and Commercial Cost.

We are now in possession of three sets of figures covering the three departments, and to get at the detailed costs of the product of each of them, use the rules 11-19 inclusive by simply adding the words "for each departments" as, for example: (Rule 11)—"Select from the list previously shown—cases *a-j*—the division desired, for each department," and after the rates per 1,000 pounds have been ascertained for each classification of the production in each of the three departments, the foundryman will be in possession of what he wants to know regarding his costs to produce.

Each foundryman must determine for himself, from his conditions, whether he wants to treat his foundry as a single department or to divide it into several. If the principal requirement is almost absolute accuracy regardless of the detail necessary, and the proposition is a large one, then there is no question but that the accounting should consider the foundry as made up of several departments. If, however, the foundry executive does not want to go into the detail that is necessary to departmentalize his foundry, and if costs are wanted that are fair and within reason, the foundryman can then consider his foundry as one department with a classified output, which will give the results he wants at a minimum expenditure.

While not within the province of this article to lay down hard and fast rules as to specific treatment, the following is offered for foundries considered as a single department, as a means of covering the ordinary conditions that are met with in the three classes of foundries previously mentioned:

1.—Foundries under Class 1, classify production according to Case *g* (customers' work) with provision to treat certain work according to Case *f* (individual castings).

2.—Foundries under Class 2, classify according to Case *d* (use).

3.—Foundries under Class 3, classify production as shown at 1.—for jobbing work, and at 2.—for work for consumption by the business of which the foundry is a part.

Through the methods above suggested, we get at the end of a period, for Class 1 foundries, the cost of production by customers, which cost is offset by the price at which the work is sold to the trade, the difference establishing the desirability of the work in question as well as the places where attention must be concentrated; and as provision can easily be made for ascertaining the cost of certain castings for certain customers, the foundryman has in his possession, through the classification suggested, the information necessary to improve where necessary, the conditions determining *how* he shall improve. We also get at the end of a period, for Class B foundries, the cost of the castings for the machine or boiler shop, according to the use, which cost is offset by the price allowed the foundry and charged to the departments using the castings.

Few appreciate the fact that consumption of castings should be at rates which recognize the difference in the cost to produce them, so that it seems important that our costing take this difference into consideration. A clothier because he purchases 100 suits at $15 each, 100 suits at $20, 100 suits at $25, and 100 suits at $30, will not sell them at $27 each simply because $27 means the average cost of $22.50 plus 20 per cent profit. Assuming, however, that he did this, on his $15 suits he would make $1,200; on the $20 suits he would make $700; on the $25 suits he would make $200, while on the $30 suits he would *lose* $300, and as a result he would have $1,800 profit in all. The chances are that he would have a hard time disposing of $15 and $20 suits at $27; while because of the quality, his customers would jump at the chance of buying $25 and $30 suits at $27. At any rate, on his two most expensive lines he would make $200 and lose $300, and he would perhaps have to trust to good fortune and "sales" to dispose of the others; so that by the time he had sold them all, he would very likely find that he was a long way from making his 20 per cent. Instead of this, our clothier would take each cost and add his profit, and if a man wanted a cheap suit, he would pay a price that would net a profit of 20 per cent, which would also be the case should a man want a more expensive garment, and when the suits were all disposed of, the clothier would find that he had made a profit of $1,800 on his investment.

This illustration applies to machinery manufacturers making their own castings. An average cost, because of the word "average," means that some cost more and others less, and there seems to be no consistent reason why the difference should not be observed. Assume that in a machine shop two lines are being manufactured—one a steam engine of simple construction, and the other a gas engine of intricate and complicated design; it will be found that the castings for the first line will cost considerably less than the castings for the gas engines. If the steam engine castings cost $2.25 per 100 pounds and the gas-engine castings $2.75, why use an average of $2.50 for all? A difference of $5.00 per ton either way is something to think about when the total weight of the castings in the engines is taken into consideration, for on the steam-engine castings it would mean a reduced cost of the finished engine, which would either result in a greater profit, if the regular price is obtainable, or the *same* profit on a larger number of sales, due to a decreased price; and while the cost of the finished gas engines would be greater, necessitating a higher price, it is reasonable to ask the consumer to pay the most for that which cost the most to produce, especially when it is a complicated proposition of superior design and workmanship, enabling the manufacturer to talk quality.

I wish to emphasize, at this point, the importance of treating *all* foundries as *jobbing* foundries. If a machine shop is purchasing its castings from an outside foundry for $2.70 per 100 pounds, this figure is naturally used by the machine shop in figuring the cost of the cast iron in the machine. Should a foundry be built and operated, the person who is placed in charge of the foundry may, through efficient management, turn out a production costing $2.45 per 100 pounds. These same castings, purchased outside, cost $2.70; therefore the castings that are made are worth this same amount to the company, the foundry being entitled to a credit of $ .25 per 100 pounds as the difference between what these castings are worth and what they actually cost to make. Suppose, for instance, a certain machine selling for $2,000 contains 20,000 pounds of cast iron which at $2.70 per 100 pounds would mean $540 as the cost of this material. Would it be good business, if the machine had a ready sale, to reduce the price by $50 simply because the castings are being made for $5.00 a ton less? Or would it be better to treat this saving as a profit—which, in reality it is—and as such having nothing whatever to do with the matter of price? The latter method seems the most logical, and if any cut in price is necessary it should be at the expense of the department getting the credit for the sale.

In estimating, market conditions largely prevail; and there seems to be no good reason why a price of $2.45 should be used instead of $2.70, if this latter quotation is near the market figure. A sales manager recently stated that whenever he bid on a job which contained considerable cast iron, he was generally able to get the work—in fact the orders seemed to fall into his lap. This led him to think over the situation, and he found that his competitors were using a *greater* rate for cast iron than he was. Investigating still further, he learned that he was using the actual foundry cost figures—which was not a complete cost by any means—instead of the rate that he would have been forced to use had his company been purchasing the castings, with the result that he had, unknowingly, been "doing" his company out of profits which would have been made had the rate been higher. At any rate, the cost figures were increased without any apparent reduction in sales.

On the other hand, suppose on account of a low tonnage or other reasons the castings should cost $2.90 instead of $2.70. Would it do to charge the machine shop with castings at $2.90—an increase in the cost of $4.00 per ton—or make the foundry stand this loss by charging the machine shop with castings at $2.70, in this way costing up the work at a price for which the castings could be purchased outside? It would certainly not do to take the $2.90 price into consideration for estimating purposes, because of the fact that the competition might be using a price around the $2.70 mark—the difference amounting to quite a little on an order of any size. At any rate there is no getting away from the fact that a loss has been made, for if castings which cost $2.90 to make can be purchased for $2.70—and only good ones at that—then $4.00 per ton is being thrown away; and as the machine shop is in no way to blame for this loss, we should make the department producing these castings stand whatever the loss might amount to. If the foundry is to take care of its own losses, *then the foundry is entitled to any profits it might make.*

The foundry should therefore be considered as a producing department, in the same sense that the machine shop is a producing department, instead of treating it as an adjunct of the machine shop. It should be carried as a separate department through the general books of the company, in this way placing the foundry squarely on its own feet—side by side with the machine shop, a position it is most certainly entitled to—besides furnishing the proper incentive to each and every man, from the foundry superintendent down to the apprentices, for the reason that they feel that if all do their share in making a success they can participate in that success through increases in pay. In addition such a procedure gives to the management a means for determining the efficiency of its foundry department, as well as deciding them as to whether it would be policy to close their foundry and purchase their castings elsewhere. It also places the foundry on about the same basis as outside foundries, which not only tends to make estimation more uniform, but competition more intelligent.

To carry the foundry properly through the books of a manufacturing company, I would suggest that two accounts be opened as General Ledger accounts—Foundry Manufacturing Account, and Foundry Income Account, and as a large number of concerns are beginning to treat all materials as "stores" until used, the plan should be to sell monthly to "stores," as "castings," the total output of the foundry at a price that will correspond as closely as possible with the price that would have to be paid for purchased castings. To illustrate: assume that the foundry produced 300 tons in a month at a cost of $48.00 per ton, or $14.400, the divisions being—materials, $6,000; labor, $3,900, and expenses, $4,500—the price allowed the foundry being $2.65 per 100 pounds, or $53.00 per ton. Our Journal entries would read:

	Charges.	Credits.
(1) Foundry Mfg. Acct..300 tons produced @ $48.00 ton....	$14,400	
Stores Acct..		$6,000
Labor Acct..		3,900
Burden		4,500
(2) Stores ....300 tons purchased @ $53.00 ton..	$15,900	
(3) Foundry Mfg. Acct..300 tons sold to Stores..................		$15,900
(4) Foundry Mfg. Acct..Profit, month's production..........	$1,500	
(5) Foundry Income Acct.—Monthly profit 300 tons...............		1,500

LEDGER ACCOUNTS.

Stores.

(2) 300 tons castings purchased from fdry @ $53.00 per ton.......	$15,900		

Foundry Mfg. Acct.

(1) 300 tons produced @ $48.00 per ton.........	$14,400	(3) 300 tons sold to Stores—$53.00 per ton.........	$15,900
(4) Monthly profit..........	1,500		
	$15,900		$15,900

Foundry Income Acct.

		(5) Monthly profit 300 tons.	$1,500

Before concluding, it might be well to state that in determining the cost of production in foundries in Class 2 and 3, consideration should be given to the fact that there are no selling expenses to be added to the production made for use for the business of which the foundry is a part, because of the fact that this expense is necessary in marketing the finished product of the machine or boiler shop, for which reason it would be a charge against the production of these departments and not against that of the foundry—the business really buying, as before stated, the entire monthly production of the foundry, this transaction being one in effect only, involving the expenditure of no money whatever as a selling expense. Defective castings returned from the machine or boiler shop because of defective workmanship in the foundry—the only selling expense element, the specialty foundry has to deal with—would be treated as "foundry errors" and included in the Foundry Charge section, at the price less scrap value. Foundries in these same classes, in the absence of an organization of their own, should be made to stand a portion of the general administrative expenditure—a combination of judgment and an analysis of the items making up this element, to determine the proper proportion to charge to the Foundry Department.

* Figures show Journal entries and corresponding postings.

THE USES OF MECHANICAL REFRIGERATION IN METALLURGICAL PRACTICE.

By Jos. H. Hart.

The opening of a new field for a mechanical operation may be as important in its significance as the original development. In the applications suggested by Dr. Hart, the possible results in economy to the mining and metal industries are even larger than those appealing to the producers of refrigerating machinery.—The Editors.

THE recent granting of letters patent to Franklin R. Carpenter for the utilization of mechanical refrigeration in the condensation of smelter fumes opens a field of application for mechanical refrigeration which has seldom been considered before, and the extent and character of its possible service in this field is scarcely realized by even the specialist.

The utilization of mechanical refrigeration for the condensation of the moisture from the blast in iron-furnace operation, known as the Gayley process, is fairly well-known today by operating engineers in this field, but the remarkable efficiency attained by the process and the wide extent of its present development are almost equally unknown. A 15 to 20 per cent increase in furnace capacity, with a 10 to 15 per cent decrease in coal consumption per ton of iron produced, define only one of its remarkable features. The further fact that the horse power of the blower required for the operation of the blast furnace is reduced to such an extent that generally two-thirds of the power saved is quite sufficient to operate the refrigerating machine is but another instance of its remarkable efficiency. Plants have been installed in the Illinois Steel Company's works, the Warwick Iron and Steel Company, the G. & H. Brooke Company, and practically every iron and steel-manufacturing company in the United States is either seriously contemplating the installation of such a plant or has already begun its installation. In addition, the firm of Gues, Keen & Nettlefolds, Ltd., of Cardiff, Wales, have recently installed the same system, under the supervision of the same engineers who have put in the plants in America. These plants range from several hundred tons up to over eight hundred tons refrigerating capacity and are among the largest in existence. The further recent test at the Illinois Steel Company's works of the utilization of a refrigerating machine for the removal of the moisture from the blast in crucible operation was equally productive of good results and showed an efficiency which is likely to revolutionize operations in this field.

As has been said, the letters patent issued to Mr. Carpenter are but a further step in this direction and open enormous fields for possible development. The chief ingredient which it is desired to remove from the exhaust gases in smelter-furnace operation is sulphur, or rather, sulphur dioxide, as it exists under this condition. Arsenic is also present, and in many furnaces a large number of the rarer metals or chemical elements such as selenium, etc., pass off in the furnace gases and flue dust. The amount of sulphur daily wasted in smelting work is something appalling. A single plant near Salt Lake City discharges nearly 500 tons of sulphur, as SO_2, into the atmosphere every 24 hours, while the Washoe, Garfield, and other plants probably exceed this. In that particular installation at Salt Lake, the discharge of the sulphur fumes has been the cause of considerable litigation. The Mormons have large salt-evaporating beds here, where the salt is produced by solar evaporation from the water of the Great Salt Lake. The salt company claims that the pollution of the atmosphere by SO_2, and its consequent deposition and chemical reaction, result in considerable deterioration of the salt product. Sulphur fumes undoubtedly destroy vegetation to a very great extent. The question has been raised as to whether damage is done by sulphurous acid or other poisonous fumes, but in some well-known cases the ores are singularly free from arsenic and other deleterious substances. Up to date practically no scheme has been devised for the satisfactory utilization of the SO_2 in the Salt Lake smelter, and operation has been absolutely prevented for a considerable time by legal processes.

The utilization of sulphur fumes is an old question, and no satisfactory solution has been made other than the production of sulphuric acid, which has been a fairly efficient and economic process where a sufficient market exists for this product at moderate freight rates. Sulphuric acid, however, sells at from two to five cents per pound, depending on the character and concentration of the acid, and in very many localities the freight rates to a satisfactory market are absolutely prohibitive. Fumes from ordinary pyritic smelters vary from four to seven per cent of SO_2 gas, while those from muffle roasters of zinc ores and those of the pot roasters are considerably higher, but all can be easily used in the manufacture of sulphuric acid. The ordinary chamber process is the one usually employed, but the Winkler or catalytic process has been introduced, which gives a fairly pure acid practically without attention and the materials used in its manufacture operate in a closed cycle with comparatively little loss. The utilization of mechanical refrigeration in this connection is the result of an attempt to obtain the free sulphur from the SO_2. Five hundred tons of sulphur present in the form of SO_2 means about 1,500 tons when transformed into sulphuric acid, and it is impossible to get rid of this in the streams or by any satisfactory process. Sulphur, on the other hand, has an equally wide market and the 500 tons wasted in this single plant every 24 hours has a market value of $10,000 if available.

Sulphur dioxide possesses the property of freezing out of its gaseous form at—10 degrees C. It is proposed to pass sulphur dioxide thus produced through a reducing chamber, with the elimination of the oxygen, or to transform a portion of this to H_2S and have the interaction between this and the SO_2 occur according to the well-known formula, with the production of free sulphur. The refrigerating capacity required for this purpose would be extremely large, since the hot flue gases would have to be cooled to this point, but undoubtedly the heat of these gases could be used to produce the work of refrigeration itself. Some adaptation of the absorption type, whereby the hot exhaust gases could be used efficiently instead of steam in the generation of the ammonia gas, will open a wide field for cultivation in this and allied fields.

The real development in the application of mechanical refrigeration to chemical processes has scarcely commenced. Practically all volatile chemical compounds today are caught and retained by means of their solubility in water or some other solvent. Thus hydrochloric acid is now produced by means of sulphuric acid acting on one or more of the common salts, with the consequent production of HCl in gaseous form. This is caught and held for commercial purposes only by means of its affinity for water, the ordinary commercial acid containing 43 per cent of the latter constituent. In practically all of these processes, concentrated products are the thing desired. In a general way they are not obtained by the ordinary methods without considerable loss in the exhaust vapors, or by extreme concentration by boiling after collection. The statements made in regard to the production of hydrochloric acid and the advantages to be obtained in the use of mechanical refrigeration in this connection hold equally in a wide variety of other chemical reactions. The production of aqua ammonia as a by-product from ordinary gas is rendered necessary in the ordinary cleaning mechanism for the gas.

The use of mechanical refrigeration in this field, with the consequent production of liquid ammonia itself by means of its own refrigerating power, is a possibility offering great economies, and these are generally of a character and order such as has been obtained in the Gayley system of removal of moisture in blast-furnace operation.

The suggestion has also been made that exhaust gases from furnaces can be cleansed for this purpose before utilization in the ordinary gas engine. The same or similar conditions hold equally in regard to the purification and cleansing of the gases from the ordinary water-gas or fuel-gas furnace, with a resulting increase in the efficiency of utilization of the gas in the production of power, as well as in the return of a considerable revenue from the products so obtained. The suggestion that the Gayley process is equally available for freezing the moisture out of air in preparation for its compression in the ordinary air-compression plant, as utilized in many mining installations, offers possibilities of efficiency not only from the removal of the vapor but on account of the increased density and consequently enlarged capacity of a given cylinder for air compression. It offers also a possibility of increased efficiency in the operation of the compressor itself. The further utilization of mechanical refrigeration is possible in the operation of condensers and in maintaining a low temperature in these, with consequent increase in efficiency of the condensing process and with enlarged capacity of the unit, whether for the production of work (which is largely a theoretical condition) or for increased capacity in the operation and efficiency of such units as sugar evaporating pans, vacuum kettles in both the condensed-milk and candy industries, and in a large number of other processes. The application in a much wider range of developments in the oil-refining industry is well-known, and the recent installation of refrigerating machines for the maintenance of the hygrometric conditions and constant temperature in the wash room of silk-dyeing establishments is equally important. In fact, it can be said in a general way that the recent applications of mechanical refrigeration for the control of hygrometric variations in water vapor and in temperature and pressure variations in this and other cases present an opportunity in mechanical refrigeration which is of the greatest importance, and probably more far-reaching in its future influence on the development in this field than a large number of direct applications considered as a whole. The future of mechanical refrigeration is remarkably bright, and new uses and possibilities of still others are daily presented to the operating refrigerating engineer.

MEANS AND METHODS FOR HEATING THE FEED-WATER OF STEAM BOILERS.

By Reginald Pelham Bolton.

III FEED HEATING BY USED OR WASTED STEAM.

In the two parts of Mr. Bolton's review of means and methods for feed-water heating already presented, he has dealt with the economy of utilizing for this purpose the heat in the waste furnace gases, and of feed heating by the use of live steam drawn from the boilers or of partially used steam taken from the intermediate receiver of multi-cylinder engines. In this his concluding section, Mr. Bolton examines the economy of feed heating by means of exhaust steam. His general conclusion to the whole study is that the subject offers a fruitful field for the ingenuity and abilities of steam engineers, and discussion of this series of papers will be welcomed both by Mr. Bolton and by the editors of THE ENGINEERING MAGAZINE.—THE EDITORS.

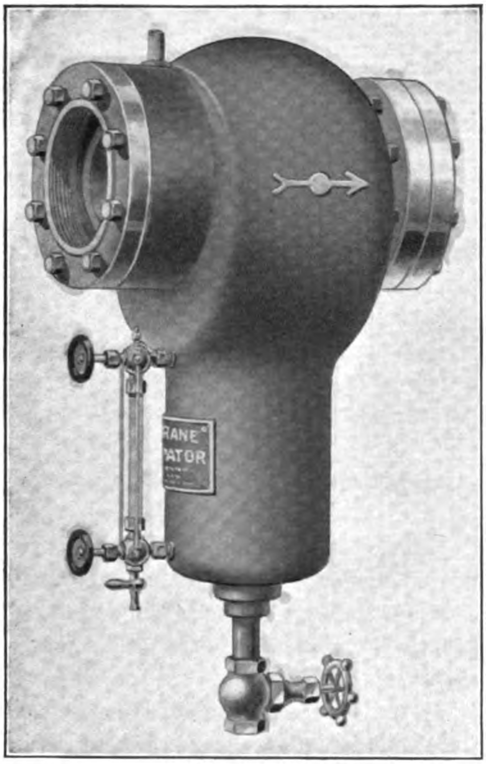
THE utilization of waste heat in exhaust steam is a recognized and substantial source of economy, which needs no argument to prove its value. The methods by which it may best be accomplished, and by which it may be supplemented by other waste heats, are very varied and afford opportunity for the exercise of detailed attention, which is too often denied to the problem, especially where combinations of heat-returning appliances are to be made effective in connection with condensing engines.

The process of heat return to the boiler should include provision for the release of air and gases, and should also at some point afford a certain storage of the heated water so that sediment may be allowed to precipitate, and, further, effective means must be secured for the removal of oil.

In general marine practice, these functions are performed by the hot-well, supplemented in many cases by similar effects at a higher temperature in the contact feed-heater.

The removal of cylinder oil from exhaust steam has appeared to some engineers to be a difficult or doubtful element, but no difficulty need be experienced in accomplishing an effective removal. provided oil eliminators of proper size are used and are effectively and freely drained of the emulsion of condensation and oil, which the appliance will separate from the steam.

It does not seem to be the practice, nor is it appreciated that in the use of closed or surface heaters there is need, to protect the



THE COCHRANE VACUUM OIL SEPARATOR.

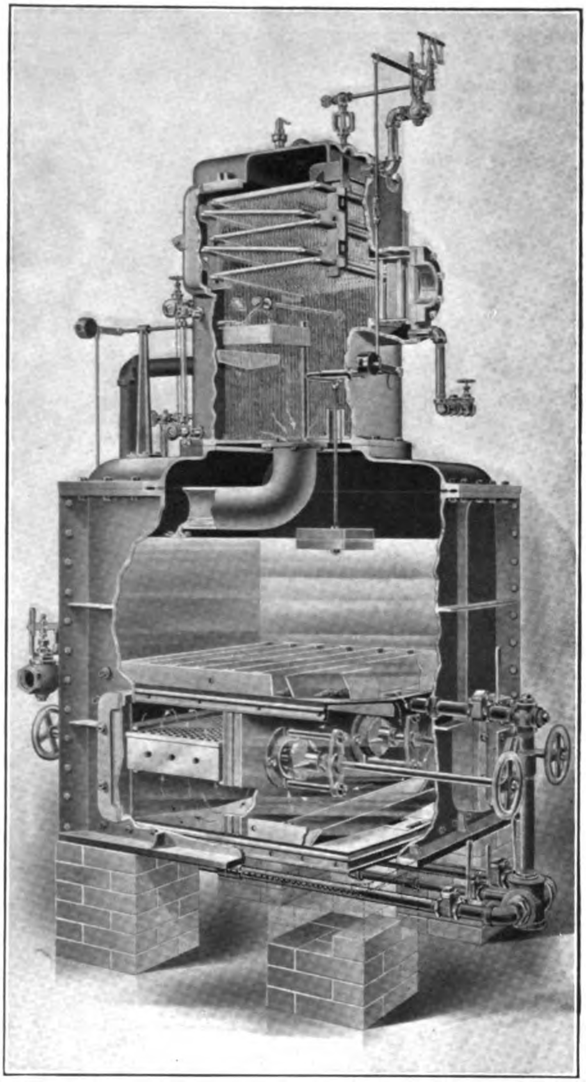
For removing oil from exhaust steam, making it suitable for use in heating, boiler-feeding and like purposes. Harrison Safety Boiler Works, Phila., Pa.

appliance against the entrance of oil in the exhaust steam; for unless this be done, the heat-transmitting surfaces are soon coated with oily deposit, greatly reducing their effectiveness, and as is not infrequently found, the entire lower portion of a heater may, by neglect, become choked with such material. It is customary to allow a considerable margin of heating surface to cover such contingencies, but the proportions should nevertheless admit of a proper speed of the water over the surfaces, or the whole appliance is reduced in effectiveness.

There is usually a difficulty in the utilization of the drip from such heaters, on account of its greasiness, and in a majority of instances it is run to waste. It might, however, with advantage be passed through a coil in a feed-tank, or be united with other foul drips in a drip-tank, in which a coil may be arranged through which the feed-water supply is drawn.

The closed or surface heater has many useful applications, and is a practical necessity if the feed temperature can be by any means raised above the boiling point, for difficulty occurs with pump operation when supplied with super-heated water, due to the formation of steam as soon as pressure is reduced in the valve-chambers of the pump. But as a means of securing all the advantages of waste heat in exhaust steam, and also in the collection of heated waste drips and separator discharges, it is not equal to the contact heater, even if its own condensation be treated as I have suggested.

One of the best and most definite tests which afford means of



WEBSTER CHEMICAL PURIFIER AND FEED-WATER HEATER.
The upper part is the regular heating chamber, impurities being precipitated by chemicals automatically fed in here, and being deposited on the inclined precipitating plates; thence the water passes downward over smaller plates to the filter, and through it upwards to the hot-water outlet chamber. The filtering material is crushed quartz held in cotton twilled bags between perforated metal sheets. The apparatus is duplex, either half being ample in capacity for the service. Warren Webster & Co., Camden, N. J.

ascertaining the available sources of waste heat, as compared with that utilized in the main engines, is that of the steamship Pennsylvania, now the steamship Mataafa, reported in Vol. XI., part 3, of the *Journal of the American Society of Naval Engineers*. This large steamship was fitted with water-tube boilers, supplying saturated steam to a five-cylinder quadruple-expansion condensing engine, and also to a complement of the usual marine auxiliaries, including a fan-engine, the exhaust of which was discharged under the furnaces and was thus lost to the return system, though doing some useful work in connection with the furnace part of the combined apparatus by increasing the draft under the boilers.

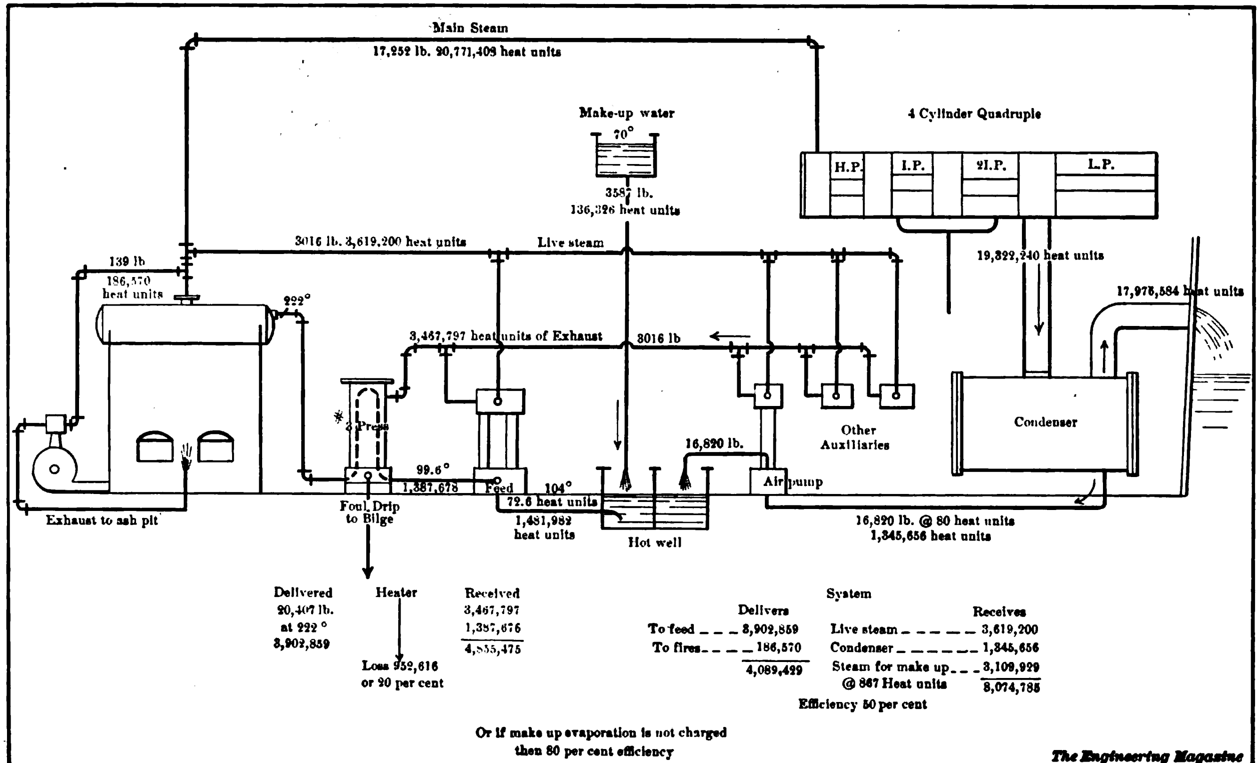
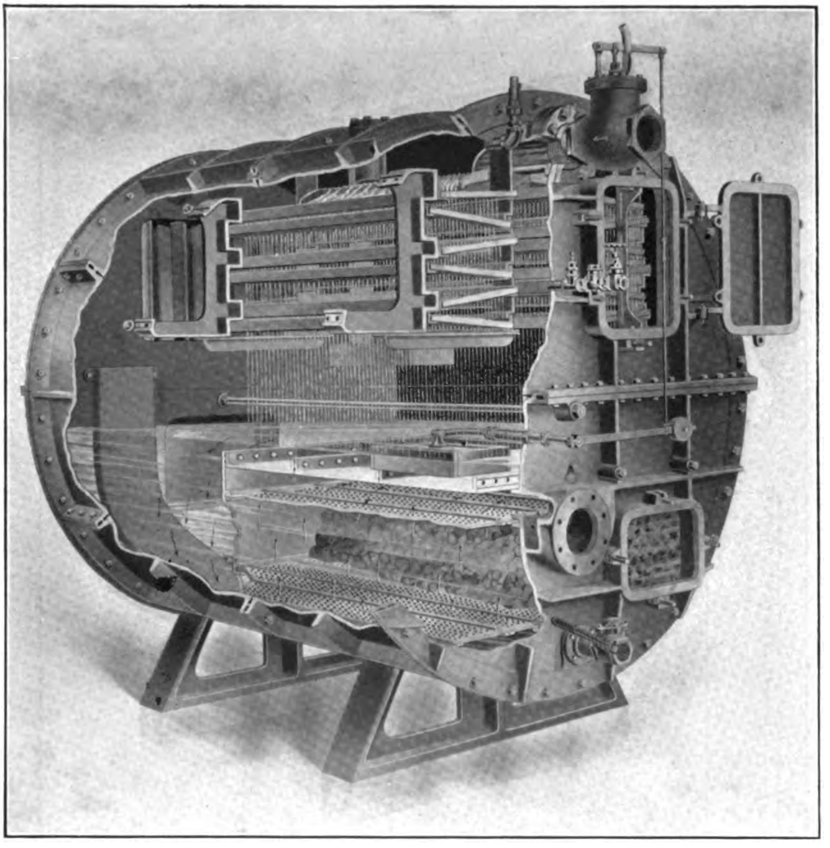


CHART VI. USE OF CLOSED OR SURFACE HEATER WITH EXHAUST STEAM (STEAMSHIP PENNSYLVANIA TEST CONDITIONS).



WEBSTER FEED-WATER HEATER FOR CAPACITIES FROM 500 TO 10,000 HORSE POWER.
Warren Webster & Co., Camden, N. J.

It was found that when the main engines were receiving a supply of 17,252 pounds, the auxiliaries absorbed an additional amount of 3,016 pounds of steam per hour, to which was added 139 pounds taken by the blower engine. The auxiliaries proper, therefore, used 15 pounds to each 100 which the main engines demanded.

The heat cycle is shown in Chart VI., the feed-water on its way to the boiler being pumped through a surface or closed heater, in which the above recorded exhaust of the auxiliaries was condensed, and by which the feed-water was raised to a temperature of 222 degrees F. It will be seen that the use of this closed heater involved the loss of the weight and of the contained heat of the condensed exhaust, and the consequent introduction into the system of make-up water to that extent.

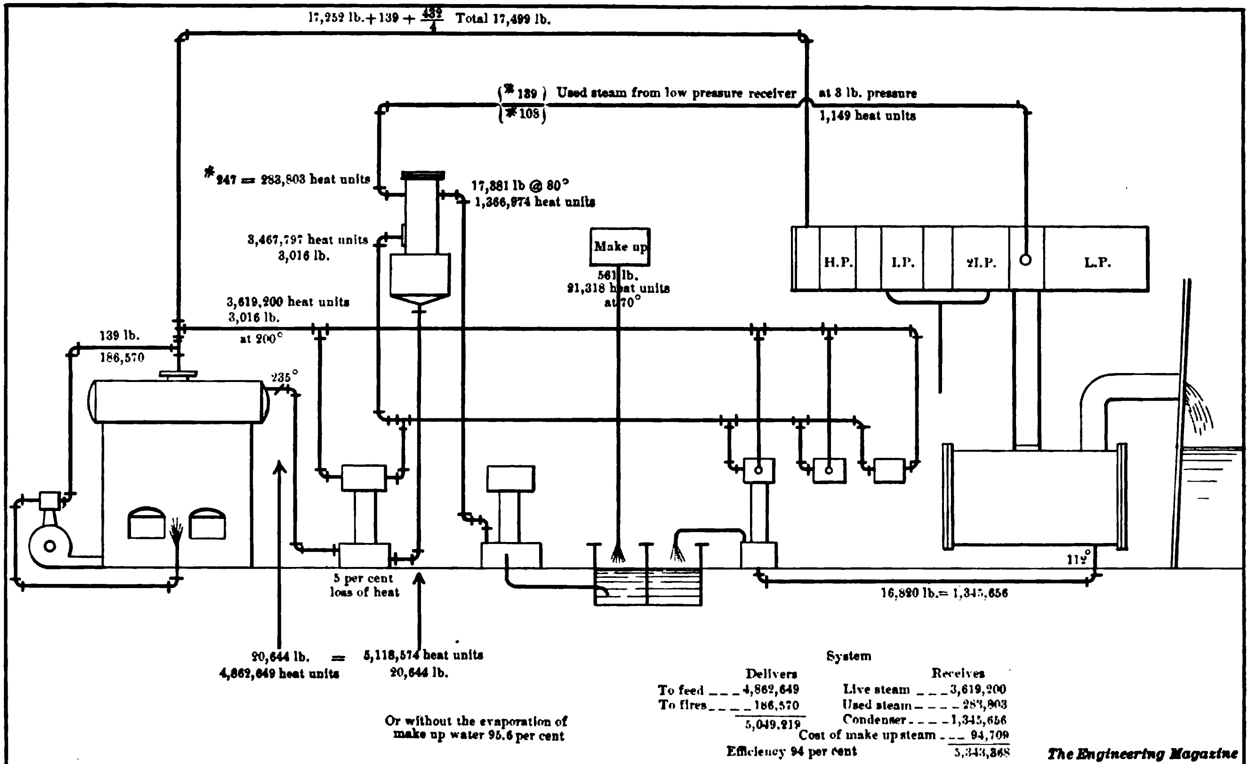
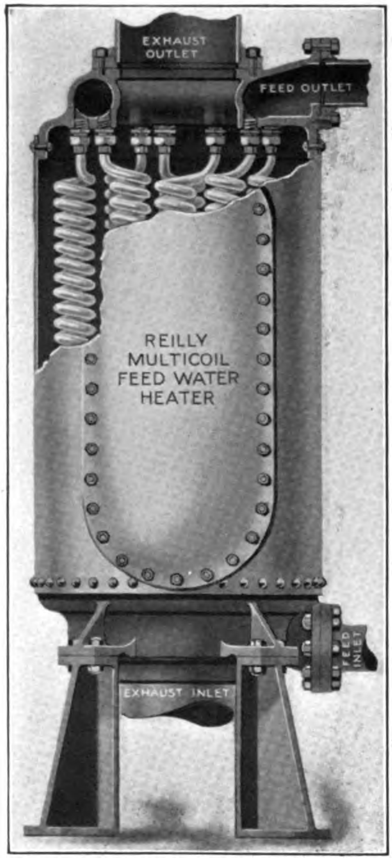


CHART VII. USE OF OPEN OR CONTACT HEATER WITH LOW-PRESSURE STEAM (STEAMSHIP PENNSYLVANIA CONDITIONS).

On the trial, this seems to have been introduced at 70 degrees F. from a stored supply, and allowing for this element, the heat-saving efficiency is 80 per cent. But inasmuch as such a supply would in other cases have cost heat for its production by evaporation, the cost in heat for such evaporated make-up may be added in the heat balance, and the whole system would then work out to a heat-saving efficiency of only 50 per cent.



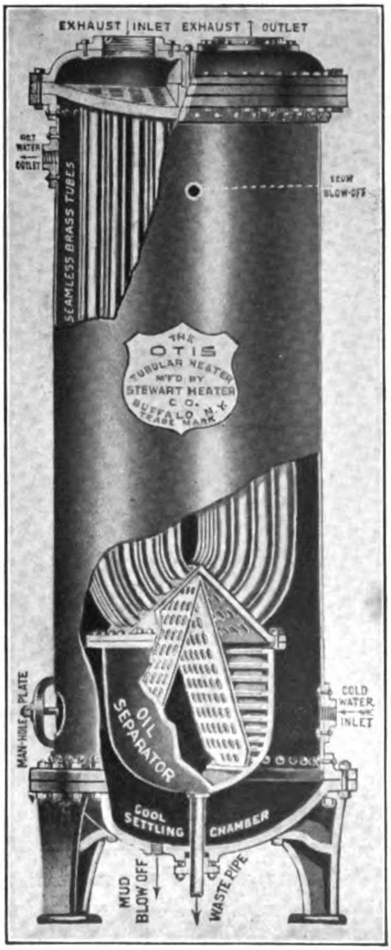
REILLY MULTICOIL FEED-WATER HEATER.
The Griscom-Spencer Co., N. Y.

In Chart VII. the same heat quantities are applied, with the substitution of a contact heater in place of the closed heater, involving the addition of a hot-well pump, the work in which, however, is practically part of that of the boiler feed-pump, as the lifted water descends to the latter with the head due to the position of the contact heater, usually high up in the fiddler casing. The result is to bring the system, inclusive of make-up evaporation, to an efficiency of heat saving of 78 per cent.

A further advance could be made on this economic result by the application to the system of partly-used steam from the low-pressure receiver, whereby, as shown in Chart VII., the feed temperature could be raised to 235 degrees, with an increase of heat-saving efficiency to 94 per cent. This result may be compared with that obtained with the various devices employed on the Inch Line steamships, which showed a heat-saving efficiency of 86 per cent.

The author of "Triple and Quadruple Expansion Engines and Boilers and their Management," says:

"There have been numerous methods tried with more or less success, for heating the feed-water, some by endeavoring to utilize the waste heat



OTIS FEED-WATER HEATER.

The exhaust steam enters and leaves at the top; the oil separator and settling chamber for sediment are at the bottom, away from the tubes, to prevent their stoppage by mud or scale. The tubes are suspended from the top to allow free expansion. The cold feed water enters at the bottom, near the center of the oil separator, with the purpose of chilling the oil which is drawn off through a drip pipe. Stewart Heater Co., Buffalo, N. Y.

in the funnel, others by means of steam direct from the boiler; and Weir's system, by using a portion of the steam in the low-pressure receiver. The latter method is generally considered to be the most efficient."

This system is the form of live-steam heater most commonly in use on shipboard, and it will be seen that it entirely differs from any attempt to take live-steam direct from the boiler. The steam is that which has already done work by expansion in the main engine, and is in position only to do a certain amount of further work of expansion from the pressure of the receiver from which it is taken. Where taken from the lower pressure cylinder, this steam, says Seaton, "might have been usefully employed in the low-pressure cylinder, but not to the full extent that it is in the heater, otherwise there would be no economy."

The steam thus withdrawn from a receiver has already done work in the preceding cylinders of the engine, so that the reduction of the work in the cylinder or cylinders from which it is diverted is compensated by additional work in the preceding cylinders.

The addition to the total volume supplied to the engine is therefore less than the amount withdrawn, in the proportion of the expansion it undergoes prior to its diversion.

Chart VIII. shows the proportion thus to be added to the total supply for an amount withdrawn from any receiver of multi-cylinder engines, and the corresponding reduction of exhaust from the last cylinder which will accompany the process, on the basis of equal dynamic work in each cylinder. When steam is thus diverted from an engine to a contact heater, its total weight, and its heat at the reduced pressure, are conserved, and both are returnable to the boiler; while the work it has accomplished in the engine is to be credited against the initial supply. The foregoing combinations bring the temperature of the feed-water well above the boiling point, and if a higher degree of temperature should be desirable, it can be attained by used steam from the receiver, at higher pressure.

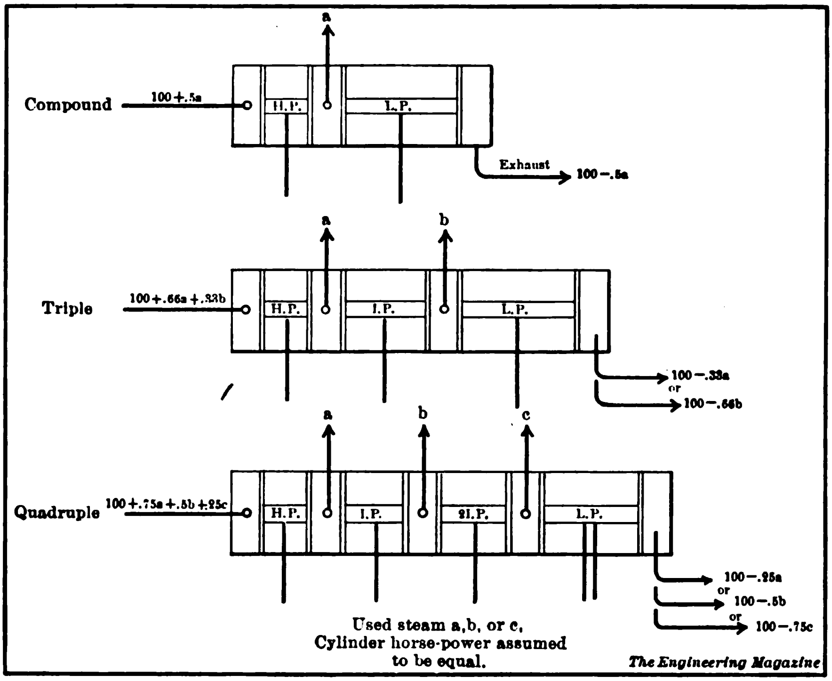


CHART VIII. PROPORTION ADDED TO SUPPLY OR TAKEN FROM EXHAUST BY STEAM USED FROM RECEIVERS OF MULTI-CYLINDER ENGINES.

The use of closed heaters would here be obligatory but the efficiency of such heaters may be increased as previously suggested by taking their drips to a coil in the hot well and discharging them at the resultant hot-well temperature.

The closed heater finds an economical adaptation on the exhaust of a condensing engine, in the form known as a "primary" heater. It is subject to the disadvantage of having all the cylinder oil carried

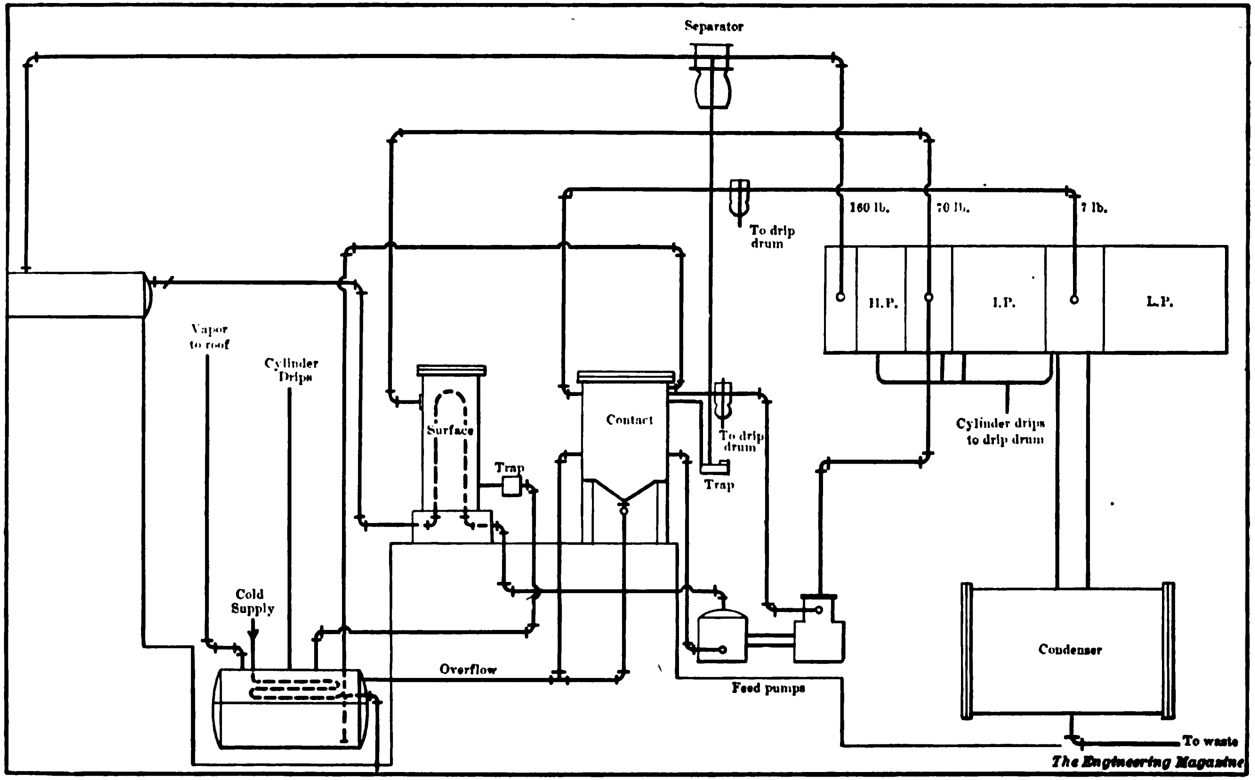
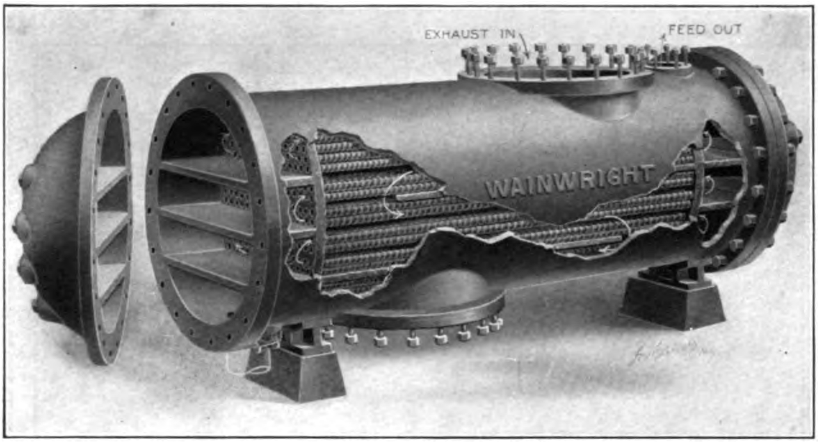


CHART IX. PROGRESSIVE FEED HEATING WITH CONDENSING ENGINE BY USED STEAM.



THE WAINWRIGHT EVENFLOW HEATER.

Secures the greatest possible temperature difference obtainable in a heater by counter-current effect, and the highest rate of absorption by rapid flow of water through corrugated tubes.

Alberger Condenser Co., New York.

over its surfaces, so that its efficiency is usually lowered after a period of use. It may be expected to raise the feed corresponding with the steam condensed only about 40 degrees, since the temperature of the closed or surface heater is only the mean between the temperature at the opening of the exhaust, and that of the interior of the condenser.

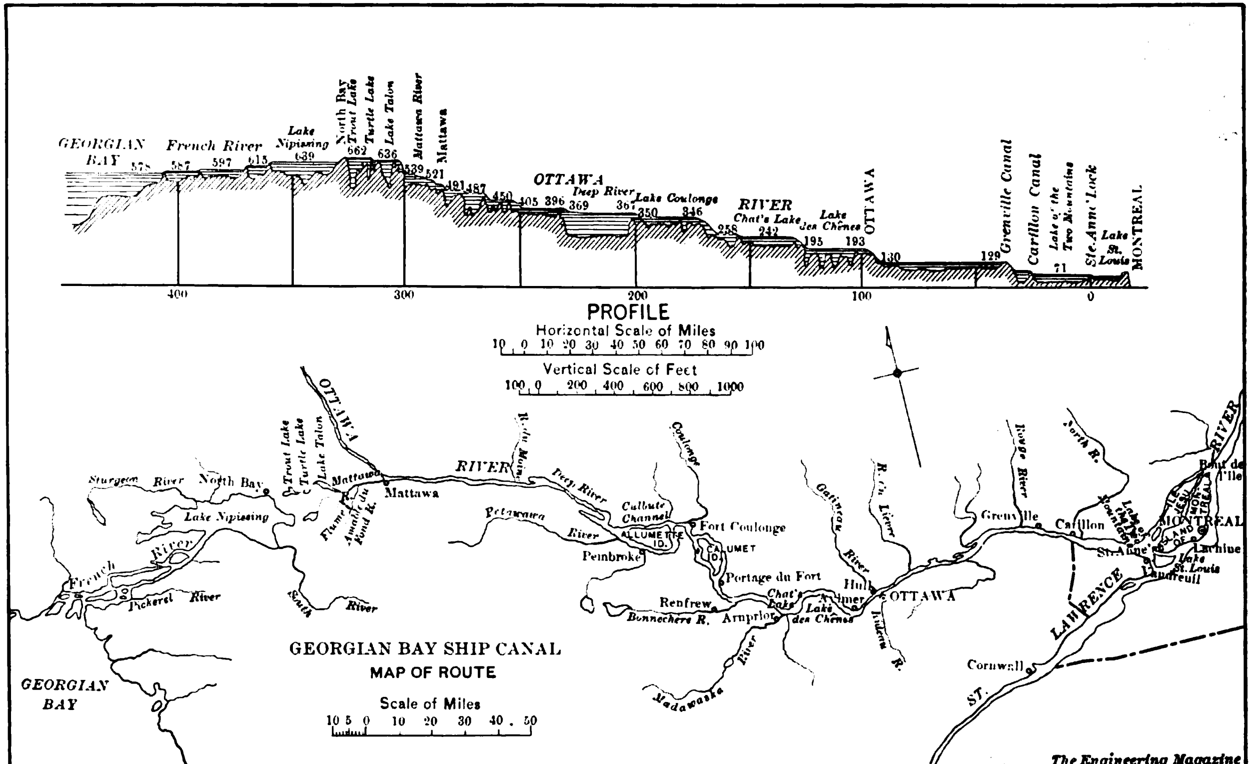
Summarizing the foregoing, we may conclude:

That the utilization of the heat in exhausted steam is a source of economy, up to the point where the amount will raise the temperature of the feed-water to 212 degrees F.

That in the absence of a sufficiency of waste heat, economical use may be made of the heat in partly expanded steam.

That the contact or open form of heater lends itself best to the utilization of the foregoing sources of heat retention, and may be usefully supplemented by the closed or surface form of heater in the process of prior heating of the supply, and also in adding to its temperature above the boiling point.

And we may well conclude the whole study, by the suggestion that the subject offers a fruitful field for the ingenuity and abilities of steam engineers.



PLAN AND PROFILE OF THE PROJECTED ROUTE OF THE GEORGIAN BAY SHIP CANAL.

THE GEORGIAN BAY SHIP CANAL.

By J. G. G. Kerry.

In a preceding article, published in our January issue, Mr. Kerry reviewed the history of the Georgian Bay Ship-Canal project and outlined the general features of the present plans for the waterway. In this concluding paper he treats in somewhat fuller detail the controlling problems of location and water-supply for the summit level, and discusses most interestingly the economic and financial elements of the proposition. His conclusion is that the undertaking is unquestionably wise in the interest of the expansion of agricultural, industrial, and mining activity throughout a great section of the Canadian West. Since the article was written, the Canadian Government has advertised for tenders for the first of the dams to control the waters of the Ottawa—one near the outlet of Lake Temiskaming. Mr. Kerry, it will be remembered, was a member of the Government commission which investigated the Quebec Bridge failure and a joint author of their very able report.—The Editors.

IN the first half of this review of the Georgian Bay Ship Canal, which appeared in The Engineering Magazine for January, the history and general outline of the project were summarized and some reference was made to the problem of providing sufficient water for the working of the summit level. Settlement and investment have rendered impracticable here the bold projects of the earlier engineers, and it is not now proposed to make any material change in the existing hydrography. The study of the engigeers has instead been directed to the estimation of the available water supply in the summit watershed and to the possible means of supplementing it. The district with its large forest areas, its severe climate and late spring, and its feeble evaporation, is well suited to a conservation of the natural rainfall and in this respect the location is most advantageous. It is intended to make a deep-water summit reach by flooding the series of small lakes, Trout, Talon and Turtle, that lie at the headwaters of the Mattawa River, and to design the summit locks so that this reach can be drawn down six feet below normal level without interference with navigation. It is estimated that the watershed tributary to these lakes will furnish a supply sufficient to allow 24 lockages to be made daily through the summit reach. This should be ample to handle all the traffic for many years to come, provided that some arrangement is made for an economical locking of the smaller craft that are sure in season to throng such a waterway.

When the demand of the traffic is such that the existing watershed cannot provide for the lockages, the flow of the Amable du Fond River will be diverted into the summit reach. The Amable du Fond is a small stream lying to the south of the canal, and it is estimated that its discharge will more than double the supply available for the summit reach; at present it empties well to the eastward into the Mattawa waters. The generally unsettled and undeveloped condition of the district makes such a diversion possible without the legal conflicts and costly compensations that would be necessary in older countries.

The total lockage from the Georgian Bay up to the summit level is 99 feet and the lockage down to Montreal 659 feet, 27 locks in all being required if the Lake St. Louis location is adopted; the lock lifts will vary from 5 to 50 feet. As has already been stated the locks will be of the usual type, but unusual care has been taken to secure the most advantageous locations for them. The estimates are made for locks with chambers 650 by 65 by 22 feet, but the possibility of an increase both in length and width has been discussed. Where possible and as a measure both of safety and of economy the locks are placed in rock cuttings, and the character of the rock encountered is such that little more than a facing of the sides with concrete will be necessary. The locks will be provided with two pairs of steel gates at each end, so that the waters of the upper reach cannot break loose if by any accident a vessel should chance to run into one pair of gates. With modern power machinery there will be little difficulty in operating the two pairs of gates simultaneously. The locks are also by preference located so that the necessary water may be drawn directly from and discharged into the main river near the centre of the lock. All culverts and sluices and valves in the vicinity of the gates are avoided as far as possible. Guide piers for incoming vessels will be run far out on one side, and on the line of the lock, so as to avoid all difficulty at entrance. The rivers will provide abundant power for the lighting and working of the whole plant.

No provision has been made in the estimates for terminals at either end. The intention of the canal being to avoid transhipment until Montreal is reached, no provision other than a protection harbour is requisite at the western entrance; and at the eastern end there is already Montreal with its wharves, sheds, elevators, tracks, and machinery for handling bulk freight. Two routes have been surveyed near Montreal, but if the teachings of history are to be regarded, the route by Lake St. Louis, which enables all existing facilities and the sites of the manufacturing and trading companies to be reached to the best advantage, will unquestionably be adopted. The Back River may subsequently be opened up to furnish facilities and accommodation for manufacturing concerns of great magnitude that may in the future desire to establish themselves near this commercial centre.

The canal location near Montreal is necessarily affected by the greater engineering problems of the city, of which perhaps the most important is the regulation of the St. Lawrence River, in the immediate vicinity, with the consequent increase of available power and the lessening of the floods and ice shoves which make the construction of terminal facilities in the harbour so costly an undertaking This problem was studied exhaustively in 1889 by the Montreal Flood Commission, of which Mr. T. C. Keefer was chairman, and a report was submitted. It was pointed out that the local difficulties arose almost entirely from enormous accumulations of "frasil" or "slush" ice, which was formed throughout the winter in the open waters of the Lachine Rapids. The remedy recommended was the creation, in so far as possible, of an ice cap over the water surface. If the construction of the Georgian Bay Ship Canal is undertaken by the Canadian Government it is hardly likely that so great an opportunity to carry out the ideas of the Flood Commission will be allowed to pass. If the regulation of the St. Lawrence River between Montreal Harbour and Lake St. Louis be successfully accomplished no canal construction near Montreal will be necessary and the available harbour frontage will be very greatly increased. This matter is not dealt with in the interim report, probably because the cost is not fairly chargeable to the canal scheme, but rather to the general development of Montreal as a commercial centre. Among the many problems suggested by or involved in the canal scheme there is probably not another equal in engineering interest or economic importance to this question of flooding out the Lachine Rapids, where the total fall of the river is about 50 feet, and the minimum flow nearly 250,000 cubic feet per second.

It should be noted that although this canal scheme calls for an expenditure (according to the latest estimates) of $100,000,000, it is to be regarded as a fairly simple piece of construction and as one that presents few problems that are not familiar to the profession. The works will be on a great scale, but there is no uncertainty about any of major considerations connected with the execution of the work; and the estimates should be very close and accurate, for the surveys have been very carefully made and the unit cost of the various classes of work proposed is well-known. Compared to such problems as the enlargement of the Erie Canal or the building of the Panama, it is a model of simplicity and certainty. The lessons learned in the Detroit and St. Mary's Rivers make the adjustment of the design to the needs of the proposed traffic almost a piece of routine work.

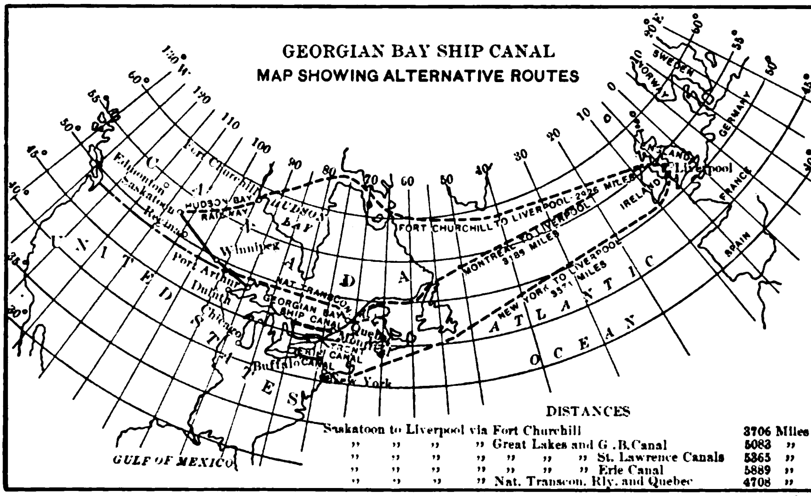
The real problem of the Georgian Bay Ship Canal is indeed not one of engineering, but of economics and finance. Will the improvement justify the outlay? This has been the question for fifty years past and it remains the question today.

In 1865, shortly after the publication of the Shanly & Clarke reports, Mr. William Kingsford, the Canadian historian, himself an engineer by training and occupation, wrote in his monograph on the Canadian Canals as follows: "The geographical situation of this navigation can only have in view the trade of Lake Michigan, for from the Lakes east of those waters the nearest route is by the St. Lawrence"; and "for purposes of Canadian navigation the canal is utterly unnecessary."

No one will now question the thoroughness of Mr. Kingsford's grasp of the situation or the soundness of his conclusion at the time of writing. The canal would then have served American traffic only.

In 1891, Mr. A. M. Wellington in his comments in *Engineering News,* practically endorsed Kingsford's opinion in the following words: "Had the route lain in American territory it would have been built long ago, and probably at Government expense as a free highway of commerce, so great is the opportunity. Were the route to-day under American control it would not be two years before work on it would be under way, but with one country to reap the chief gain and another country to pay the chief price for it, the prospect for any immediate action is poor." It may be said again that at the time of writing this conclusion was true.

The time has now come, however, when the Canadian publicist has ceased to look to the United States as the source of the traffic which his works are to handle. The growth of the settlement along the north shores of the Great Lakes, the rapidly increasing output of the prairie Provinces, and the diminishing importance of the United States as an exporter of heavy food stuffs, have combined to create conditions in his present which his predecessors could only predict for the far future. He realizes that England is still the great pur-



MAP SHOWING ALTERNATIVE ROUTES BETWEEN WESTERN CANADA AND EUROPE.

chasing market and that the returns to the Canadian farmer and shipper are determined by the prices ruling in Liverpool and London. Every reduction in the cost of transportation—and it should be remembered that it is a case of the transport of heavy material of low unit value over great distances—means therefore an increased price at the farm, and pending the growth of a local market, the Canadian West eagerly advocates every proposition that promises to reduce the cost of its export shipments. The West, however, has not been a very vehement advocate of the Georgian Bay Canal because the disability that is closest to it, and consequently most felt, has been the inability of the railroads to deliver its crops to the Great Lakes steamers at Fort William and Port Arthur before the close of navigation.

In my opinion there is little reason today why the West should advocate the construction of this waterway, for it is by no means clear that it would materially aid in the solution of the West's particular problem. The engineers in their report cannot find that the Georgian Bay Canal offers any advantages for grain shipments that cannot be obtained at a lesser cost by improving the St. Lawrence canals between Lake Erie and Montreal, and the climatic advantage of the St. Lawrence route has already been mentioned. Moreover, there are two great schemes, now more or less under way, to which the West looks with much interest and which affect it directly. The first of these is the National Transcontinental Railway, now building from Winnipeg to Quebec, with an east-bound grade of 0.4 per 100, and a very direct route; and the second is the Hudson's Bay Railway, from Saskatoon to Fort Churchill, which is to tap each of the great grain-gathering railway systems and to deliver its traffic to the problematical navigation of the Hudson Bay and Hudson's Straits. This railway is now under survey. It may be reasonably predicted that the next few years will see the St. Lawrence route much improved, the National Transcontinental Railway in operation and the Hudson Bay Railway also. Each of these will take some share of the grain traffic, which in itself will not for many years to come be sufficiently great to justify the investment called for in the Georgian Bay scheme, even if all the export grain were carried by that route.

The engineers have based their design upon a probable traffic of 20,000,000 tons per annum, and when we bear in mind the history of the traffic passing Sault Ste. Marie there is little reason to question the estimate. Conditions are changing and settlement is advancing so rapidly towards the north that estimates based on the facts of today are a little less valuable than guesses of the traffic that will exist twenty years from now. I am a profound believer in the wisdom of constructing a Georgian Bay Canal, although not necessarily of the dimensions now planned, and this even though I do not think that the grain traffic from Western Canada will be a predominating item in the traffic returns of the canal. The work is necessary to the development of the region through which the canal is projected, and of the wealth and possibilities of that region we have abundant evidence. The Sault Ste. Marie traffic has grown on the coal and iron south of the Great Lakes at a rate beyond all prediction; but who knows what wealth lies to the north of those waters? Sudbury is not much over twenty years old, and its nickel-copper industry, now not half developed, is the result of an accident of railway location and was not in the minds of the men who built the Canadian Pacific Railway. Cobalt is not ten years old and might have lain unknown and undisturbed had not the Province of Ontario run a haphazard railway into the unopened north. Moose Mountain has not yet commenced to send out its iron, and no engineer will question the value of cheap transportation in the development of these mineral resources which come from surely only a few of the treasure spots in the unknown north. There is also the possibility of building up along the great valley with its water powers, its varied mineral deposits, and its wealth of timber, a manufacturing region unequalled on the continent. To this valley, which has raw material in such abundance tributary to it, cheap power and cheap transportation are necessary, and with the advance in the demand for power for heavy manufacturing and the growth of the world demand for every staple, there seems little doubt that the Canadian people is economically justified in developing the Ottawa waterway. Its power supply will not be greatly in excess of the demand by the time that construction is complete, and the traffic of the Georgian Bay Canal, in my judgment, will be created mainly on or close to the canal and will be of a volume to justify its construction. Holding such opinions, it is waste of words for me to discuss the statistics of quantity, distance, and cost of operation, which would ordinarily be the determining factors in such an undertaking. It is not necessary that a great public improvement shall earn interest on its cost. Neither the Intercolonial Railway nor the Canadian Canal system have as yet ever done so, but the wisdom of building both these great works at public expense, in spite of all the minor errors of planning and administration, has never been questioned. They were essential to the welfare of the country that built them, and in a minor measure the same is true of the projected Georgian Bay Ship Canal.

THE NATURE AND CHARACTERISTICS OF THE NEW STEELS.

By O. M. Becker.

The literature of high-speed steel, in English, contains many excellent and useful articles relating to shop applications—many summaries, more or less empirical, of instructions for preparing and using alloy steel tools. There has been a marked deficiency, however, in the clear and comprehensive presentation of the whole range of knowledge on the subject—a lack of serviceable answers to the questions what are high-speed steels, how do they act, and why?

In this short series Mr. Becker addresses himself to this mode of treatment. The article here presented deals with the physical constitution of steels and the phenomena of tempering. A following paper next month will discuss in detail the influence and effect of all the ordinary alloy elements.—The Editors.

UNTIL comparatively recent times the name "steel" was given by general consent to a combination of iron and carbon (as we now know), together usually with certain other substances present as impurities, such that when treated in a particular way the result was a material of high tensile strength, homogeneity, toughness, and ability to resist crumbling. The distinction between steel and some varieties of iron has been so slight that it is very difficult to make a definition which will include, even in the case of the carbon steels, all those iron alloys commonly designated steel, and which at the same time will exclude those of practically identical composition (though perhaps of different structure) which are admittedly ***not*** steel. It is, in fact, impossible to draw a sharp line between mild steel, produced in an open-hearth furnace, and iron made by the puddling or other process. The latter not infrequently has a higher carbon content than the mild steel. Before the development of the modern steel-making processes, it was comparatively easy to decide whether a given sample was steel or iron. If it hardened on being quenched in water after having been heated to a good red, and took a "temper," it was plainly steel. But mild steel, with its low content of carbon, does not take a temper any more than wrought iron does. With the advent of the newer steels still greater difficulties are in the way of a suitable and precise definition, and it would be hazardous to venture one here. It is sufficient for our purpose to take for granted that the name steel may properly be applied to any alloy of iron and the so-called hardening metals which is of such a structure as to permit hardening or tempering in such a way as to combine a relatively high tensile strength, reluctance to fracture, and as said above, resistance to crumbling.

Since the discovery that substances other than carbon, in virtue of their presence give iron the quality of becoming hard and tough under certain treatment, it has become necessary to make distinctions among the various kinds of steels, and it is now customary to speak of them in a general way as carbon, Mushet or air-hardening, and high-speed or rapid steels, etc. Various other terms have been suggested but have not come into general use, though indeed the term "alloy steel" is commonly used to designate all steels other than those depending upon carbon chiefly for their specific qualities. The alloy steels in turn are frequently designated as vanadium steel, tungsten steel, and the like, according to the hardening alloy which predominates; and because tungsten was the first and still is the most common of the hardening metals used in the alloy steels, they are often spoken of as tungsten steels even though that element be in particular cases of minor importance or quite absent. Like carbon steel, the alloy steels are used for various purposes to which each is especially suited. Nickel steel, for instance, is largely used for armor plates and projectiles, and chrome and vanadium steel are largely used for the structural parts of machinery subjected to great strains, as in the case of certain automobile parts. It is not with this use of alloy steels however that we are at present concerned.

Ordinary carbon steel, such as has through the ages been used for tools, contains small proportions of elements other than iron and carbon. Some of these are useful and perhaps even necessary to make the steel easily workable, either in forging or melting. This is the case of silicon and manganese. Both tend to make steel sound by preventing the formation of blow holes. Silicon, in the quantities usually present in tool steels, has small, if any, effect upon the tool; though in steels for some other purposes, where the proportion of silicon may be larger, it causes stiffness and possibly also adds to the hardness. When present in excess of, say, 3 or 4 per cent, it causes brittleness and red-shortness. Manganese acts as a sort of antidote for sulphur, phosphorus, and perhaps other impurities found in steel. It prevents red-shortness, promotes the formation of fine and uniform crystallization, increases fluidity when the steel is melted, and makes it easy to work under the hammer or in rolls. Excess of manganese however makes steel cold-short (brittle when cold) and causes surface cracking, especially upon quenching.

Certain other elements, however, as phosphorus and sulphur, are not only useless, but distinctly harmful; and the greater the proportion of either present, the more inferior the steel. Sulphur tends to make steel "red-short" (brittle at a red heat), and therefore difficult to forge; while phosphorus tends to make it "cold-short," and therefore brittle when cold. A very minute proportion of either will make a steel worthless for tools of almost any sort. Steel for cutting tools is usually expected to contain less than 0.02 per cent of either, though in some Mushet or air-hardening steel the sulphur and phosphorus content have each been found to exceed 0.05 per cent. In "extra special" grades both are kept below 0.008 per cent.

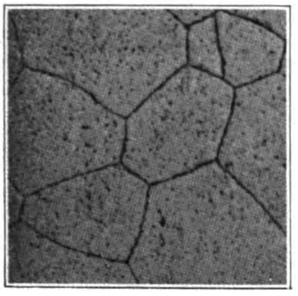
It will be seen that ordinary carbon tool steels, speaking in a general way, are constituted of iron, very small proportions of silicon and manganese in combination with carbon ranging from about 0.05 per cent to 1.5 per cent, and minute quantities of impurities such as phosphorus and sulphur. The variation possible in the carbon content of tools is well illustrated in the analyses of three well-known brands of carbon steel in use for lathe tools, whose performance was practically identical. The figures are quoted in part from Taylor. It is seen that the percentage of carbon varies from 0.681 to 1.240.

Steel.	Iron.	Manganese.	Silicon.	Sulphur.	Phosphorus.	Carbon.	Tungsten.
III & Z	98.524	0.189	0.206	0.017	0.017	1.047	
II	98.350	0.156	0.232	0.006	0.016	1.240	0.079
S	98.867	0.198	0.219	0.011	0.024	0.681	

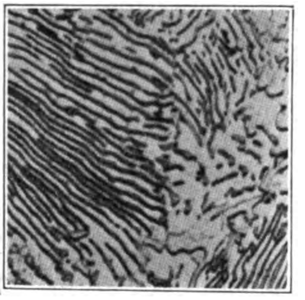
Besides carbon, manganese, and silicon, self-hardening steel contains a considerable proportion of tungsten, chromium, molybdenum, vanadium, or certain other elements, generally in definite combinations, as shown hereafter. The silicon content is practically the same as in carbon steel, as also is the permissible amount of sulphur and phosphorus; but the carbon and manganese are much higher, the former running from 1.25 per cent to over 2 per cent, and the latter varying from rather more than 1 per cent to 3 or more, according as the tungsten content is high or low. Chromium, when present, takes the place of a portion of the manganese or the tungsten, which latter ranges from about 4 to 11 or 12 per cent. The analyses here given are characteristic of these steels:

Steel	Carbon.	Tungsten.	Molybdenum.	Chromium.	Manganese.	Silicon.	Sulphur.	Phosphorus.
A........	2.150	5.441	.....	0.398	1.578	1.044	.....	.....
B........	1.615	.....	4.580	3.430	1.650	0.285	0.016	0.027
C........	1.750	10.000	.....	1.000	1.750	0.060	.....	.....
D........	1.812	11.580	.....	2.694	2.430	0.890	0.007	0.023
E........	1.220	7.020	.....	0.078	0.300	0.180	0.010	0.0170

From the fact of its containing rather more than 7 per cent of tungsten, the steel marked E and separated from the other four in the table would naturally be thought like the others, self-hardening. This however is not the case. Though it has a tungsten content about a half greater than that of some very good self-hardening steels, this steel has no such property, when heated to the customary temperatures, at any rate. It hardens only on being quenched in water, as is the case with ordinary carbon steel. This raises the question as to what causes tungsten steel to be self-hard, and why steel of any kind becomes hard under certain conditions.



FERRITE



PEARLITE.

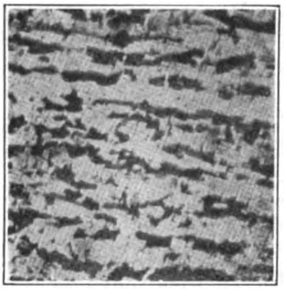
Both × 1,000. From Prof. H. C. H. Carpenter's paper before the Iron & Steel Institute.

The hardening of ordinary carbon steel, as is very well-known, is accomplished by heating the piece intended to be hardened to a red color ranging between a dark and bright cherry (something like 735 degrees C. or 1,350 degrees F.), and then quenching it in a water or other suitable bath to about the normal temperature of the air. This process seems to change entirely the structure of the steel as seen when examined under the microscope. Careful investigations into the nature of these changes have been made, and a number of theories or hypotheses have been advanced to account for or rather to explain them. The several hypotheses differ more or less among themselves; but those that are most generally received agree substantially that steel may exist, according to temperature or quenching temperature, in three type forms. At temperatures below 735 degrees C. or thereabouts carbon steel exists in the unhardened or annealed state. Between 735 degrees C. (1,350 degrees F.) and 820 degrees C. (1,510 degrees F.) it exists in a hardened state; and above 820 degrees C. it exists in a state harder than the first and softer than the second, and at the same time is very tough.

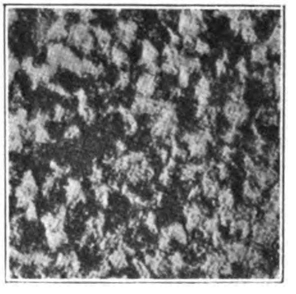
In the first or annealed state, corresponding approximately to the α steel of Osmond and others, carbon-iron steel is constituted of pearlite, or pearlite with cementite, or of pearlite with ferrite, according as the carbon content is at, above, or below 0.89 per cent.

Ferrite is iron free of carbon, and practically free of impurities. It is soft and forms substantially the whole of wrought iron and the greater portion of mild steel, both of which owe their essential characteristics to it. Cementite, on the other hand, is very hard, and also brittle. It is a carbide of iron, formed apparently in the presence of manganese and other elements found in steel, stated by some investigators to be of the chemical combination represented by the formula Fe_3 C. It is cementite that gives unhardened steel its stiffness, and at the same time tends to make it brittle.

Pearlite is an intimate mechanical mixture of cementite and ferrite, which forms the whole of unannealed carbon steel when it is saturated, or when the carbon content is just 0.89 per cent.*



PEARLITE (BLACK) SEGREGATED IN FERRITE.



CEMENTITE (BLACK) WITH CONTAINED PATCHES OF FERRITE.

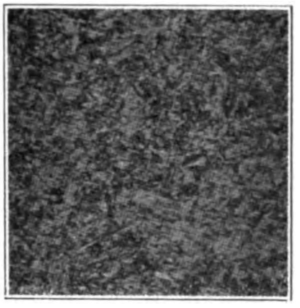
Prof. H. C. H. Carpenter. Both × 250.

Pearlite exists either as a crystalline mixture of the cementite and ferrite, or in a lamellar form in which exceedingly thin flakes or lamellae of cementite alternate with flakes of ferrite, giving a beautifully iridescent play of colors when viewed under the high powers of a microscope by the aid of oblique light. It is from this circumstance that pearlite has its name, because of its resemblance to mother-of-pearl in this play of colors. The lamellar form occurs in steel slowly cooled from above 735 degrees C., and the granular form usually is found in worked steel or steel re-heated to a low temperature.

As just pointed out, saturated steel at temperatures below 735 degrees C. consists wholly of pearlite. If a carbon content greater than 0.89 per cent be present, the excess of carbon crystallizes out as cementite; and if the percentage of carbon be lower, ferrite crystallizes out. In the first case (supersatuated or hypereutectoid steel)

* Professor J. O. Arnold, "Influence of Carbon on Iron."

the structure consists of pearlite and cementite; and in the second case (unsaturated or hypoeutectoid carbon content below 0.89 per cent) it consists of pearlite and ferrite. In the former case it is therefore more "steely" than in the latter.



MARTENSITE. (PROF. H. C. H. CARPENTER.)

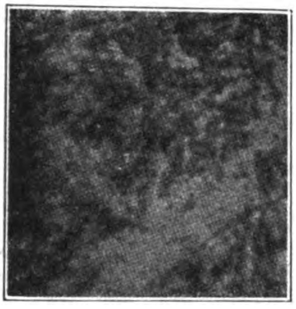
MARTENSITE AND CEMENTITE COMPLETELY SEPARATED.

The martensite is × 150 and the right-hand figure × 1,000.

Between the temperatures 735 degrees C. and 820 degrees C. (1,360 and 1,510 degrees F.) steel is very much harder and is in a state distinctly different from that just described. At about the point 735 degrees C. most of the cementite and ferrite which are mechanically combined in pearlite pass into a chemical compound, a very hard carbide, having, according to Arnold, the composition Fe_{24} C, which gives to hardened steel its essential characteristics. This intensely hard carbide, variously called hardenite or martensite, constitutes the whole of saturated steel. In unsaturated steel there is present, besides some indefinite portions of pearlite, cementite, and martensite, imperfectly segregated, also free ferrite, as in the first stage; while in supersaturated steel the martensite is accompanied by cementite. Martensite has already been stated to be much harder than the soft ferrite, which latter of course constitutes the greater or less proportion of steel according as the carbon content is high, (but still under) or low relatively to the saturation point, already stated to be 0.89 per cent of carbon content.

The higher the percentage of carbon, above the point of saturation, the greater the proportion of cementite formed. When present in excess, the cementite surrounds the crystals of martensite or hardenite with walls corresponding to the cell walls in living matter. Obviously, the greater the proportion of cementite, and therefore the thicker the walls surrounding the particles of martensite, the more brittle is the steel.

Above 820 degrees C. (1,510 degrees F.) hardened steel begins to lose some of its hardness; and at about 900 degrees C. (1,650 degrees F.) it has passed into a condition unlike either of the two already described, though it is not until a temperature of about 1,050 degrees has been reached that all the cementite disappears as such. In this state steel is neither so hard as in the second, nor so soft as in the first; but it is a great deal more tough, as already indicated. The change in structure and properties comes about through the solution of the ferrite or cementite, as the case may be, in the martensite; and the formation of a new structure called austenite,* which gives to steel the characteristics previously mentioned, of being harder than in the stage where ferrite predominates, and not so hard as in that where martensite or hardenite predominates.



AUSTENITE (× 900). PROF. H. C. CARPENTER.

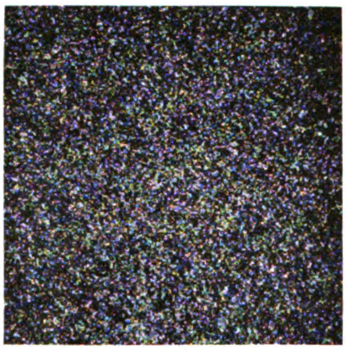
It is well-known that if carbon steel is heated to a bright red, and even higher, and is then slowly cooled, it possesses little or no hardness; but if quickly plunged into water or oil, and thus cooled suddenly, it is hard, the degree of hardness depending for the most part upon the proportion of carbon in the steel. In the first case the steel has passed from the martensitic back to the pearlitic condition; in the latter the re-conversion into the normal or annealed condition is arrested in some way, and the steel remains in the martensitic state. If now the heating be carried well up, say above 820 and as far as 1,050 degrees C. (1,510 to 1,925 degrees F.) the point at which the steel has passed into the austentitic (γ or semi-hard) state, and is then slowly cooled, it passes successively into the martensitic and the pearlitic states again. If quenched, the result is still different from what might be expected in view of what happens

* Besides the ferrite, pearlite (in two forms—lamellar and granular), cementite, martensite or hardenite, and austenite, certain other forms, intermediate in reference to those named or very closely resembling some of them, are pretty well defined by metallurgists. Such for example, is troostite, which closely resembles martensite but is softer, and is plentifully found in steel as ordinarily hardened or tempered. Sorbite is a slight modification of pearlite, from which it differs by having a finer structure, the farthest removed from the crystalline yet found in steel. It is formed by rather rapid cooling (but not quenching) through the critical range, and is considered important in steels intended to resist wear and erosion. Certain alloy elements tend to promote its segregation naturally. In addition to these two variations from the regular structure of steel, some Continental writers speak of a still further modification of β iron, which they name hardenite, distinguishing it from martensite. Most often these two names are used to indicate the same formation, as is the case in this review.

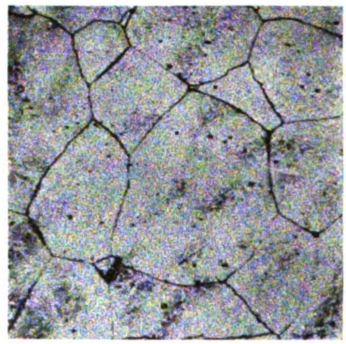
when steel is quenched in the martensitic state. The steel comes out, not in the austenitic, but in the martensitic condition, and is in almost the same state as when quenched from the lower temperature. The austenitic condition did not remain. By microscopic examination, indeed, small particles of austenite can generally be found, mixed with martensite, cementite, or pearlite and ferrite, as the case may be; but the steel cannot in any sense be called austenitic. This condition is exceedingly difficult to "trap," to fix in a stable state so as to be characteristic in the cold metal. No matter how quickly a piece of steel may be quenched, even when plunged dazzling white into ice water, the change to the martensitic condition takes place still more quickly, and but a small amount of austentite will be found in it, so strong is the tendency to revert to the form characteristic of the lower temperature. Only in steel containing above 1.10 per cent of carbon is austenite to be obtained in any considerable proportion, and then only with difficulty.

If steel could be retained in this austenitic or γ condition it would be not only hard enough, but strong or tough enough, for most purposes; though it would not indeed affect the speed qualities of the steel, as will be shown hereafter. Though the discoverers seem to attach little importance to the circumstance, the Taylor-White discoveries have proved (if indeed Mushet did not do so before) that this austenitic or γ state can be trapped, and is trapped in steels containing combinations of tungsten and certain other elements in addition to carbon—and that too without quenching.

The second or martensitic condition, that in which hardened carbon steel for the most part exists, is trapped with comparative ease. If steel be quenched in water, or any other suitable bath, while at any temperature above the first critical point, already given as about 735 degrees C. (1,360 F.), fixation takes place quickly enough to prevent a reversion to what may be called the basic or normal state, that in which pearlite predominates. This condition continues practically permanent unless the steel is again heated. If the temperature be raised to a point above that of quenching, and cooling subsequently takes place slowly, the steel is "let down" to the annealed condition, as if it had never been hardened. Much the same thing, in degree at any rate, takes place when a piece of hardened steel is heated to a temperature lower than that of quenching, but above, say 200 degrees C. (390 F.); and indeed in some cases it takes place to a slight extent without any heating. The tendency is for steel to return to the "normal," pearlitic, or annealed condition; and as the temperature is raised higher and higher, more and more of the hard or semi-hard carbides are resolved into that less hard and more tough condition, which is requisite to tools of most kinds. This is just what takes place when tools are tempered after hardening. The "tempering," or "drawing" of the temper as the process is frequently called, consists merely in gradually heating a tool made of steel of a known quality to a temperature shown by experience to be most suitable for obtaining the desired degree of hardness or toughness.



TYPICAL STRUCTURE OF ANNEALED STEELS. 150 DIAMETERS.

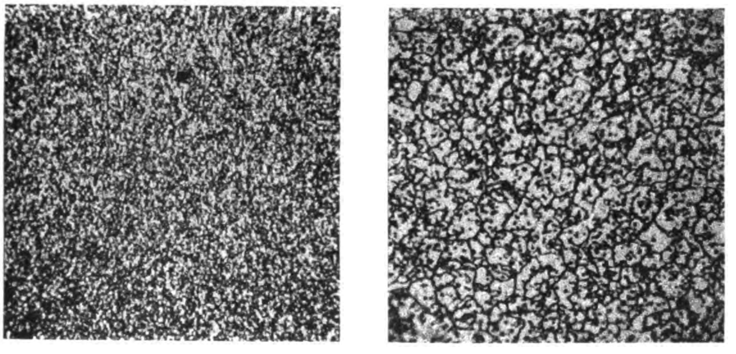


STRUCTURE OF HARDENED HIGH-SPEED STEEL. 1,000 DIAMETERS.

The photographic reproductions on this page and the pages following are taken by permission from Mr. C. A. Edwards' paper on The Function of Chromium and Tungsten in High-Speed Steel, in the Journal of the Iron & Steel Institute.

In carbon steels of ordinary composition the softening begins, as just indicated, at about 200 degrees C. (390 F.), at which point the polished surface begins to assume a slight straw color; it continues through a range of about 170 degrees C., passing through the well-known color scale generally given as faint yellow, straw, dark straw, purple, dark purple, deep blue, dark blue, sea green and black. At this point, about 370 degrees C. (700 F.), carbon steel has lost all its hardness. The temper-resisting quality of high-speed steel, its so-called red-hardness, is indicated in this: that softening does not begin much, if any, below 550 degrees C. (1,020 F.), and it is not completed until a temperature close to 700 degrees C. (1,300 F.) is reached. At this point the steel is already quite red, though considerably short of the bright cherry red so much used as a standard of reference. In some high-speed steels considerable hardness remains even at this temperature.

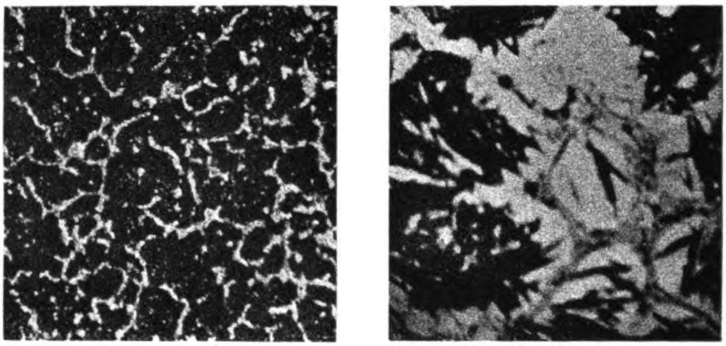
The "critical points," the temperatures at which or within which these important chemical and structural changes take place, have been given above approximately only. The fact is, it is not possible to state them with absolute precision, not only because of the difficulty of making accurate observations with the instruments at hand; but because they vary more or less according to conditions. There is, for instance, a variation governed by the percentage of carbon present. Also, there are in low-carbon steel, say below 0.3 per cent., not one, but three rather well defined critical points near 700 degrees C., which in steel of higher carbon content merge into one another so as to be indistinguishable. The presence of tungsten and manganese, and certain other substances also, in a steel likewise affect the transformation points, the critical temperature being lowered approximately in proportion to the alloy present. In the case of chromium, singularly enough, the tendency is the other way, and the critical points are likely to be lower in consequence of the presence of this element than without it. Furthermore, the transformation points are not the same for cooling as for heating, the latter being somewhere between 30 and 100 degrees C. (in high speed steel generally near 100) higher than the former. The change which takes place in cooling, it has been shown, cannot occur until the steel has first been heated above the point where it takes place in heating; so that in treating tools it is necessary to consider only the rising critical point, that at which the change occurs in heating. Inasmuch as the changes do not take place instantaneously, but on the contrary rather slowly, the steel must be held at a temperature somewhat above the desired critical point for a longer or shorter time as may be necessary to insure complete conversion.



TYPICAL OF ALL ALLOYS CONTAINING MORE THAN 9.0 PER CENT TUNGSTEN AND 3.0 PER CENT CHROMIUM.

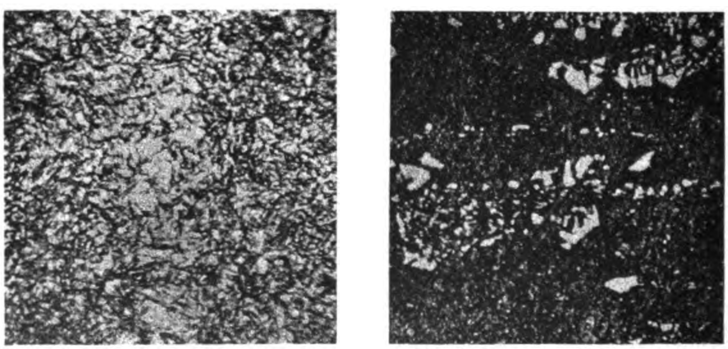
On the left, 150 diameters; on the right, 1,000 diameters.

The transformation points are accompanied by a singular phenomenon by which they are identified with comparative ease, and from which they are sometimes called "points of recalescence." The most marked one, observable in practically all steels, is that which occurs when the pearlitic structure is transformed into the martensitic. A piece of steel placed in a furnace whose temperature is kept constant at a very high point, absorbs heat at a rather uniform rate which very gradually diminishes in a geometrical proportion, approximately, until a temperature in the neighborhood of 700 degrees C. (1,300 F.) is reached. Here a singular thing take place. Instead of rising in temperature as before, the steel for a short time (from half



TEMPERING OF AN ALLOY WITH CARBON 0.67, CHROMIUM 6.18, TUNGSTEN 12 5 PER CENT.

On the left, heated to 730 degrees C.; 150 diameters. On the right, heated to 730 degrees C.; 1,000 diameters.



TEMPERING OF AN ALLOY WITH CARBON 0.68, CHROMIUM 3.01, TUNGSTEN 19.37 PER CENT.

On the left, heated to 680 degrees C.; 1,000 diameters. On the right, heated to 730 degrees C.; 1,000 diameters. The changes of structure are not so rapid as in (A).

a minute to ten minutes or more, according to circumstances) rises in temperature very slowly compared with the former rate, remains quite stationary, or in some cases even falls slightly, in certain steels as much as 30 degrees. Evidently some important molecular change is going on within the steel, which is absorbing enough heat to retard or stop entirely the rise in temperature; and this change doubtless is the transformation of pearlite and its concomitants into martensite.

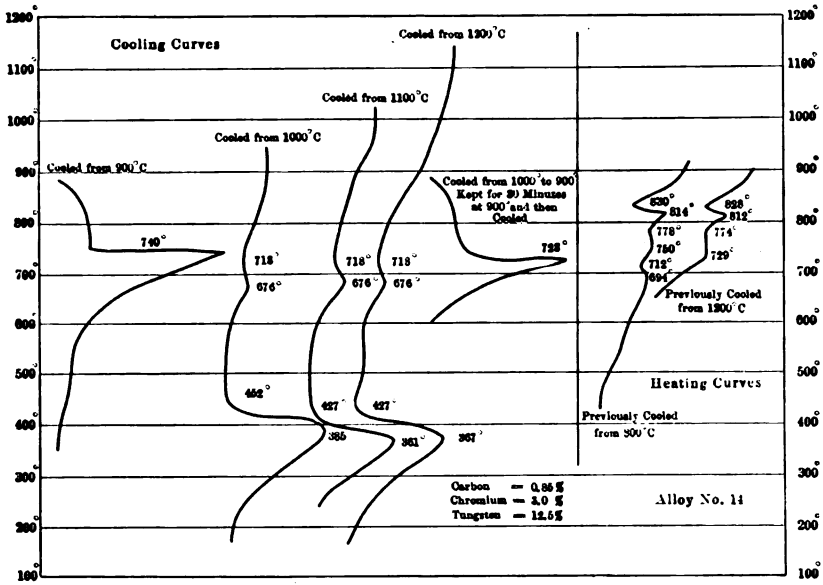


CHART SHOWING CLEARLY THE LOWER CRITICAL POINT—THAT CONNECTED WITH THE PHENOMENA OF TEMPERING.

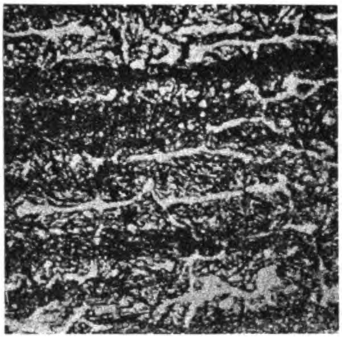
Movements of the differential galvanometer, about 1/25 size. Prof. H. C. H. Carpenter before the Iron and Steel Institute.

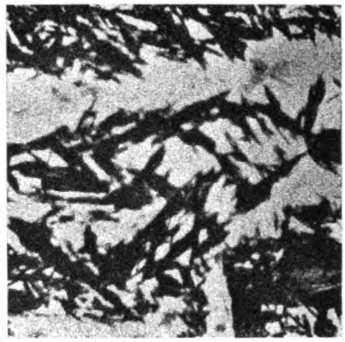
A somewhat similar phenomenon has been observed in the case of certain metals when the crystalline (solid) structure is changed to a fluid, at the melting point.

Singularly enough when the steel is cooling the reverse change does not occur at the same point as when heating, but, as might be surmised from the statement above, the transformation points for cooling and heating are not the same. The curves of the recording pyrometer show that the retardation or stationary point for cooling is something like a hundred degrees C. lower than that for heating; and that there is no such point of recalescence, as it is sometimes called, unless the steel has been first heated above the recalescence or critical point some hundred degrees above.

In high-speed steel the curve for heating is much more uniform than in the case of carbon steels, there usually being but a slight variation at the critical point. The cooling curve, while still much more regular than that for carbon steel, is yet considerably more marked than the heating curve.

The deviations in the curves also occur, for the most part, at temperatures considerably lower than in carbon steels. Especially is this true of the transformation point between pearlite and martensite, that is, between the hard and the soft or annealed state.

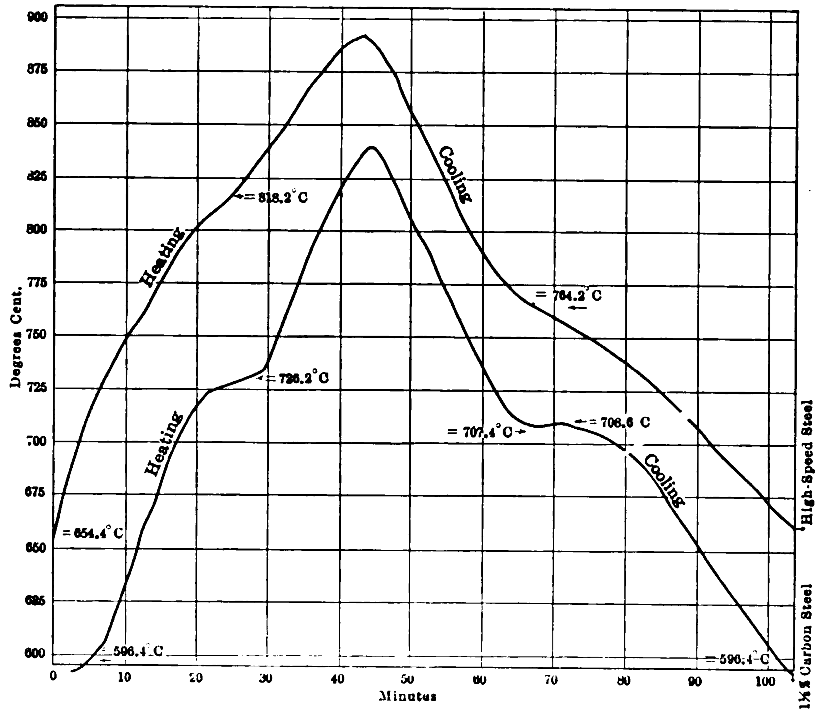




STRUCTURE OF THE NOSE OF A HIGH-SPEED TOOL AFTER CUTTING AT ITS MAXIMUM SPEED FOR 20 MINUTES.

On the left, 150 diameters; on the right, 1,000 diameters. Long white austenitic streaks embedded in a martensitic structure.

It is through this lowering of the transformation point to such an extent that the martensitic structure continues unchanged until it has become "fixed," that is, has reached the temperature where this structure no longer tends to change into the soft pearlitic or annealed, that steels become self-hard, and do not require quenching. This lowering of the transformation point is due to the presence of tungsten and manganese or chromium, or the like combination of the steel-hardening substances (vanadium excepted); and it is approximately in proportion to the amount of alloy contained. In the case of some of these alloy materials, especially of those most used in high-speed steel because of their cheapness or the qualities they impart, this tendency to lower the critical point or range, high as well as middle and low, becomes active only when they are combined with certain others in more or less definite proportions. Thus tungsten, to which the most important part in giving high-speed steel its peculiar properties has been until recently attributed, does not at moderate temperatures at any rate, lower the transformation points much, if at all; and neither does molybdenum. If, however, these are combined with chromium or manganese, and possibly to a slight extent with certain other substances, this lowering takes place; and when these elements are present in such proportion that the tendency of the steel to revert from the austenitic (γ or medium hard and tough) condition to the martensitic (β or hardenitic, which is the very hard state) condition is counteracted until the temperature has passed below the point where this change can take place; then the structure of the steel becomes fixed or permanent in that condition, and the steel is austenitic, or high-speed, and that without quenching. Precisely the same thing in respect of the change to the pearlitic (soft) state, takes



CURVES SHOWING RELATIVE LOCATION AND NATURE OF CRITICAL RANGES IN CARBON AND HIGH-SPEED STEEL.

The lower position of the cooling recalescence range, compared with the heating range, is also shown.

place when the alloy steel is heated to the temperature at which the martensitic form occurs. The combination of alloys retards the change from one condition to the other, entangles the martensitic structure as it were, until the temperature has become lower than the point at which the change can take place. The steel is then also self-hard without quenching; but is in the martensitic or very hard state, and does not have the high-speed properties to any considerable extent, if at all.

Now the old Mushet or self-hardening steels were alloys in which the above changes took place in the manner indicated. The tungsten, in the presence of a sufficient proportion of manganese (or in some cases, of chromium) prevented the change from the martensitic to the pearlitic structure until that condition had become fixed or permanent through normal cooling or cooling in an air blast, quenching being therefore unnecessary. Since however the temper-resisting properties of tungsten steels are for the most part found when it is in the austenitic or γ state; and since this state occurs only when the steel is heated to a white heat, above say 820 and up to near 1,050 degrees C. (a temperature to which the Mushet steels were rarely or never raised); and then only when the percentage of alloy is very high, much higher than was found in the old self-hardening steels: it is evident that the Mushet steels lacked in those very things which are characteristic of modern high-speed steels and which were discovered or developed by Mr. Taylor and his associates.

The anomaly exhibited by the last steel mentioned in the table on page 802 is now explained. Even though it contains a relatively high percentage of tungsten, rather more than 7 per cent, it will be seen by referring to the table that it contains but 0.3 per cent of manganese, and but little more than a trace of chromium. Though there is ample tungsten to make the steel self-hard, it is not combined with a sufficient amount of manganese or chromium.

Not all the hardening elements act in the same way to produce the effects here described, though with the exception of carbon and vanadium their action is more or less like that of tungsten—or perhaps it were better to say like nickel and manganese, which latter two may be taken as typical from the circumstance that they alone, as it would seem, act directly to lower the transformation or critical points in steel normally and without noticeable complicating phenomena. Molybdenum also behaves in almost the same way, very closely resembling tungsten in its influence. Both tungsten and molybdenum form with carbon, even when there is but an infinitesimal amount of the latter present, certain soft and brittle carbides whose presence in steel tends to make it worthless for tool purposes. The transformation points, already described, are not lowered materially unless the steel has been first raised to a very high temperature, close to 1,200 degrees C. (2,200 F.), and the double carbides destroyed. If the molybdenum or tungsten is low, the steel is then martensitic, self-hardening, and very much like Mushet steel; and if high, it is austenitic, air-hardening, and to a greater or less extent high-speed.

EFFICIENCY AS A BASIS FOR OPERATION AND WAGES.

By Harrington Emerson.

VIII. THE EFFICIENCY SYSTEM IN OPERATION.

The parts of Mr. Emerson's series, which began in our issue for July last, already presented have discussed the world-wide evils of inefficiency in almost every branch of human activity; the peculiar national qualities which have thus far helped the leading industrial uations to mitigate the losses due to inefficiency; the necessity for supplementing the line system of organization on which industrial management principally depends with modern staff organization; the relation of standards to organization and to results; and the realization of standards in practice. In the December and January installments he reached the "modern theory of cost accounting," which in his view requires that actual costs must be subdivided into standard costs and preventable wastes; that standard costs must be based on full equivalency in service rendered for money spent; that standard costs must always be predetermined; that average wastes are part of general expense and can be currently anticipated; that the chief duty of the operator is the maintenance of all standards; and that cost standards can only be attained through methods, records, ideals and checks furnished jointly by the comptroller and the efficiency engineer to the executive line officials.—THE EDITORS.

IN the last essay the method of reconciling predetermined allotted costs with actual expenses was outlined as to a real case, in which efficiency methods reduced unit costs from $0.1031 to $0.048, effecting a saving of $345,933.*

The reduction of cost is an efficiency result compared to which the method of stating it in the accounts would be unimportant, were it not that the ability to follow efficiency methods and to convince others of their value and effect depends largely on clear and easily understood statements, and these statements are difficult to obtain and do not carry weight unless at some point they are certified by the accountants, and thus tied into the official expense reports. Efficiency records and accounting records can coincide only at one point—namely, where the same equivalents are used. All the expenses of the year appertaining to a unit, divided by all the units for the year, can be used by both efficiency engineer and by accountant, but in this case no statement of efficiency and expense will coincide for a shorter period or for a smaller number of units. If at the other end—the single unit for the smallest time—cost-accountant and efficiency engi-

* For reference, this table is repeated in simpler form on the next page, and errors which escaped the proof reader are corrected.

ALLOTTED AND ACTUAL COSTS AND THEIR RECONCILIATION.

	1903-4.	1904-5.	1905-6.	1906-7.
Total units	4,725,000	4,785,400	5,776,000	6,462,800
Allotted unit standard costs	$0.06	$0.06	$0.06	$0.05
Allotted unit wastes	0.04	0.04	0.01	....
Allotted total unit costs	$0.10	$0.10	$0.07	$0.05
Actual unit costs	0.1031	0.1017	0.065	0.048
Allotted standard costs	$283,500	$287,124	$346,560	$323,140
Allotted wastes	189,000	191,416	57,760	....
Allotted total costs	$472,500	$478,540	$404,320	$323,140
Actual costs from President's annual report	487,171	486,620	376,106	315.844
Credit to Efficiency account	....	....	$28,214	$7,296
Debit to Efficiency account	$14,671	$8,080	....	....
Credit carried from preceding year	....	....	....	$5,463
Debit carried from preceding year	....	$14,671	$22,751	....
Credit to carry to following year	....	....	$5,463	$12,759
Debit to carry to following year	$14,671	$22,751	....	....

neer agree as to a method of stating cost for the single unit of work, then the records built up from this base will diverge immediately, as efficiency corrections are not identical with expense corrections. It is however very important that both efficiency statements and cost statements keep close together, that both should use the same unit, that both should use equivalency (standard cost) and that expense shall be stated in two terms: Standard Cost and Waste. It will prove convenient for the accountant to standardize from previous records both the current percentage of waste and the general burden resulting from indirect expense, rather than to carry into the daily operative expense statement the actual but partly accidental waste and the actual fluctuating burden, especially as the standardization of waste permits a very close prestatement of cost which is always of advantage and also brings back forcibly to the accountant the great purpose for which accounts were originally evolved and developed—namely, to locate and eliminate wastes. Whether efficiency records receive the assistance of accounting statements or not, the methods of attaining efficiency are as follows:

The volume of work to be done is carefully measured or estimated in advance on a unit basis.

In preparing to build a line of railway today the tons of rails, the number of ties on the mileage basis, the quantity of earth and rock handled on a cubic-yard basis, are easily predetermined. Predetermination was not always resorted to in the early days, and there is a story current that after the first trans-continental road was built the number of ties actually under the rails was only half the number that had been paid for. From the stories told me by eye-witnesses of and participants in the methods of counting ties delivered I am surprised that the final result was so good. It would have been just as easy to have estimated "ties required" in advance, to have accepted no more than enough, and to have paid only for those under the track, in fact, to have counted first and have paid afterwards, instead of paying first and counting afterwards. Similarly it is possible as to any operating road to estimate in advance and in detail the reasonable unit cost of each item of repair and also the reasonable number of each kind of units. The number of some units may increase, owing to unforseeable causes; but as units increase, cost per unit should go down, offsetting to some degree the accidental increase. When a careful pre-estimate is made of the reasonable cost of the great items of operative cost on a railroad it is found that they are not infrequently less than half the actual cost, and I do not know of any important railroad within the limits of the United States in which the locomotive repair cost of $0.06 per mile ought not to be ample, instead of the $0.08, $0.10, $0.12 calmly embodied in annual reports.

The cost of ties for a new railroad depends less on the number required than on the cost of each, since even the grossest waste of supply can scarcely double the quantity; but there is almost no limit to the amount which corruption and similar carelessness may pay for individual items, as has been recently well illustrated in the State House furnishing scandals of Pennsylvania. So also in manufacturing operation. While the volume of business has an important bearing on cost, it is not as important as the unit cost of operation which need not be appreciably more for a few operations than for many. It is the methods used to secure control of unit cost which are important, little known and rarely used. The cost of any operation consists of four items:

1.—Material used

2.—Labor service used

3.—Equipment service used

4.—Indirect expense, carried partly in 3 and partly as a burden on all labor service used.

Items 2, 3 and 4 can be combined in a single "service" requisition. Item (1) is covered by a "material" requisition.

Two forms of requisition are therefore sufficient to cover every possible item of operation expenses, of cost, of accounting and of efficiency, and, except as to form, there is no difference between a material expense order and a service expense order.

The best basis for a cost and efficiency system is: Not to issue any material without a full requisition, not to permit any work to be done without a service order.

Stores Issued To Department ____________________		State Use For ________________________	
ITEM	DESCRIPTION	ACCOUNT	CHARGE
		Entries to be by storekeeper	
QUANTITY	QUALITY	COST PER $	TOTAL VALUE $

	Month	Day	Year
Storekeeper please issue above material To _____________________________ (Give Name. Do not make out to bearer)			190

Approved by ____ Foreman
(Values to be filled in at storehouse)

Issued by ______________________________ Entries made by ____________________

(Name of Plant) *The Engineering Magazine*

FORM I. MATERIAL REQUISITION. THE ORIGINAL IS 5 INCHES WIDE.

Figures 1 and 2 illustrate the two forms of requisition. Nearly all operating concerns realize the importance of these fundamental records which provide both material and service cards, but it has been my experience to find them curiously incomplete, therefore largely without value and in consequence neglected and distrustfully used. They are supplemented and obscured in a mass of independent and confusing records and forms, which are superfluous since all the information is more exactly contained and in more potentially available form in the original requisitions. Virtually the whole of efficient management can flow from an able superintendent making proper use of complete requisitions. The objection to full requisitions lies partly in the inherent objection of almost everybody to exactness and precision and partly in the panicky fear of managers that their use will increase "indirect expense" for clerical help. It is however a fact that the same amount of tabulated information will cost less if based on and built up from these requisitions than if secured along independent lines.

Industrial shops could well learn from other concerns as banks or restaurants which use similar requisitions effectually. A club restaurant finds it expedient to exact from each guest a minute written requisition in duplicate, signed and dated, for the meal he orders. If the requisition is paid in cash on delivery of the supplies it becomes the voucher in the cashier's hands, but if charged it is carried to the account of the individual and becomes the voucher for his bill. The duplicate goes to the kitchen and becomes the kitchen's record of portions served. A third copy should go to the commissary department and there be analyzed and tabulated so as to know and check whether 100 pounds of purchased turkey resulted in 200 portions or in only 150. If a restaurant is able to obtain original requisitions in this manner in the rush of the noon hour, virtually without expense, an industrial plant can very much more afford to do the same thing. It is obviously very much better for a foreman to think one minute and write on a requisition "Give to John Doe one lead pencil No. 3, and do not give him another for a month," than it is to write in 30 seconds, "Give bearer all the pencils he wants." The careless method apparently saves 30 seconds, costing $0.005 of the foreman's or the foreman's clerk's valuable time, but it results in $0.10 to $0.20 extra expense for pencils.

MATERIAL REQUISITION.

No material, whether lead pencil to clerk, or steamer-load of coal to power house, should be supplied except on requisition, and this should state the use to which the material is to be put, and specify the amount, kind and quality. As every material issue should be standardized, the moment the standard is exceeded (as for instance lead pencils to a given clerk) reproof comes back to the foreman and to the individual before the requisition is twenty-four hours old. It is no more legitimate to overissue material, even a lead pencil, without inquiry, than it is for a bank to pay an overdraft check without proper consideration and authority. The material requisition cards, containing as they do, very full data, should be sorted and resorted in many ways, being used as checks on individuals or on foremen, against departments, against operation, or against accounts. The use made of the requisition cards is a special department of management. The extreme of simplicity is to charge the requisitions against certain accounts, then to sort and file them away and use them only for special investigations. If for instance the question is asked why there are so many incandescent lamps purchased, it is immediately possible to collect the requisitions for all the incandescent lamps issued to each department, even to each socket, and to trace the exact point of leak or waste, due rarely to the inevitable, generally to carelessness and sometimes to dishonesty. The extreme of completeness is to transfer by means of perforation all the requisition facts as fast as they are filled to a Hollerith card, to run the sorting and tabulating machine at night, and to present a complete tabulated array of cost and efficiency facts before operations begin the following day.

Service Card							
Workman's Name				Plant and Department			
Mans No.		Machine No.			Dept. %		
Mans Rate		Machine Rate			Hourly Cost		
Date	Schedule	Account	Charge	Standard Time	Actual Time	Efficiency	
	•						
Time Started		OPERATION					
Time Finished							
Elapsed Time							
Foreman							
------------------------------							The Engineering Magazine

FORM 2. SERVICE REQUISITION. THE ORIGINAL IS 5 INCHES WIDE.

WORK OR SERVICE REQUISITION CARDS.

These are issued and used in the same manner as the material cards. No work is undertaken, whether by individual or gang, except on order. The order contains all the data and when returned records the exact time taken for the operation. The cards therefore cover the whole of every workers' or gangs' time in minute detail and as to the kind and volume of work done in equivalency for the time and wages. The minutes and hours are accurately accounted for in proper sequence. All the time of every man or gang, subdivided to operations, being available, it is easy to use the records in many ways. In practice the original order card or service requisition can be made out in three or more carbon copies. The original order starts from the dispatching board, which is prepared with spaces 4 inches by 10 inches for each man, machine, or gang of men. The space is large enough to hold three cards one above the other. The uppermost space shows the job on which work at the moment is being done, the space below contains the cards of the work to be next taken up, and the last space contains the amount of work impending but not yet ready. The dispatcher, in charge of the board, who may work in conjunction with the foreman, sees to it that the first two spaces are always provided with order cards. If the two lower spaces are both bare the worker should be laid off, or if he is retained in idleness his time should be charged to a waste account.

The efficiency engineer or his subordinates will note on every card, preferably before it goes to the worker, the standard time for the operation determined as accurately as current circumstances will permit, so that both the actual time and the standard time become part of the record. A guess as to standard time is a great advance over no recorded statement, but a guess is unpardonable, except for an emergency and until reliable methods are provided. Whether first record card or carbon duplicates are used, whether the original record cards are transferred to Hollerith cards, is immaterial. It is of importance that every kind of information and efficiency as to every man and every part of his work become available, and more than this is not needed to show where leaks occur. A few uses of the cards in this regard will be enumerated.

COST ACCOUNTING.

The card contains the standard time, the cost for standard time of men, equipment, and department per hour, also the operation and the account to which the time is charged. It also contains the actual time and it is therefore in itself an efficiency record. The cost accountant can either charge up the standard cost adding the current departmental percentage of inefficiency, or he can charge up the standard cost and the actual accidental waste. If the records given him are carbon duplicates he can file them away as vouchers.

STANDARD COST OF SCHEDULES.

A schedule is the numbered description of an operation. If an operation is often repeated a schedule is formally and most carefully made out, but if the operation is a new one or one not likely to be repeated the same amount of care is not taken to fix the standard time, although any inaccurate estimates as to this time are easily traced to the man who made them. Every time a schedule is put in operation a carbon duplicate of the service card is filed under the head of the schedule, and a study of the repeated operations of the same schedule shows whether it averages more or less than standard time and cost, whether the different men take more or less time, whether the same man takes more or less time on different days. These variations are a mine of information for departmental improvement.

EFFICIENCY OF MEN.

When the service card is returned and the actual time noted on it or on a carbon copy it is filed against the worker and makes any other record of his going or coming unnecessary. In a working month of 250 hours the cards will show whether a worker was present all or only part of the time—thus determining the efficiency of presence or availability; the summation of the standard hours of work delivered and the actual hours taken during a pay period shows the efficiency of each man, while cash job record shows the efficiency as to every separate job. If a worker in 250 hours delivers 250 hours of standard work his efficiency is 100 per cent; if he delivers only 200 standard hours his efficiency is 80 per cent, and if he delivers 300 standard hours his efficiency is 120 per cent. When records of this kind are maintained the efficient men as to steadiness and output loom up like mountains from a plain and the inefficient appear like sink-holes. If the efficient men are appreciated and rewarded at their true value, if the inefficient are allowed automatically to eliminate themselves, an *esprit de corps* is developed that will make the working shop force as active and powerful an aggregation as a football or baseball team. Excellence is not gauged by any hustle and drive standards. In railroad operation the trains that pass between distant terminals in the shortest time are not those that run the fastest between local stations, but they nevertheless cost less to operate, they give less trouble to the dispatcher, they are not as destructive to motive power, equipment, and roadbed, they use less coal and water, and they earn generally per mile run the highest revenue. Similarly that shop works at highest efficiency which steadily employs steady and reliable men.

EQUIPMENT OPERATION.

The unit cards, whether the original or carbon duplicate be used, give a complete record of the operation of the equipment, showing the machine, its number, rate, the man using it, the work done on it, and the time taken. It is possible from the records to compare the time and cost of different machines on the same work, the total time that any machine is working. The equipment specialist scans the records and he will not be satisfied if a worker operates one machine for six hours at 100 per cent efficiency and then for four hours another machine at 100 per cent efficiency. This is no better than if a furnace runs continuously under a boiler while the fireman sits idle half the time. The equipment specialist is concerned that one machine owing to idleness operates at 60 per cent and the other, for the same cause, at only 40 per cent. It is often possible to combine the work of two machines on one and dispense with the other. It is even more likely unnecessary purchases of equipment will be avoided.

It is impossible briefly to describe all the methods to secure a reasonable standard time for a unit operation, whether of man, or machine, of gang, or as to an aggregate group of operations extending over the whole plant, as the completion of an order for fifty locomotives or the running of twenty trains a day during a month over a road. Whether the unit or the aggregate is under consideration the methods of the analytical chemist prevail, each detail is considered separately, both as to itself and in its relation to preceding and subsequent details. Studies of this kind reveal remarkable inefficiency in usual operations. When all the conditions were made exactly right, bricks have been laid in a rough wall at the rate of twenty a minute, and ¾-inch rivets have been driven with a pneumatic gun in structural iron work also at the rate of twenty a minute. Owing to the perfect adaptation of conditions the operator found his work no more exhausting than the usual pace. This rate cannot be maintained for a long period because attending conditions cannot be kept up to the ability of the man, but a very high average rate can be maintained day in and day out and the worker thrive under it both physically and financially.

Constant reference has been made to the extra reward paid to men, for high efficiency. There are many methods of rewarding efficiency, and several of them are outlined in THE ENGINEERING MAGAZINE for November (Carl Bender). The standard-time determination usually shows that fully 50 per cent more work can be turned out per machine and per man if all the methods, machines and men are toned up. A satisfactory way of toning up the men and securing their co-operation is to offer them an increasing bonus on their wages for increasing efficiency. Assuming the current output of the shop to be on a basis of 67 per cent, a bonus is paid for any improvement above 67 per cent. At 100 per cent efficiency 20 per cent bonus is paid, and above 100 per cent efficiency the worker is given at his standard rate *all the time he saves* in addition to 20 per cent bonus for the time he works. The bonus table is as follows:

Efficiency, per cent.	Bonus per $1.00 wages.	Efficiency, per cent.	Bonus per $1.00 wages.	Efficiency, per cent.	Bonus per $1.00 wages.	Efficiency, per cent.	Bonus per $1.00 wages.
67	.0001	78	.0238	88	.0832	99	.1881
68	.0004	79	.0280	89	.0911	100	.20
69	.0011	80	.0327	90	.0991	101	.21
70	.0022	81	.0378	91	.1074	102	.22
71	.0037	82	.0433	92	.1162	103	.23
72	.0055	83	.0492	93	.1256	105	.25
73	.0076	84	.0553	94	.1352	110	.30
74	.0102	85	.0617	95	.1453	120	.40
75	.0131	86	.0684	06	.1557	130	.50
76	.0164	87	.0756	97	.1662	135	.55
77	.0199	87.5	.0794	98	.1770	140	.60

If a man's wages are $0.30 per hour, if in the month he has been present 240 hours and has delivered 210 hours, his efficiency is 87.5 per cent, his wages $72.00, his bonus is 7.94 per cent, its amount $5.72.

The foreman's efficiency consists in the efficiency of the men under him. If all of his men have delivered in a month 7,211.6 hours of standard work but have been paid for 7,523.5 actual hours, then the efficiency of the foreman is 95.8 per cent and his bonus 15.36 per cent on his wages. If work is defective and has to be done over, owing to fault of worker, standard time is credited but once and the efficiency of the man as well as of the foreman diminishes.

It is preferable that standard times should be made public before work is begun, that changes in standard time, whether up or down, should be made on some definitely understood and fair plan, and that the amount of reward for efficiency should also be public knowledge. There are workers so shortsighted as to think that they can prevent a determination of standard times, that they can prevent a determination of individual efficiency and prevent the reward or promotion of efficient men. If the management is fair, skilled, and wise it is not possible to make effective opposition to propositions which can be put into force just as powerfully without publicity as with it, but secrecy harms the worker more than it does the employer. In considering the gains due to efficiency it is not sufficiently taken into account by either employer or employee that net profits are the difference between gross earnings and expenses, that gross earnings could be greatly increased by a growth of the volume of business, and that a shortening of time permits increased output without increase of expenses, therefore reduces the unit expense. If the worker earns $75.00 per month and spends $70.00 his net profits are $5.00 per month; a discouragingly small sum—but if he earns $15.00 in bonus his net profits become $20.00, an increase of 400 per cent. When unit costs (including material) are reduced to the manufacturer even as little as 10 per cent and, owing to standard time and efficiency, a 30 per cent larger output is secured, if net profits were 10 per cent, they become 24.7 per cent, an increase in net of 247 per cent.

The bringing up of an individual worker from 60 per cent to 100 per cent efficiency is to his advantage; the bringing up of a shop from 60 per cent to 100 per cent is to the advantage of its owners; but the bringing up of all shops and all operations in a country from 60 per cent to 100 per cent is to the advantage of all the people. The potential interest of the community in increased efficiency will be considered in the next article.

ERRORS AND DIFFICULTIES IN MANUFACTURING COSTS.

By W. M. S. Miller.

Mr. Miller's study is not directed to any individual cost system, but to the clear understanding of the great elements which go to make up the cost of manufacture, and particularly to the proper treatment of that most perplexing and often deceptive factor—general expense or burden.—The Editors.

THE extremely active competition existing in many branches of the machinery-manufacturing business has created new conditions that are becoming very difficult to meet successfully, being in many cases the result of unsound business methods practiced by short-sighted sales managers in their efforts to take business away from competitors. The publicity and prestige accruing to a smaller concern by reason of its having secured an "important" order against the competition of larger and better established firms, often lead them to go into a negotiation with predetermined intention of sacrificing all profit if necessary in order to secure the business. While larger and more conservative concerns may not attempt to meet such competition, the effect of these low prices remains indefinitely; and at a later time when either concern tries to get similar business at profitable prices, it may be found impossible to do so. Unfortunately it often occurs that the smaller concern, having had little previous experience in building similar machines, or having no accurate knowledge of the costs of machines previously built, find that they had underestimated the cost and actually lost money on the order. This sort of competition is largely responsible for the unreasonably low prices prevailing in many lines, having produced a condition that is equally unfair both to manufacturer and purchaser—unfair to the manufacturer because it prevents his making a reasonable profit, and unfair to the purchaser because it produces a tendency on the part of the manufacturer to cheapen construction beyond the limits of good engineering.

Manufacturers, therefore, of a necessity are paying more attention than formerly to the matter of maintaining cost-keeping systems that will give accurate and intelligible manufacturing costs, and all works where any pretense is made at conducting the business intelligently now have some sort of a system for obtaining costs on individual orders. In a small shop it may consist in the use of a "time card" or "job ticket" which is made out when the order is entered in the shop and on which all the men who work on that order mark their time. A record of the material used on the order is either kept posted on the job ticket, or the foreman figures up the amount of material used after the job has been completed. Larger factories will have more elaborate systems for keeping costs, the basic features of which are the daily time slip of the workman and a "bill of material" or "material specification" on which the material is charged as it is used. These systems may vary in detail according to the size of the factory, the character of the product manufactured, and the individual ideas of the persons who had to do with the installing of the system.

Without describing in detail any of these shop cost-keeping systems, it may be said that their respective merits vary largely according to the conditions to be met in different works, and the value of the results obtained from any one of them depends more upon the diligence of the foreman in seeing that the workmen charge their time properly, and the accuracy and intelligence of the clerks who compile the costs from these records, than upon the particular system used. There are, however, a number of sources of error which are not chargeable to either of these causes, but are due rather to the methods of treating certain items of expense that are incidental but important factors in manufacturing cost.

The elements that enter into manufacturing costs are of three classes:

Material and Labor,

Indirect Labor and Miscellaneous Factory Expense,

Administration, Sales, Publicity, etc.

The "factory cost" of any machine covers the actual cost of the material and labor required in producing it, plus its share of the indirect labor and miscellaneous indirect expenses in the factory. The amount added to the material and labor cost of an order to cover this indirect or "overhead" expense may be called the "factory burden."

The "commercial cost" of a machine is the factory cost plus its share of the administrative expense. The amount added to cover administrative expense may be called "general burden."

With a shop cost-keeping system that is operated with reasonable accuracy, direct material and labor costs on any individual order should be a more or less positive quantity. The final figures representing factory cost or commercial cost, however, are susceptible to considerable variation according to the method of determining the burdens, and the manner of treating the various items that enter into them. It is to these things that I wish to call attention.

The highest economy in manufacturing is obtained where it is possible to confine the business to the production of standard machinery. The expense of making new designs, the cost of which is difficult to predetermine, and which consequently cannot always be covered in the price obtained, can thus be kept down to a minimum, and machines built in quantities from standard designs, making possible the use of jigs and other devices for economy in shop operation. Most manufacturers, therefore, endeavor to confine their business so far as possible to the manufacture and sale of standard machinery, yet even under the most favorable conditions it is necessary to make new designs from time to time, and to build a certain amount of what may be considered special machinery. We may, therefore, consider that in every machinery-manufacturing works, there will always be these two distinct classes of machinery going through the shop: standard machinery and special machinery.

On an order for special machinery the cost of the designs, patterns, etc., will form a legitimate part of the cost of the order, and if the order is to be a profitable one will be fully covered in the price obtained. If, however, the order is taken with the intention of eventually developing the design into a standard from which other machines are to be made and sold in the future, then such designs may be considered an asset and their cost charged to capital account, or it may be treated as an expense to be gradually absorbed in the same manner as other overhead expense. The cost of all development, however, including drawing, patterns, etc. for new designs should be taken care of in such a manner that on orders for new machines it can be included as part of the cost of the order, or not, as may be determined after the order has been completed, depending upon whether or not the design will be considered as a future standard. Should the question of the disposition of the charge not come up at all, it should in some manner be taken care of automatically. This may be done by charging the cost of all development and incidental drawings, patterns, etc., to separate "expense" orders; and in reporting the costs on individual sales orders, all expenses incurred covering items of this nature should be appended to the cost of the order.

Separate expense orders should be provided in the works to cover the following: Designing Engineer's Time, Draftsman's Time, Patterns, Tools, Dies, Jigs, etc.

All work for drawing, patterns, or tools should be charged to one of these accounts, whether it be for new designs, for incidental patterns, or for tools for standard machines.

There will be a monthly reserve set aside for "Development" of each class of standard machine, forming a "Development Reserve Account" which will be charged to factory expense. All the above expense orders will be charged to this account, and the monthly balance of the same or the difference between the amount of the reserve and the amount charged during the month will be charged or credited to factory expense. When it is decided to charge all development cost against the profit on the sales order, the development account will receive a corresponding credit. Or if the development is charged to capital account the development account will be similarly credited. Thus all development expense not taken care of in the cost of the order or not charged to capital account will be automatically taken care of in general expense and absorbed in the factory burden.

Returning to the question of costs on individual orders, it will be apparent that by segregating these items of expense and appending them to the cost of the order proper, the normal cost of the order will never be destroyed by the event of unusual development expense, while at the same time the additional item appended to the cost will show what the development expense has come to.

The common practice of determining factory burden on the basis of the ratio of the indirect factory expense to the direct-labor pay roll, while not a theoretically correct one, is in most cases accurate enough for all practical purposes, and in the ordinary shops where the machinery built is all of the same class has proved itself to be very generally satisfactory. It is quite common, however, for a manufacturing concern to build two or more different classes of machinery, or machinery requiring radically different factory equipment, in the same shop, as for instance, electric generators and lighting transformers. The building of generators requires a fully equipped machine shop, with an erecting shop with cranes, etc., while lighting transformers can be built with comparatively little equipment. If, in rendering costs on machinery made under such conditions, the same burden be used for both generator and transformer, the resulting costs would be lower than true costs on the generators, and higher than true costs on the transformers, for the reason that the latter would be made to carry a part of the burden belonging to the generator. To obtain satisfactory costs in such a plant, rather than attempt to install an elaborate system on the "machine-hour" or "man-hour" basis, it is more practicable and equally satisfactory to segregate the two classes of product in the works so that the factory expense applicable to each can be determined separately and a different burden applied to each. The separation of different classes of product in the shops is very desirable for other reasons also, and should be followed just as far as it is possible to do so.

The plan of applying factory burden as a percentage to be added to direct-labor cost, is based upon the assumption that the amount of indirect labor and other overhead expense applicable to any job is proportional to the amount of direct labor expended upon that job, and as this is never strictly true, the costs made up in this way are fairly accurate only so long as the relation between the material cost and the labor cost is about the same in all of the products made in that shop. Where an order is put through the shop on which the relation between the material and labor is very different from that of the regular product, the cost on such an order will be higher or lower than a true cost according to whether the labor item is proportionately higher or lower than that of the standard product. For instance, if in a shop where the general run of the product has material and labor cost in about equal proportion, an order is entered for a machine on which the material is a very large item, the cost that will be obtained will be lower than the true cost for the reason that the cost of handling and the use of the additional floor space for the excess material will not be covered in the factory burden. For this reason it is very desirable in a large works to separate from one another the products in which the ratio between material and labor is very different, so that the burden for each class of product may be compiled and applied separately to the costs of each.

It may in some shops be quite difficult, and in others it may seem entirely impracticable, to segregate the products to the extent that we have suggested; but in a large works where there is a great difference in the character of the products made, they should be separated even where it may seem very difficult to do so, and it will be found that the ultimate results will fully justify the trouble and expense.

The statements which have been made with reference to "burden" apply only to "factory burden," which has been considered as covering all indirect expense in the works including salaries of works superintendents, foremen, time-keeper, clerks, cost of light, heat, power, maintenance of buildings, tools, etc., but does not include administration, selling, or advertising expense. The latter items, which are usually termed "general expense," are taken care of in "general burden," and usually applied to the cost of each order as a certain percentage of the total factory costs. In some works the general burden is determined by the ratio of the administration expense to the direct-labor pay roll, or in other words, in the same manner as the factory burden. This, however, is not logical, as there is no reason for assuming that administration expense bears direct relation to the factory pay roll.

In carrying out the plan of having separate burdens for different classes of products it should also be applied so far as possible in the application of the general burden. This, however, might in some cases be quite difficult, but it is essential where the different products handled are subject to very different methods of sale. For instance, some smaller products might be sold through jobbing concerns while the larger machines will be sold by direct representation, in which case the selling expense of each class of machinery should be kept separately, so that each class of product may have its own "general burden."

The spoiling of a certain amount of work is a condition that will always obtain in any factory, even where the most skilled labor is employed and the best material used; regardless of all the precautions that may have been taken to prevent it. When this does occur the cost of the order upon which the work is being done will be excessive, sometimes to the extent of wiping out all of the profit on what might otherwise have been a very profitable order. At other times the amount of the additional cost resulting from the spoiled work may not be enough to cause a loss or even to indicate any abnormal condition, but such a cost if used as a basis for the price in a future negotiation might cause the loss of an order that would have been profitable under normal factory conditions. It is, therefore, very desirable that the additional cost resulting from such spoiled work be either eliminated entirely from the cost of the order on which it occurred, or that in reporting the cost, such extra cost be segregated from the cost proper, so as to show the normal cost of making the machine covered by the order and the extra cost due to the spoiled work.

When the item of cost covering spoiled work has thus been eliminated from the order on which it occurred, it is evident that the manufacturer has been put to an expense for which he gets no returns, nor would it show against profit and loss account unless some further provision is made for taking care of it. This is best provided for by establishing separate shop expense accounts to which all such items will be charged. At the end of each month the total amount charged to this account will indicate the expense that has resulted from spoiled work during that period, and a review of this account from time to time by the superintendent will be valuable to him in his efforts to keep such expense within minimum limits. As such cost is clearly an expense that is always present to a greater or less degree, it is proper that this account be charged to "factory expense" and absorbed in factory burden. This means that each order will be made to bear its share of this expense, and in reviewing the cost of an individual order on which an abnormal amount of spoiled work has occurred, the item covering such spoiled work can be ignored with the knowledge that such contingencies are fully taken care of in the factory burden.

It is desirable that there be separate shop expense orders for each of the following:

Defective Workmanship,
Defective Material,
Defective Design.

The workman in making out his time slips will be properly instructed by his foreman that all extra abnormal labor will be charged to one of these orders, but no charge will be made to an expense order without authority being obtained from the foreman or his assistant. In entering the charge on the time slip, the expense order number will be followed by the job order number so as to indicate the job on which the spoiled work occurred. The charge on the time slips may read, 30-6743 3 hours. In which case the number 30 may represent "defective material" and 6743 the job number on which the defective material was encountered.

The suggestions given in this paper apply particularly to larger manufacturing plants, as it is in them that conditions obtain that make accurate cost keeping most difficult. The points referred to are, however, important to the smaller manufacturer as well; and by giving them consideration before it comes time to make extensions, the arrangement of the works can be planned with a view both to economy in manufacture and to the facilitating of accurate cost keeping.

The subject of cost keeping is always more or less complicated, and for this reason is one upon which there is a good deal of theorizing about ideal systems and new ways of doing things, probably because there are so few persons in a manufacturing organization who come in close enough contact with the details of cost keeping to have a practical knowledge of the subject. The cost-keeping system is usually under the jurisdiction of the accounting department, who are apt to make too much of a book-keeping proposition out of it, and to consider that if an accurate account is rendered of the total cost of an order, including all incidental expenses lumped in together, their duty is done; while what the commercial end of the concern requires is the normal cost of each machine built. But they also want the contingencies taken care of in the cost in such a way that each order may bear its share of all these extra expenses. These unusual expenses should also be classified, and monthly reports rendered to those whose business it is to watch them and to keep such cost down to a minimum. When the costs obtained are not entirely satisfactory for their purposes, the commercial head of a concern is too apt to become convinced that the system is all wrong, and if attention is called to some magazine article describing a system that has worked successfully in some other plant, he may immediately want to install it in the works, perhaps without having any definite knowledge as to whether that system is any better than the one already in operation.

I know of a large manufacturing concern which installed two different new systems within a space of two years and at an enormous expense, with a result that for a long time they had costs coming through on three different systems, and it was more than three years before they could get costs that were any way satisfactory. And, unfortunately, after the last system was finally working all right, the costs were not as satisfactory for commercial purposes as the ones they obtained by their original system.

The cost-keeping system of an organization is so vital that it is dangerous to attempt to make any radical changes without due consideration of all the conditions. When it is found that the results obtained are not satisfactory, a careful study should be made of the existing system to ascertain where it is faulty; then such changes should be made from time to time as may seem desirable, thus evolving a system best adapted to the particular line of business, and at the same time avoiding radical changes which might render costs inaccurate during the transition period.

REPRESENTATIVE DATA FROM ELECTRIC POWER-PLANT OPERATION.

AN ANALYSIS OF RECENT FIGURES FROM TYPICAL STEAM STATIONS.

By Howard S. Knowlton.

THE reduction of power costs is a problem of permanent importance to the industrial world. As long as anything like the present margin exists between the potential energy of fuel and the realized energy at the station bus bar, there will be no lack of incentive to analyze the expenses of generation and to seek to find the equipment and combinations of apparatus best adapted to economical power production. Important as is the reduction of generating costs in general industry, it is vitally essential to the broadest commercial success of the modern central station. Figures of cost drawn from central stations where intelligent efforts are constantly being made to reduce the expense of operation are intrinsically suggestive to the power owner and operator in other branches of industry. Not only do they suggest comparisons between similar items common to his own experience; they point out the economy of generating power on a large scale, and in a measure set a limit toward which plants similarly equipped may work.

In the following paragraphs the latest available power costs are presented for seven of the larger central stations of Massachusetts depending entirely upon steam power for the operation of their plants. None of these plants is fortunate enough to be able to generate part of its output by hydro-electric methods. Practically the entire output is produced by coal costing from $3.99 to $4.79 per ton. The equipment of each plant is of modern type, thoroughly representative of good practice in the design of steam generating stations using either reciprocating engines or turbines, and operating condensing. The figures presented are for the year ending June 30, 1908. The companies considered are the Edison Electric Illuminating Company, of Boston, the Worcester Electric Light Company, the Lowell Electric Light Corporation, the Fall River Electric Light Company, the Malden Electric Company, the Cambridge Electric Light Company, and the Lynn Gas and Electric Company.

Table 1 gives the total kilowatt hours manufactured by each company for the year, the capacity of the generating plant in engine horse power, load and fuel particulars.

TABLE I.

	K. W. H. Manfd.	Coal Used, Tons.	Cost per Ton.	K. W. Max. Load.	H. P. of Engines.
Boston	88,535,490	102,717	$3.99	35,511	73,500
Worcester	5,400,192	7,868	4.79	22,212*	5,900
Lowell	9,426,511	14,101	4.75	3,498	7,390
Fall River.....	4,061,284	7,630	4.68	1,561	4,433
Malden	4,647,453	5,555 coal	4.49	1,575	4,875
		1,000 coke and breeze	3.72		
Cambridge	6,043,204	9,377	4.40	22,772*	6,750
Lynn	8,776,166	13,917 coal	3.60	3,700	8,200
		3,364 bbls. tar	1.50		

The total cost of manufacture is made up of the following items in the figures presented:

Fuel cost, Rentals of Real Estate at Plant, Station Tools, Oil and Waste, Water, Wages at Station, Station Repairs, Steam-Plant Repairs, and Electric-Plant Repairs. In the accounts of the several companies a careful record is kept of these items throughout the year, which are totalized in the returns filed according to law with the Massachusetts Board of Gas and Electric Light Commissioners. The coal used in these stations is in general of a good quality of bituminous, Georges Creek and Pocahontas being favored, while some companies use New River coal. Details of the exact kind of coal burned are not at hand, but it does not differ very greatly in the different cities in price and desirability. In all the plants there is now a good margin between the maximum load and the rated capacity of the machinery. Table 2 shows the toal cost of manufacture, with the component items segregated to enable their proportion to be seen. The importance of the different factors entering the cost of power production can readily be appreciated, together with the factors which deserve the most immediate study in any steam plant in relation to their total yearly influence upon the profits of the enterprise. In each case the fuel cost is the principal element of expense, station wages taking second place.

In the table opposite rentals of real estate were not included, as only three companies had such an expense. For the same reason the cost of station tools and appliances were not included, four companies having such listed expenses. Under the former heading, Boston expended $19,465.87; Worcester, $175.00, and Lowell, $120.00. Under the latter item Lowell expended $1,972.39; Fall River,

* Maximum kw. hour output in any one day.

TABLE 2.

	Fuel Cost.	Oil and Waste.	Water.	Station Wages.	Plant Repairs. Station.	Plant Repairs. Steam.	Plant Repairs. Electric.	Total Cost.
Boston	$409,841.07	$7,348.13	$21,667.03	$170,393.66	$13,521.01	$37,269.72	$49,774.01	$729,280.50
Worcester	37,970.06	1,477.31	1,843.79	19,429.59	650.80	2,945.15	2,949.49	67,441.19
Lowell	67,032.97	846.04	730.04	24,742.81	1,881.90	1,859.69	885.54	100,071.37
Fall River	35,707.29	1,302.16	465.12	21,884.77	466.14	1,491.73	1,168.46	65,075.29
Malden	29,479.72	780.55	1,492.24	15,817.19	1,640.23	3,325.22	653.24	54,652.53
Cambridge	41,546.43	1,118.05	3,281.28	20,920.49	1,241.30	3,557.91	2,761.12	74,426.58
Lynn	54,158.32	1,030.83	3,551.79	25,937.79	4,547.00	12,932.54	3,993.03	106,374.03

$2,589.62; Malden, $1,464.14, and Cambridge, $222.73. In the case of Malden, the figure for apparatus and machinery included horse, wagon and automobile maintenance, in addition to tool expenses.

Examining the above tables, it will be seen that the size of the output does not invariably mean a proportionate cost of production, although in a general way the company having the larger output approaches a higher total cost. In all the stations covered by the figures the fuel cost for the whole year represents a sum well worth reducing in every reasonable way. A saving of a fraction of each ton in the coal used amounts to a notable figure in the case of a company like the Boston Edison, whose total fuel bill is rapidly approaching the half-million-dollar mark for twelve months. On a daily basis the coal cost in Boston is about $1,120, and in the plant having the lowest total fuel consumption, Malden, the cost of coal is nearly $81 per day. It is of course possible for a company like the Edison of Boston to purchase coal in enormously greater quantities than the smaller organizations with more limited resources and storage facilities.

The Boston Edison Company's principal station is one of the larger combined engine and turbine plants of the Atlantic seaboard, located on tide water, with admirable coal-handling facilities and condensing arrangements. Economical production is thus possible on a very large scale, and hand labor plays but a small part in the operation of this company's generating equipment. The coal fields of the principal plant at L street, South Boston, have a total storage capacity of about 70,000 tons.

The Worcester company's generating plant is gradually passing through an evolution from belted to direct-connected apparatus, and the adoption of direct-connected engines and a turbine equipment by this company presages still better fuel economy in the future. For the year ending June 30, 1908, the equipment of the Worcester station was in general thoroughly modern, only a moderate portion of the output being handled by belted machinery. During the early part of this fiscal year both the Fall River and the Lowell plants were revised in design, each of these companies now having a turbine station of excellent character. The Cambridge plant is a well-equipped reciprocating-engine station located on the banks of the Charles River, about three miles from its mouth, and the Malden plant is another example of a well-managed reciprocating-engine plant, not located on tide water, but operating a cooling tower in connection with its condensing equipment. The Lynn plant installed two 1,500 kilowatt Curtis turbines about a year ago, in addition to its existing reciprocating-engine capacity, direct-connected apparatus being the order here. The Malden and Lowell plants are each operated by syndicates managing similar properties elsewhere, and presumably have the benefits of data secured under widely different conditions, as well as purchases on a considerable scale.

Oil and waste play but a small part in the cost of operation in all but the Boston station. Here the total quantity used is so considerable that the annual cost runs to over $7,000 per year, not a large sum per kilowatt hour generated, but worthy of constant scrutiny. The cost of water is by no means a negligible quantity in the smaller plants, although it cuts little figure in Lowell and Fall River. In Boston it is about $60 per day, while at the extreme end of the line, in Fall River, it is less than $1.30 per day. Local conditions, of course, affect the terms under which water can be secured, but these figures show that the water question is by no means unimportant, after all, and deserves more constant study in some cities than it has received. It would seem that in some instances a reduction in the water rates might properly follow such improvements in the municipal service as the voluntary adoption by lighting companies of more efficient lamps, like the tungsten or tantalum units, giving the public service of superior quality at less cost, as in street lighting. A station which is obliged to pay for every gallon of water used in its boilers at a high price is entitled to some reduction, in my opinion, if it installs for the city tungsten lamps of greater candle power for the same net rate per year, even taking into consideration the gain in efficiency.

The totals of station wages show the importance of studying further the capacity of employees to handle boilers, engines, turbines and auxiliary machinery, as well as the labor requirements in the electrical side of the plant. Few data of complete character exist on this point. So far as the returns of these companies to the Gas and Electric Light Commission show, the following are the approximate number of employees required in power-station operation:

BOSTON.	Employees.
Generating steam division	136
Generating electrical division	98
Total	234

WORCESTER.	
Firemen	5
Engineers	4
Other station attendants	16
Total	25

LOWELL.	
Engineers	5
Oilers and cleaners	4
Station electricians	6
Boiler plant	10
Total	25

FALL RIVER.
Employees not classified in returns.

MALDEN.	
Engineers	4
Oilers	3
Steam fitters	2
Firemen	3
Switchboard men	2
Total	14

CAMBRIDGE.	
Engineers	4
Oilers	3
Firemen	6
Engine wipers	1
Coal passers	2
Switchboard men	4
Total	20

LYNN.	
Engineers	6
Firemen	6
Oilers and cleaners	4
Coal passers	2
Switchboard men	22
Total	40

Station repairs are clearly an item affording little chance for comparison, depending upon many other considerations than the work of the machinery in any given period. It is of interest to note that in most cases electric-plant repairs were less than steam-equipment repairs. The reliability of electrical machinery is pretty well established by this time, and the problem of maintenance, in the best modern apparatus, has been brought within very reasonable figures.

Table 3 represents the approximate cost of power on the unit basis, the cost of the different items indicated in Table 2 being calculated per kilowatt hour manufactured. Some of the smaller quantities in this table are only approximate, on account of their low proportion to the total cost of production at the station. Under "miscellaneous" are included rentals, tools and tool maintenance.

TABLE 3. COST IN CENTS PER KILOWATT HOUR MANUFACTURED.

	Boston.	Worcester.	Lowell.	Fall River.	Malden.	Cambridge.	Lynn.
Fuel	.462	.703	.710	.880	.635	.690	.618
Oil and waste....	.008	.027	.009	.032	.017	.019	.012
Water	.024	.034	.008	.012	.032	.055	.040
Wages	.192	.360	.262	.538	.342	.347	.296
Station repairs ..	.015	.012	.020	.012	.035	021	.052
Steam repairs ...	.042	.055	.020	.037	.072	.059	.147
Electrical repairs.	.056	.055	.009	.029	.014	.046	.045
Miscellaneous ...	.023	.000	.022	.080	.033	.000	.000
Total.........	.822	1.246	1.060	1.620	1.180	1.237	1.210

In examining the above table it is obviously not feasible to separate the power generated in the stations of any of the companies before they were remodelled during the year, from the power generated by the later apparatus. This condition is so widely present in power-plant analyses, however, that it need not be regarded as vitiating the general lesson of the table, which is the wide difference in the unit cost of the various factors entering the expense of power generation in the same general locality. These considerations encourage the further study of itemized costs on the unit basis in all plants where the desire to reduce expenses to the lowest point consistent with reliable service is a controlling factor. Time and money expended by individual companies in the interpretation of their cost records are worth a great deal in the long run. If the reasons for discrepancies are known, the possibility of applying a remedy can be intelligently considered. Local conditions will often modify the costs more than appears at first indications.

EDITORIAL COMMENT

The Aeroplane in War.

BRITISH watchfulness, ever alert against anything destructive to the protection afforded by England's fleet-encircled insularity, has risen in warning against the flying-machine.

Prof. Newcomb's apparently well-grounded demonstration of the very small efficacy of the aeroplane as a war engine (published in the *Nineteenth Century* for September and reviewed at length in our November issue) has brought to minds of this type not re-assurance, but increased agitation, and Major B. Baden-Powell replies to Prof. Newcomb in the November *Nineteenth Century*.

The introductory argument of the advantages and asserted disadvantages of the aeroplane offered in rebuttal of Prof. Newcomb's case may be passed with little comment. It is fair to assume that when Major Powell speaks of the aeroplane as traveling "infinitely faster for the same propulsive power," he intends to use the language of enthusiasm rather than that of engineering; his assertion that the aeroplane is "practically invulnerable to bullets" must perhaps be left to future demonstration, though we would be disposed to back the machine gun very heavily as the winner on that issue; but when he offsets the objection that the aeroplane "can not stop to have its machinery repaired or adjusted" by the plea that "the engines could be stopped for a few seconds while the machine soars downwards," he is taking the discussion out of the bounds of practical engineering. The prospect of effecting mechanical repairs to the power or transmission of an aeroplane during "a few seconds" of downward soaring is not attractive from a mechanical point of view.

It is on the military side, however, that Major Powell's enthusiasm for the aeroplane leads him to the most curious proposition of all. Turning to the question of the invasion of England he asks "what valid reason is there why, within a few years' time, a foreign nation should not be able to dispatch a fleet of a thousand aerial machines, each carrying two or three armed men, and able to come across to our shores and land not necessarily on the coast, but at any desired inland place?"

Let us suppose that there is no valid reason why the 2,000 or 3,000 armed men should not be landed at any place, coast or inland, and let us ask Major Powell in return what would they do—3,000 men in the middle of England with only such ammunition as they could carry, without field guns, without cavalry, without commissariat, wagon trains, or base of supplies—with nothing but their rifles and a few cartridges?

Wage Systems.

MR. BENDER'S commentary on the Gantt bonus system in our December issue, while undoubtedly a fair statement of his own observations, to the best of our judgment does not express an average impression of the results secured, probably because it was not based upon typical examples. Nothing is more certain than that the personal equation leads to varying results in the installation, administration, and interpretation of any system, and the best interests of engineering progress demand the greatest freedom in the expression of individual experience and opinion. Mr. Bender's comparisons are valuable in proportion to his opportunities for observation and his accuracy in deduction, and it was not the disposition of this Magazine, in publishing them, either to curb his liberty of opinion or to assume coincidence with it.

To avert any chance of mistake, however, it is fair to record our dissent from the view that the appearance of "psychological disadvantages" is characteristic of the use of the bonus system. A salient feature of this system, indeed, is its advantageous grasp of psychological principles, especially that principle laid down by Mr. McFarland in the leading article of that same (December) issue—that "to show the men that it is to their interest to produce the highest efficiency, the most practical way . . . . . is to provide an adequate reward." Nor does it stop here. A more subtle psychological perception yet dictates the further step that discipline is better enforced by reduction from the bonus class to plain day wages than by dismissal. The discharged man is a martyr; the reduced man is a butt for ridicule.

Concerning the preliminary removal of causes of inefficiency, the painstaking provision of the best instructions that can be prepared by the best experts in the accomplishment of the work, and the offer of liberal reward for success, there can be little difference of opinion. The point at which the workman's co-operation as an originator of methods should be enlisted, the fixation of the standard, or of any definite minimum, to be attained, and the incidence of the bonus (whether gradual or sudden) are perhaps fairly debatable questions. There is strength, however, in Mr. Gantt's argument that the workman should not become instructor until he has learned all that skilled specialists can teach him, and that the margin of possible extra accomplishment should not be left so very wide that employers are tempted to reduce it by raising the task or cutting the bonus, when from their point of view excessive earnings are made. Certainly the Gantt system is known to have produced excellent results in many places where it has been applied.

For a Tariff Commission.

THE call for a National Tariff Commission Convention to be held in Indianapolis February 16 to 18, 1909, has been issued by a group of more than twenty important manufacturing and commercial organizations, led by such bodies as the National Association of Manufacturers, the Merchants' Association of New York, the Manufacturers' Association of New York, and the Boston Chamber of Commerce. The purpose is "to give immediate and adequate expression to the existing public demand for the creation of a permanent, non-partisan, semi-judicial tariff commission, which shall collect, collate and study industrial and commercial facts in this and other countries pertaining to the tariff question, for the information and use of Congress and the Executive."

We have long held the conviction that whatever tariff we have, its adjustment should be in the hands of a non-partisan body—expert, judicial, above reproach or approach, at least equal to the Interstate Commerce Commission in dignity and authority—and that the adjustment should be continuous, not spasmodic. Our present method of infrequent revision means periodic dislocation of the whole manufacturing and commercial body.

We let everything get wrong because the machinery for righting tariff inequalities is so cumbersome to start, and when it is to be put into operation everything else in the country stops. Under a competent commission the process of continuous readjustment would be as little disturbing to business at large as the operation of the courts. The time is peculiarly suitable for a revision that will revise justly, and the inauguration of a new mode of regulating our tariffs that will avert for the future the alternating periods of vicious stagnation and distressing upheaval we have experienced in the past.

REVIEW OF
THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

THE BAGDAD RAILWAY.

A DISCUSSION OF FINANCIAL ARRANGEMENTS, PROGRESS OF CONSTRUCTION AND PROBABLE ECONOMIC RESULTS.

Edwin Pears—The Contemporary Review.

AMONG the many striking features of the beginning of the new era in Turkey, none is of more importance than the signs of a desire for the development of the internal resources of the Empire. The recent appointment of Sir William Willcocks as adviser for irrigation work in Mesopotamia and other parts of the Empire is indicative of the intelligent and increasing activity in this direction. The men who have made the revolution recognize fully that improved transportation facilities are necessary for the proper development of the wealth of the country and the Minister of Public Works has declared that roads and railways will have his first attention. Of the latter the major project for a number of years to come is likely to be the completion of the already planned and partly executed Bagdad Railway. A long article on this project is contributed by Mr. Edwin Pears to *The Contemporary Review* for November, 1908. Mr. Pears is principally concerned with the political aspects of the railway but we abstract from his paper a few paragraphs of general interest on the methods of financing the work, the progress already made and the probable economic results.

"The proposed line starts from a village named Haidar Pasha, on the Asiatic side of the Bosphorus, and immediately opposite Constantinople. It goes to Ismidt, the ancient Nicomedia, and thence to Konia, the Iconium of St. Paul's travels. Thence it crosses the range of the Taurus Mountains to the east of the famous Cicilian Gates to Adana, whence, crossing the Amanus range, famous for the struggles between Alexander the Great and the Persians, it strikes eastward running along the southern slope of the Taurus, crosses the Euphrates near Birejik, about ninety miles from the Bay of Alexandretta, and still going east to Helif, where there will be a junction for Mardin on the north, it continues its course through Northern Mesopotamia, turning in a southeasterly direction till it reaches Mosul on the Tigris, near the site of ancient Nineveh. From thence the line will follow the Tigris on its right bank until it reaches Bagdad. There it will diverge for a few miles to the south-west, and recross the Euphrates not far north of Babylon, passing through Kerbela, the ever-sacred city of the Schiah Moslems. Then it will follow the latter river on its right bank to Bassora or to some other place on or near the Persian Gulf.

"The time has gone by to say that the railway cannot, and will not, be made. It has been commenced, and has been opened for traffic over a distance of nearly 600 miles, 125 miles beyond Konia. An agreement was concluded on June 2 last for advancing it further to Helif near Mardin. It is now reasonably certain that the railway will be completed to the Persian Gulf in a few years."

The history of the project is as follows: "In January, 1889, while Sir William White was the British Ambassador in Constantinople, an English group with a small Austrian interest, which was in possession of the railway from Haidar Pasha to Ismidt, was forcibly dispossessed by the Porte, and their railway given over to a German group. The English group had a right of preference in the case of extension beyond Ismidt, and their expulsion was a flagrant violation of their rights. The dispossessed group received the sum of 133,000 pounds as compensation from the Porte. The German concessionaires formed an Ottoman company known as the Anatolian Railway Company, and were subsequently allowed to extend the railway from Ismidt to Konia.

"During the following ten or eleven years the project for extension of the railway from Konia to Bagdad had been seriously considered by the Germans and the Turkish Government. Two other groups had been endeavoring to persuade the Porte to grant them the concession to build the Bagdad Railway, one of which was represented by a strong international syndicate. They were at a disadvantage because the Germans were already in possession of the head of the line at Haidar Pasha. In July, 1903, the negotiations with the Germans, which had been greatly stimulated by a visit of the Kaiser to the Sultan in the autumn of 1902, resulted in the granting of an Imperial Firman, which allowed the Anatolian Railway Company to extend the existing line to Bagdad. The Firman stipulated that the concessionaires should form a new Ottoman company to work the new concession. Shortly afterwards this company was formed, and took the name of the Bagdad Railway Company.

"Many of the features of the concession are remarkable, and so far as I know unique. The Turkish Government finds money to enable the company to build the railway, and guarantees an annual revenue of 15,500 francs per kilometre when it begins to work. The railway is to be built in sections of 200 kilometres (125 miles each). The first of such sections, beginning at Konia, where the Anatolian line ended, and extending to Eregli, has already been completed and opened for traffic.

"The Turkish Government provides for the building of the line in the following way: When the financial details regarding the construction of each section of 200 kilometres have been arranged between the Government and the Bagdad Railway Company, a convention embodying them is signed. Against its signature the Government hands over to the Company a number of negotiable Government bonds. These bonds represent the capital necessary to secure at 4 per cent., with a small addition for redemption, an annual interest of 11,000 francs per kilometre and for 200 kilometres. In consideration of this delivery the Company undertakes to build the railway. In the case of the first section the Government paid 54,000,000 francs, which works out as payment of a nominal sum of 170,000 francs, or £10,800 per kilometre. This is the paper value, but the amount actually realised will, of course, be somewhat less.

"The Turkish Government will, of course, have to pay interest on these bonds from the date of their emission. But in order to urge on the completion of the work it stipulated that the interest paid during the time of the construction and until the line is declared ready for traffic, shall be returned by the Company to the Government.

"The amount thus paid to the Company for building the railway is admitted on all hands to be ample. Indeed the Company's report shows that in the first section there was a large profit; but that section was through a level country, one of easy construction. The following sections will be much more costly on account of the engineering difficulties which will have to be encountered. Still, no one doubts that the Company has a reasonable chance of making a good profit on the construction.

"The section of the line having been built, the question of the profit or loss on the working has next to be dealt with. The Turkish Government provides a guarantee for the working of the railway in the following manner: The Company is allowed to keep the annual receipts of the railway up to the amount of 4,500 francs per kilometre. If the receipts do not amount to this sum, the Government undertakes to pay the difference. The receipts in excess of 4,500 francs up to 10,000 francs per kilometre are to be credited to the Government; above 10,000 francs they are to be divided, sixty per cent. to the Government and forty to the Company.

"The Government guarantees the Company an annual income of 4,500 francs per kilometre for working expenses. How the guarantee works out may be illustrated by an example. Suppose the receipts in any one year are 3,000 francs per kilometre, then the Company will retain the 3,000 francs and the deficit, namely, 1,500 francs, will be paid by the Government. Apart from this, the Government will have to pay 11,000 francs for the service of the construction loan, or a total of 12,500 francs.

"As with the first section built, so also with the second, as to which the terms and conditions were agreed to in June last. This convention covered four sections of a total length of 840 kilometres or 525 miles, the most difficult and costly part of the line. It extends from Eregli, 125 miles beyond Konia, to Helif, a town 25 miles south of Mardin. The crossing of the Taurus range presents serious engineering difficulties, and the Germans propose to make a new survey of the district and have been given until next June within which to present their plans.

"By thus dealing with the line in separate sections the Porte hopes that the whole line to Bagdad and beyond to the Persian Gulf will be completed. The owners of the concession are to have the usual advantages of taking ballast from the Government quarries, of cutting timber in the Government forests, of making harbors, quays and warehouses at Bagdad, Bassora, and other places and of utilising water power for electric traction. The concession gives a number of preferential rights to mines in the vicinity of the railway, and so many rights to construct branch lines as almost to constitute a monopoly of railway traffic through a wide tract of the Empire from the Capital to Bagdad. The most valuable concessions are those for the building of branch lines to places of considerable population and where it is believed a good paying traffic can be at once found.

"It is beyond all doubt that, in the interests of the population of Asia Minor, the railway should be built. It will develop the resources of the country and materially lessen the poverty of the inhabitants of the districts through which it passes. Hitherto the difficulty of getting goods to market has prevented the cultivation of land. I have repeatedly chronicled the fact that to carry corn down to a seaport costs more than a like article, coming from Russia by water, or even from the United States, could be bought for at such seaport. The result has been that lands have been allowed to go out of cultivation. The peasants have grown only sufficient for their own wants. Men who in any European country would be living in comparative affluence are in poverty. This is the case even in Mesopotamia, which under other conditions would be as fertile as Egypt. It is, of course, true that misgovernment, non-government, and the want of security for life and property have produced this poverty, but the want of means of communication, of taking their stuff to market, and the insecurity of such miserable roads as exist are the results of such misgovernment. A well-managed railway would go far to assure to the peasant the fruit of his labours.

"Commerce and trade have been frightfully hampered in Asia Minor by the cruel restrictions upon the simplest form of travel, which in the case of Armenians meant a total prohibition to go from one place to another. These restrictions have been only recently abolished by the Committee of Union and Progress. The railway will not only increase facilities for travel and transport but gradually, insidiously even, lead to the removal of other hindrances to commerce. Everywhere the prospect of the railway being opened is welcomed as a great reform. Wherever in Turkey railways have been worked there has followed a notable, even a quite remarkable, increase in production. Fifteen years ago not a single ton of grain reached the sea-coast for export from the districts from which the Anatolian Railway runs. During the last four years the annual grain export alone from the same districts averaged 1,250,000 Turkish pounds, say £1,150,000 sterling. In the same manner the two lines from Smyrna have enormously increased the exports from that city.

"The establishment of the Bagdad Railway will confer two great advantages upon the Turkish Government itself and many smaller ones: first, it will cause an increase of revenue from the increased produce, which for the first time can be sent to market at a profit: and second, a further very large portion of the public revenue will be placed under the Department of the Public Debt, which means that it is really being placed under international control."

THE RELATION OF RAILWAYS TO CANALS.

THE NEED OF WATER TRANSPORTATION FACILITIES IN THE UNITED STATES AND THE PRINCIPLES ON WHICH CANAL BUILDING SHOULD BE UNDERTAKEN.

John F. Stevens—Atlantic Deeper Waterways Association.

A CONSIDERABLE part of the discussion of the problems connected with the improvement of inland navigation in the United States, which are now receiving so large an amount of public attention, centres around the relation of railway to water transportation, the economic possibilities of canals in the face of railway competition and the probable attitude on the part of the railways to any large scheme for the improvement of inland navigation. These questions were discussed at length by Mr. John F. Stevens at the convention of the Atlantic Deeper Waterways Association in November last. We take the following extracts from his paper from *Engineering News* for December 10, 1908.

"Within sixty years—about one hardy business lifetime—our railway main lines have risen from nothing to 225,000 miles, over which traffic, both freight and passenger, is carried, at speeds equal to, and at rates, generally speaking, lower than in other countries, where the cost of labor and material is much less than with us, and where the density of tonnage is far greater. But a time has now come when the railways, considered as a unit, are not capable of handling satisfactorily the interchange business of the country, even supplemented as they are to a certain extent by water lines.

"The gigantic strides our internal commerce has made, have demonstrated that while railways serve a purpose which waterways can never do, they need to be supplemented by a cheaper, if a slower carrier. There are immense volumes of low-grade traffic, which to be moved at all require very low rates. Such traffic is now being handled by the railways to the detriment of their other and faster-moving business, at a loss to themselves and to the public also.

"There seems to be a general impression that the railways are opposed to the exploitation and construction of canals. That there is good ground for such opinion, the writer does not believe. The consensus of opinion among our ablest, most far-sighted railway owners and executives is undoubtedly that canals, properly planned, honestly financed and constructed, will not only aid the development of the country, but will create new business, and be of assistance and value to the railways themselves.

"It is improbable that private capital can be found to finance—excepting, possibly, in a few unimportant instances—such systems of canals as the public needs may find necessary; and if the demand—which is already insistent—that the national government take up the matter, is granted, then it clearly devolves upon the national authorities to see that such systems are so planned, and the work is so executed, that the greatest good to the greatest number will result. And such work will naturally divide itself into three classes: the improvement of harbor facilities, the enlargement and control of rivers, and the creation of new and the rebuilding upon more generous lines of existing canals.

"The improvement of harbors, and the fitting of such of them as may be most available, in connection with interior transportation lines, to become suitable terminals for foreign business, is in itself a great and important work: and the mistake of spending millions for deep water, for ample room with safe anchorage, and neglecting to provide means for cheap and quick exchange between ships and interior lines, must be avoided. By the lack of such foresight, New York has built up Baltimore, Norfolk and Newport News, and the business which now avoids her port, because it can be done cheaper elsewhere, will never come to her doors. In fact, the providing of ample and well-arranged terminals is the greatest single item among the many which go to make up the total of efficient transportation facilities.

"The matter of building a railroad at the present day is a different proposition than it was in years past. Now, as a first preliminary, the amount, nature and probable revenue of all prospective traffic seeking movement, is carefully estimated. These factors, with such reasonable additions as future development may seem to warrant, fix the character of the road to be built, from right of way to equipment, and hence, the amount of the investment in the proposed enterprise. And the same sound principles should be observed in the planning of canals. They should be fitted for the work they will be called upon to do, as far as it can be predicated.

"First, and foremost, should come the big trunk lines, to be built where no doubt can exist that the business waits, or will develop, for them, and where nature has provided, without prohibitory cost, physical conditions which make them feasible.

"After such trunk line or lines are decided upon, then the question of branch or feeder lines should be given the same careful consideration, and the relations of such minor links in the general scheme, to the whole, including the railways should be thoroughly worked out; and the dimensions which govern the capacity and consequent cost of operation of every one, trunk and branch lines alike, should only be decided after the most intelligent and painstaking inquiry, remembering always, that the cost and delay of transferring freight from one vehicle to another is generally more than the hauling of it for many miles. The construction of a canal, or of a system of canals, is a simple matter, as compared to the conception of, and the correct solution of all the preliminaries.

"Once financial means are assured, once we establish the policy that such adjuncts to our present lines of traffic are to be provided, a wild and senseless scramble will ensue for 'a slice from the pork barrel.' Every little town, every city—not to mention every state—will demand to have its own little pet canal, and such demands once conceded, would not only cover the face of nature with useless and unsightly scars, but would drive the nation, and probably some of our states, nearly to bankruptcy. The only way to prevent such wasteful results will be to take the whole matter absolutely out of politics—as much so as the deliberations of the supreme court.

"We might have a commission large enough in numbers so that the details of work could be divided and yet not large enough to become unwieldy, the members to be selected, not by reason of party proclivities, or geographical distribution, but because of their known ability as business and transportation men, in the broadest meaning of the terms. Such men should be paid salaries commensurate with those they can earn in private life, and the tenure of their office should be fixed, not by the caprice of political necessity, but by a natural age limit of retirement, with a fair pension thereafter until the end of life. If we are going to spend, as has been suggested, from fifty to one hundred million dollars each year for an indefinite period, we can spend none of it more wisely, than in providing the very best counsel and supervision that the talent of the United States affords.

"Such a commission should be given the final power of decision, not only as to details, but also as to the general, and, in fact, all features; with the authority to examine, accept or reject, as it saw fit, any project advanced for consideration; to plan and to carry into execution, by contract, or otherwise, any work it might decide upon as proper to be done, subject, of course, only to regulated financial limitations.

"And such a course would, it is believed, meet with the approval of leading men of the railway world, in common with all other thinking citizens. It would be as much—probably more—to the benefit of the railroads to have the locating, planning and construction of waterways carried along on sound business principles, as it could possibly be to any other commercial interests.

"Looking into the future, there is another factor, which, although a side issue, may become a very important one. In the construction of canals, as a natural result, there will be the development of a large amount of water-power, which, properly handled, can be made to produce, at a low cost, power, heat and light, through the medium of electricity. This will enable us to conserve our coal supply, and thus to add millions to our material resources which we are drawing so heavily upon. And no interests are more concerned in the cheapness of power—whether produced from coal or any other agency—than the railroads. For this reason alone, they should feel a deep concern in the successful inauguration of a canal system from which they are bound to derive such substantial benefits."

THE CHARACTERISTICS OF A FOREMAN.

A DISCUSSION OF THE PROPER TRAINING SCHOOL FOR THE DEVELOPMENT OF THE BEST TYPE OF FOREMAN.

Engineering.

IN the issue for December 18, 1908, *Engineering* comments editorially on the gradual change which is taking place in the characteristics of foremen in the mechanical trades. Before manual labor had been so extensively superseded by machinery, the primary qualification of a successful foreman was superiority in handicraft, the moral and mental qualities of self-control, administrative ability, etc., being of secondary importance. The application of mechanical methods of manufacture however, has affected the order in relative importance of the necessary qualifications, and the successful foreman of today must be a man of thought, of independence of character and of administrative ability. *Engineering* discusses as follows the best school of training for the development of these qualities:

"There are many who doubt the expediency now of promotion from the bench to the foreman's post. It is contended that the changes in methods of manufacture are so radical that there is not now the same need for the superior handicraftsman—that what is required is a controller, a master of method and of organisation. We can only accept this contention with the important proviso that the man of thought who is to be the ideal foreman of the future shall first have such a practical training at the bench as to have acquired a sound knowledge of workmanship and a complete sympathy with workmen. Contact is imperative for both acquisitions; without them a man cannot control men or methods. There is nothing more subversive of discipline than the ridicule even of one man, and it is quickly awakened, and justifiably so, by the slightest display of incapacity to do any bit of work. A man cannot be a really efficient foreman without being a capable workman. He must, however, be more than that, and the elements of development are in this direction; so also are the divergencies from unanimity of opinion.

"The workman who aims at being a foreman must secure as great a degree of technical and general education as is possible to him. If the attendance at evening classes involves hardship and self-sacrifice, the result is advantageous in the formation of character. It is important that he should know, for instance, about the qualities of the metals used, the principles of mechanics and physics, and the whys and wherefores of the details of the designs to be embodied in metallic form, as well as the elements of machine-tool design and power distribution. There are other important studies, but these examples suffice. Even in the case of a ship-fitter, smith or forgeman, where manual labor obtains still to a large extent, there is need for technical training. And in all cases there is possible great gain by the pursuit of knowledge which, although not immediately useful, tends to general culture. This point need not be elaborated here; the development of a disciplined mind will be regarded as of great importance.

"Drawing-office experience is equally necessary; but the cases are very rare where a foreman who has been trained exclusively as a draughtsman has been successful; there is always the lack of intimate knowledge of workmanship. Indeed, it is possible that a prolonged period in the drawing-office may partly unfit for foremanship a man with earlier workshop training. The atmosphere of the drawing-office, and the psychological conditions prevailing, are very different from those obtaining in the shops. In the one case the problems are associated with strains requiring calculation, and there is more or less of mechanical method; in the other the difficulties are connected with personal idiosyncracies, where conditions do not repeat themselves and cannot be standardised. In the one instance it is mathematics, in the other humanity. A foreman should be able to easily read a drawing and to readily discern an inaccuracy. This latter raises a point which has involved heartburnings between the drawing-office and the shops. The duty of the workman, the machineman, is to obey: to follow his drawing implicitly. Any other rule would mean confusion. But this scarcely holds with the foreman, who from his practical experience in the shops and drawing-office ought to be able to suggest modifications which are acceptable, because they simplify machining or fitting, or for other reason. The foreman who neglects to make, and the draughtsman who refuses to accept, such suggestions fail in their duty.

"There are some firms who only promote men to foremanship if they have been in the premium, bonus, or costs department. This course is satisfactory; but again we must interject the reservation as to the duration of service in a department which is only an adjunct to the factory. The premium-bonus system has proved very satisfactory; but there is a tendency to make too much of it. The happy mean is difficult to strike, and in this, as in many other cases, our English pastime of hobby-riding is very pronounced. The card system is another case. We have heard of a works where there is a staff appointment of a 'card-inventor.' Inventors, to which class belong premium fixers and card and index-makers, are like mothers whose goslings are all swans. Where they have uncontrolled sway there is trouble. What is wanted is a reasonably good system of premium standards and cards, which should be altered reluctantly, and only on unquestionable grounds. They should be operated conscientiously. A foreman ought to know the system well to be able to restrain and regulate the rate-fixer. Men who become imbued with the spirit of the card system sometimes have their imagination limited by the four edges of the card. That is well for one who is to remain a member of the premium-bonus staff, but it is otherwise with a foreman.

"The training of the successful foreman should thus be composite. He should have a liberal education, although this, fortunately, may be supplied in later years by reading and other means of culture. He should have a sound training at his trade in the shops; this is indispensable. Technical training is invaluable, and to this should also be added some experience in the drawing-office and costs department. But to these there must be added those qualities which mark men as leaders. There is, first, ambition in the truest sense, and the readiness to suffer privation in achieving an end. This is akin to self-discipline, to the development of a well-balanced mind, and, therefore, to a strong sense of the relative importance of justice and right. These two will enable him to avoid nepotism and favouritism—two of the greatest pitfalls. This, it may be urged, is a gospel of perfection; but it is well, once in a while, to aim high. Moreover, we are persuaded that employers could do much by encouraging intercourse betwen foremen to a greater degree. There are, it is true, foremen's associations but they are not sufficiently supported by the men who could profit by them; nor do they meet often enough. It is important that there should be considered at their meetings economic and social problems associated with production as well as purely technical questions, while visits to works at home and abroad should be arranged at frequent intervals. Nothing tends more to efficiency in management than perfection of system, and many hints in this direction could be gleaned by travel. There should be no difficulty: one firm might welcome the foremen of another in exchange visits, to the advantage of both. Even an international exchange might be possible. But in any case there can be nothing but advantage from any effort to improve the characteristics of foremen. On them the economy of production greatly depends. They should be exemplary, being first men, as well as oversmen, even at six o'clock in the morning."

THE REPAIR OF MARINE BOILERS BY AUTOGENOUS WELDING.

A DISCUSSION OF THE ADVANTAGES AND DIFFICULTIES OF THE PROCESS AND THE SECURITY OF ITS RESULTS.

André Le Chatelier—Revue de Métallurgie.

A VERY interesting and comprehensive paper on the employment of autogenous welding for the repair of marine boilers, by M. André Le Chatelier, appears in the *Revue de Métallurgie* for November, 1908. We have not space to review his valuable practical notes on the methods of executing repairs of various classes but we quote at length from his discussion of the safety of repairs made by the autogenous welding process.

For the repair of all classes of boilers the process offers two advantages of capital importance: first, it permits water-tight and durable repairs to be made without the use of rivets, which, although the only method of repair available up to very recent times, has always proved unsatisfactory on account of the tendency of riveted repairs to develop leaks after a greater or less period of service; and, second, it offers a means of effecting repairs impossible by any other process, and in many cases of avoiding the necessity of replacing furnaces or other important parts of boilers or even of whole boilers. Extensive corrosion of the tube plate, due to leakage of the tubes, or of certain parts of the furnace walls where a riveted patch could not be counted on to remain water-tight would in most cases lead to the condemnation of the entire boiler. The repair of such damage can be rapidly and cheaply effected by the autogenous welding process and the cost of replacement of the whole boiler avoided.

In the particular case of marine boilers the process, generally the most economical method of repair under any circumstances, is of especial importance on account of the rapidity with which repairs can be executed. Repairs of any magnitude by riveting are not only expensive in themselves but they keep the vessel out of commission for days or, in many cases, for weeks. On this account boilers are usually kept in service as long as possible without repair with the result that deterioration goes on at a very rapid rate. Autogenous welding offers a means of effecting repairs of considerable importance during a stay of one or two days at a port, and a judicious and frequent utilization of the process results in keeping the boilers always in good condition. The process has a very important application in the case of boilers too badly damaged to be repaired by any other means. In many cases the costly replacement of certain important parts or of the whole boiler may be avoided or at least postponed for several years. This is especially of importance in the case of old vessels whose boilers are worn out but whose hulls are capable of several years' service, but not enough to warrant the installation of a complete new boiler plant.

The question of safety is of so much importance that in many quarters it is considered unwise to employ autogenous welding for the repair of boilers, especially for executing repairs of much importance. Distrust of the method has been caused by the fact that not infrequently welds made by inexperienced workmen break throughout their entire length. In considering the extent to which this distrust is well founded it is important to recall the modifications which take place in the mechanical properties of metals at temperatures around 200 degrees C. to which the boiler plates are subjected. These are, briefly, first, an increase in the ultimate strength in tension, second, a decrease of about 12 per cent. in ductility, and third, a decrease in malleability in about the same proportion. These modifications are produced by a transformation of which the nature is little understood and of which the effects are most clearly manifest between 100 to 200 degrees C., the range of temperatures to which boiler plates are commonly subjected. The most troublesome effect is the great reduction in ductility and malleability. The furnaces and fireboxes of boilers particularly are subjected to stresses due to expansion and contraction, which, notwithstanding special designs of plates used in their construction, eventually destroy the elasticity of the metal and give rise to the flaws and cracks which appear in the furnaces of all marine boilers at the end of a few years' service.

As regards repair by autogenous welding, however, these modifications in mechanical properties offer no difficulties. They are the same for the metal of the weld as for that of the plate. It is only necessary that the welding material should be a steel equivalent in quality to the material of the plate and of as low carbon content as possible, the latter because the reduction in malleability depends to a great extent on the amount of carbon present in the metal. A well-made weld will show resistance and extensibility values amounting to 80 per cent or more of those of the plate, a higher value than is possible with riveted repairs.

But the most important point to be considered in connection with autogenous welding is that of brittleness. At the point of welding the metal has been melted and cast and has lost a large part of its power of resistance to shock. It is possible to restore this quality to a certain extent by reheating the weld and by hammering at a red heat, but in general a weld can not be counted on to be so free from brittleness as the rolled plate. As a matter of fact the quality of fragility would not necessarily render a steel unfit for use in boiler construction were it not accompanied by its correlative fissility. The later quality is of capital importance. In a fissile steel a crack once started is extended very rapidly by very small stresses. It is evident that a steel of this nature could not be incorporated in a boiler without the risk of serious accident. When a weld is badly made and does not extend through the whole thickness of the plate, the unwelded part forms the nucleus of a crack equally dangerous with those formed at the surface of the plate through the influence of expansion and contraction. Distrust of the autogenous welding process on this account merits serious consideration and seems at first sight justified by the frequent breakages of welds throughout their entire length under comparatively slight shocks. If welds made by this process retained when hot the fissility they might possess when cold it would indeed be unwise to employ autogenous welding to any great extent in the repair of boilers. But, fortunately. the temperatures between 100 and 200 degrees C. which have so serious an influence on the malleability of the steel have a most beneficial effect on the fragility and fissility. The latter are qualities characteristic of low temperatures and they diminish very rapidly as the temperature rises, a rise of even 5 degrees producing an appreciable improvement in the steel. Above 100 degrees they no longer exist, and between 100 and 200 degrees two steels which, when cold, would have shown very different degrees of fragility and fissility will be practically identical so far as these qualities are concerned. The result is that a crack which in cold metal would be extended by very slight shocks is increased only by considerable deformations at a temperature above 100 degrees. Hence a weld which might when cold be of a quality much inferior to that of the plate will become of practically the same quality when hot, so far as fissility is concerned, and will possess no special danger. If badly made, of course, the flaw will increase in extent, but gradually and without the danger of sudden and complete rupture. If the weld is made with a good quality of metal, if it is uniform throughout the entire thickness of the plate, and if as an additional precaution it has been reheated, it will give perfect security. In fact experience shows that when welds in boiler plates fail it is almost always immediately after they are made, rupture being caused by the stresses due to contraction to which they are subjected at that moment.

M. Le Chatelier described at length the various applications of autogenous welding which may be made in the repair of various parts of marine boilers and gives numerous illustrations of work executed at Marseilles. He emphasizes the fact that the process is not simple. On the contrary it is a very delicate operation requiring for its success a great many precautions and a high degree of skill on the part of the workman. The lack of skilled workmen is the most serious obstacle in the way of the extension of the use of the process. The workman using it for the repair of boilers must not only be manually dexterous but he must have a keen sense of responsibility. The manual dexterity can be obtained in from 6 to 9 months but the moral qualities are so rarely found that there are not above ten workmen in the whole world, outside of Italy, to whom the more important repairs could be entrusted with perfect safety, and not above 20 others capable of performing satisfactorily the more ordinary operations. The process is, however, making rapid strides. At the end of 1907 it was used for repairing marine boilers only at the ports of Marseilles and Genoa, but during the past year it has been introduced in Belgium, Holland, Spain, Germany, England, Russia, Roumania and Brazil, and there is no doubt that within a few years facilities for executing repairs by autogenous welding will exist in every port of importance in the world.

THE NATURE OF ALLOYS.

AN ELEMENTARY GRAPHICAL DESCRIPTION OF MODERN THEORIES AS TO THEIR FORMATION AND CONSTITUTION.

Engineering.

As an introduction to a review of three highly technical papers based on modern theories as to the constitution of alloys, read at the first meeting of the newly formed Institute of Metals, *Engineering* for November 20, 1908, gives one of the most lucid descriptions of the elements of these theories which has come to our notice. For specialists in metallurgy and metallography, of course, so elementary a discussion will possess but little interest, but we believe a majority of engineers will find in the following full abstract a valuable presentation of a subject concerning which little is generally known. It is of especially timely interest for our readers in connection with Mr. Becker's discussion of high-speed steel which begins on another page of this issue.

"According to the modern theory an alloy in general resembles a mass of granite which consists of a number of entirely different constituents in the crystalline state, held together by the solidified mother-liquor, from which the crystals in question were deposited during the process of cooling. The crystals which separate out before the mass solidifies as a whole, may, in theory at least, either be chemical elements or definite chemical compounds, or more generally 'solid solutions.' What is meant here can best be illustrated by taking an example.

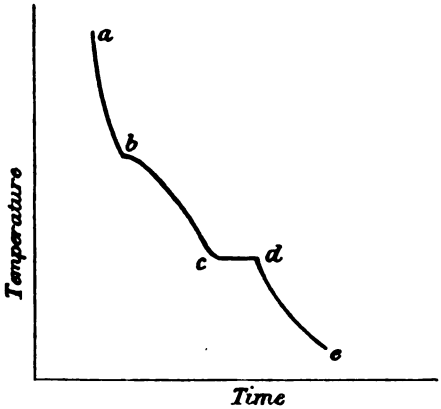


FIGURE I.

"If an alloy of two metals is melted and allowed to cool, and an autographic diagram of the temperature taken during the whole time of cooling, a curve is obtained which is generally of the character represented in Figure I. From *a* to *b* the temperature falls steadily with the time, but at *b* the rate of cooling slackens, and it appears that at this point crystals of one of the two constituents crystallise out, so that the portion remaining liquid is poorer in this constituent.

"As the temperature falls further, more of the constituent in question solidifies, thus still more impoverishing the mother-liquor, and the part of the curve represented by *b c* is traced. At the point *c* the mother-liquor itself begins to solidify, and until this is completed the temperature remains constant, tracing the horizontal part of the curve *c d*. Following this the temperature falls uniformly again, as indicated by *d e*. The crystals deposited during the period corresponding to *b c* are relatively large, whilst those deposited during the freezing of the mother liquor are very small.

"If the two constituents of the alloy are denoted by Y and Z respectively, then in the ideal case the crystals first deposited consist solely either of the metal Y or of the metal Z; whilst during the period corresponding to *c d*—that is, during the freezing of the mother liquor —the solid separated consists of minute crystals of Y laid down side by side with similar minute crystals of Z. This solid is known as the eutectic. Whatever the proportion of Y to Z originally present in the alloy, this eutectic contains exactly the same proportions of the two metals. It is, however, in no sense a chemical compound, but consists, as stated, of separate crystals of each metal laid down side by side.

If the same metals Y and Z are melted in a different proportion than in the case represented in Figure I, the point *b* in the new diagram will make its appearance at a different temperature than before; but the temperature corresponding to the freezing of the eutectic, represented by *c d* in the figure, will be constant for all cases. Hence, by plotting the temperatures corresponding to the point *b* for all proportions of the two metals, a diagram similar to the upper line in Figure 2 is obtained.

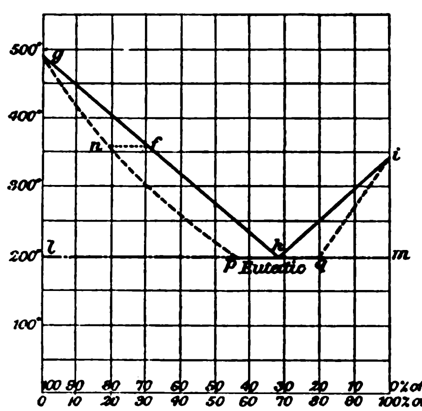


FIGURE 2.

"The diagram shows that the pure metal Y melts at temperatures of 490 degrees, and the pure metal Z at 340 degrees. An alloy containing 70 per cent. of Y and 30 per cent. of Z is perfectly fluid until the temperature falls to 360 degrees. At this point, represented by *f* in the diagram, it begins (still keeping to the ideal case) to deposit crystals of the pure metal Y. Hence the mother liquor is impoverished in Y, and will not deposit more of this metal unless the temperature falls further. As it continues to cool, however, more and more of the metal Y is deposited, until at last the temperature reaches 200 degrees, at which temperature the mother liquor consists of 32 per cent. of Y and 68 per cent. of Z. At this point, corresponding to the line *c d* in Figure 1, both Y and Z freeze out simultaneously and the whole mass solidifies. Up to this time one portion on the total mass has been liquid, and another portion solid. Similarly a melt containing 80 per cent. of Z and 20 per cent. of Y begins to deposit crystals of Z at a temperature of 250 degrees, and freezes into a solid mass as before at 200 degrees. Drawing a horizontal line *l m* across the diagram at 200 degrees, we have the two critical temperatures shown for all proportions of the constituent metals. One of these critical temperatures, that corresponding to the point *b* in Figure 1, varies with the proportion of the two metals originally present; but the other, the temperature corresponding to the freezing out of the eutectic, is constant.

"The state of affairs described above is an ideal one, not satisfied accurately by an alloy. In general, when the Y component begins to freeze out at the point corresponding to *b*, it carries down with it some small proportion of the metal Z. Hence the crystals first formed are not pure Y, but a solid solution of Z in Y. Similarly, if Z is the metal to freeze out first, it carries with it a certain amount of Y, the crystals then formed being a solid solution of Y in Z. These solid solutions are also known as 'mixed crystals,' a not altogether fortunate term, which would seem almost more applicable to the eutectic. It is really meant to imply that the crystals first separated contain less Z than those coming down subsequently, there being a continuous increase in the proportion of Z held in solid solution until the eutectic proportions are reached. In other words, for the case in which Y crystallises out, the proportion of Z dissolved in the crystal varies with the temperature at which the solidification is effected. On the other hand, the proportion of the two constituents in the crystal deposited at any temperature is not the same as in the mother liquid at the same temperature.

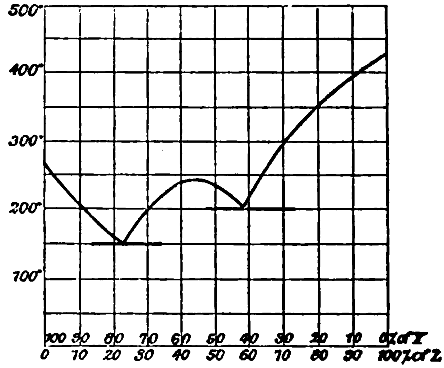


FIGURE 3.

"Thus whilst the line *g h i* shows the composition of the mother liquor at any temperature, that of the crystal which is separated at the same temperature is widely different. Thus in Figure 2 another line, *g p q i*, can be drawn showing the composition of the crystals which separate out at any temperature. Thus the composition of the crystals deposited from a mother-liquor containing 70 per cent. of Y and 30 per cent. of Z can be found by drawing from *f* a horizontal line cutting the line *g p* at *n*, which, it will be seen, corresponds to a composition of 82 per cent., Y carrying, in solid solution, 18 per cent. of Z. It will also appear from the diagram that the eutectic consists of two sets of crystals, one (corresponding to the point *p*) containing 54 per cent. of Z dissolved in 46 per cent. of Y, and the other (corresponding to the point *q*) 20 per cent. of Y dissolved in 80 per cent. of Z. When the mutual solubility of the two metals in each other is small, the point *p* lies close to the 100 per cent. line for Y, and the point *q* close to the 100 per cent. line for Z. Alloys having compositions corresponding to points on the left of *p*, or the right of *q*, do not deposit eutectics.

"The case represented in Figure 2 corresponds to one in which the two constituents do not unite to form chemical compounds. When such a compound is formed the complete curve can be drawn by combining two diagrams, one obtained when the mixture consists solely of the metal Y and the compound Z Y, and the other when the mixture consists solely of the metal Z and the compound Y Z. These may then be juxtaposed to form the complete curve.

"The kind of curve then obtained is represented in Figure 3. Taking, again, the ideal case in which no solid solutions are formed, but pure constituents separate, the diagram shows that for compositions containing more than 78 per cent. of Y, the latter crystallises out alone until the temperature falls to 150 degrees, when the eutectic solidifies. This eutectic does not, however, consist of crystals of Y, laid down simultaneously and side by side with crystals of Z, but of crystals of Y laid down side by side with crystals of the compound Y Z. For mixtures containing less than 78 per cent. of Y, and more than 56 per cent., the crystals which first separate out are crystals of the compound Y Z, and the eutectic is the same as in the previous case. When next the mixture contains less than 56 per cent., but more than 42 per cent., of Y, the diagram shows that the crystals which first separate out are crystals of YZ; and the eutectic now formed consists of crystals of the compound YZ and of the metal Z, the metal Y being absent in the uncombined state. The melting point of this eutectic is 200 degrees. Finally, when the mixture contains less than 42 per cent. of Y, the metal Z crystallises out first, and the eutectic finally formed is again that melting at 200 degrees. In actual practice the crystals formed are never quite pure, but each is a solid solution. If the two constituents can form more than one compound, the curve will be still more complicated. A hump like that shown in Figure 3 generally denotes the presence of a compound, the composition of which is represented by that of the maximum ordinate."

THE VALUE OF THE IMPACT TEST.

AN OUTLINE OF TYPICAL METHODS OF IMPACT TESTING ON NOTCHED BARS AND AN ESTIMATE OF THEIR VALUE.

F. W. Harbord—Institution of Mechanical Engineers.

SO many methods of testing steel by impact have been suggested by engineers during the last few years that it has become a matter of importance to investigate the value of these tests as compared with the ordinary tensile tests, upon which in the past it has been the custom largely to rely, and also to compare the better-known methods of impact testing with each other, to see which gives the most concordant results. An investigation of this sort was recently undertaken by Mr. F. W. Harbord with the objects, first, of comparing the results obtained by different methods of impact testing, and, second, of determining whether such tests detected any irregularity in steel not revealed by the ordinary tensile tests, and to what extent they are in agreement with each other, the results of which were communicated to the Institution of Mechanical Engineers on November 20, 1908. Mr. Harbord's paper contains a vast number of data which it is impossible for us to reproduce; the following brief abstract is limited to his outline of typical methods of impact testing and a very general summary of the conclusions he has drawn from the results of his tests.

The materials used in the tests comprised three very high class Sheffield steels, referred to as "standard steels," and a series of steels made by the acid Bessemer, acid open-hearth, basic Bessemer and basic open-hearth processes, so that all steels used by engineers for structural and railway work were represented. In all, over 800 bars representing over 40 different steels were experimented with. In the experiments with the standard steels, six duplicate tests were made on each steel by each of the methods investigated, except in a very few cases when material was available for only two or four tests. Tensile tests of all the steels and hardness tests by the Brinell method were also included.

"Broadly the methods of impact testing may be divided into four or five classes, each having its supporters, and all being more or less used by different engineers and metallurgists. The methods of testing in common use may be divided as follows:

1. One notch in the centre of the bar: two supports: fracture effected by a series of blows of a falling weight. *(Seaton and Jude.)*

2. One notch in the centre of the bar: two supports: fracture effected by one blow of a falling weight. *(Frémont.)*

3. One notch not necessarily in the centre: one support: fracture effected by one blow on overhung portion from a falling pendulum or weight. *(Izod.)*

4. Two opposite notches not necessarily in the centre: one support: fracture effected by a series of blows of a falling weight on overhung portion. *(Brinell.)*

5. Same as 4, but with an arrangement for reversing the bar after every blow." *(Kirkaldy.)*

The five methods indicated in italics above were chosen as representatives of the five general classes of impact-testing methods mentioned. The tests were carried out on each machine under the direction of the inventors, Mr. Harbord supplying the test bars already machined to the size taken by the different machines. The test bars were all cut from rolled bars of approximately the same section and into which about the same amount of work had been put in rolling. They were also subjected to the same heat treatment to remove any possible stress due to cold rolling.

"In the Frémont method the test-piece is machined to the size 35 by 10 by 8 millimetres. It has a groove 1 millimetre deep in the centre and is supported on a bearing at each end with the groove downward, and is broken by one blow from a falling weight striking it in the centre. The residual energy in the weight not expended in fracturing the specimen is measured by allowing the weight and broken test-piece to fall on a steel plate placed directly below the test bar and supported on two strong springs. The compression of these springs so produced is measured and recorded by a lever, the short arm of which is attached to the steel plate, while the long arm is provided with a pointer or pencil which travels over a graduated scale. The energy required to fracture the bar is the difference between the original impact energy of the weight, deduced from its mass and height of drop, and the residual energy as recorded on the scale. The error in reading amounts to about 0.3 kilogramme with a 10-kilogramme weight, or about 1-75 of the energy required for a fairly tough sample.

"By the Izod method a sample 2 inches long, ⅜ inch wide and 3-16 inch thick, with a V notch, supported at one end in a clip or vise, and held vertically, is fractured by one blow from a swinging pendulum striking the overhung portion, the residual energy in the pendulum being measured by the arc through which it swings after fracturing the sample. This residual energy is recorded by a special attachment. In this method, as in the Frémont method, an exact measure of the energy expended in fracturing the sample within a very slight error is obtained.

"In the Seaton and Jude method the sample, 4 inches long and ½ inch square in section, with a V notch in the centre ⅛ inch wide and deep, is supported on a bearing at each end, and broken by a series of blows from a falling weight striking it on the centre. The weight and height of drop can be varied at pleasure, according to the class of steel under test. The energy absorbed in breaking the samples is calculated into foot-pounds. In the case of ductile steels requiring a number of blows, say seventy or more, the actual energy absorbed can be obtained to within one blow—that is, 1-70 or so of the total energy; but in the case of brittle steels requiring only one to three blows, the error is still one blow, equal at the least to one-third of the total; or even if one-half the last blow be taken as the breaking weight, the error would still be one-sixth of the total.

"In the Brinell method the sample of the same form and dimensions used in the Seaton and Jude method, with two opposite V notches each ⅛ inch wide and deep, is supported at one end in a suitable block and fractured by a series of blows on the overhung portion. The tests may be made in two ways—namely, with the notch either horizontal or vertical. In this method, as in that of Seaton and Jude, the force required to fracture the bar is calculated into foot-pounds, and the degree of accuracy largely depends upon the number of blows which the steel stands before fracture. In ductile steels the error would be small, but in hard steels comparatively large. A very serious objection, however, to this method of testing in the case of ductile steels is that when the notches are horizontal after a few blows, but before the fracture, the bar bends so much that the notch in the under side entirely closes, and the test cannot be continued."

Mr. Harbord attempted to prevent this by slotting away a portion of the bar on one side of the notch down to the depth of the latter. In the case of the ductile steels, however, it was found that even this expedient would not produce accurate results and the tests by the Brinell method were abandoned.

"In the case of the Kirkaldy method the sample is of the same dimensions as that used by Seaton and Jude and Brinell, but instead of V notches it has two opposite circular grooves, each ⅛ inch wide and deep. The test bar is supported in a suitable block or vise at one end, and fractured by a series of blows from a falling weight on the overhung portion; but after every blow the entire block is turned over by a cam attachment, so that blows are delivered alternately on each side of the test bar. In this method, as in the Seaton and Jude, the force required to fracture the bar is calculated into foot-pounds, and the degree of accuracy largely depends upon the number of blows which are required to produce fracture; owing, however, to the reversal after each blow, the number of blows required to produce fracture, even in very brittle steels, is comparatively large, and consequently the error is not very considerable, and in moderately ductile steels is inappreciable."

The results of the first series of tests on the three standard steels, which contained respectively 0.26, 0.32 and 0.41 per cent. of carbon, to determine whether the method of testing could be depended upon to give concordant results in duplicate tests on the same material, showed such wide variations that it was considered advisable to extend them to steels of inferior quality but of uniform composition and structure before drawing any general conclusions. A certain number of bars were therefore heated to 1230 to 1250 decrees C. to destroy their ductility partially and half of them were partially restored by re-heating to a lower temperature. Tensile tests of the bars thus treated showed them to be uniform and free from marked irregularity, but the results of the impact tests showed still wider variations from concordance than those on the untreated bars.

"The variation in duplicate tests by the same method is so important that it is desirable to consider these somewhat in detail. In the case of the 0.26 per cent. low carbon untreated steel we find that the Kirkaldy vertical gives the most uniform results, showing a variation of only 2 per cent., while the Kirkaldy horizontal gives the maximum variation on duplicate tests of 30 per cent., the maximum variation shown by the other methods being 25 per cent., and the minimum 7 per cent.; and these if they stood alone might be considered satisfactory as approximating to the variation in duplicate alternating and tensile tests. If, however, we consider the overheated steels, we find the Seaton and Jude method showing a mean percentage variation of 69 per cent., Izod 35 per cent., and Kirkaldy methods 29 per cent. and 27 per cent. Turning, however, to the restored steels, we find the same methods giving totally different results, and instead of the Frémont methods showing the best results with a variation of from 20 per cent. to 25 per cent., we get a variation of 57 per cent., while the Seaton and Jude shows 60 per cent., the Izod method showing relatively small variation for this low carbon steel.

"An examination of the 0.32 per cent. and 0.41 per cent. carbon steels by Seaton and Jude methods gives a variation of 55 per cent. and 50 per cent. respectively for the overheated, and 48 per cent. and 95 per cent. for the restored; by the Frémont method, 14 to 16 per cent. for the overheated, and 78 to 109 per cent. for the restored; by the Kirkaldy horizontal, 59 and 60 per cent. for overheated, and 29 per cent, for the restored; and the Kirkaldy vertical, 36 and 49 per cent. If we examine each steel, it will be seen that some methods show the greatest variation on the overheated bar, others on the restored bars, so that there is nothing in the results to suggest that variations are due to lack of uniformity in the steels.

"From a consideration of the above it seems reasonable to assume that the irregularity disclosed by the different methods of impact testing is not due to lack of uniformity in the material, but largely, at all events, results from the defects of the method of testing, and it is a serious question how far methods showing such variations should be relied upon by engineers to differentiate between the physical properties of different materials."

Without going into details it may be said that wide discrepancies exist also in the results of the tests made on the standard and commercial steels to compare the impact method with the tensile and alternating-stress tests. "Taking the results as a whole, the Kirkaldy methods and the Izod method give results more in accordance with the tensile tests, and also show less variations in the duplicate tests, but some of the results obtained by these methods vary so much that their value seems very doubtful.

"The claim of the supporters of impact testing is that it indicates certain latent defects not shown under a static test, and therefore it is unfair to condemn impact results when they do not agree with the tensile tests; to some extent this is true, and if experiments had shown that duplicate tests might be relied upon to agree with each other within reasonable limits, and the results were in general agreement with experience, this contention would carry much weight; when, however, we find tensile tests on two steels show a difference of only about 4 tons with approximately the same elongation, and these results are confirmed by the analysis, and then impact tests of two such steels show by two methods the relative brittleness to be as 100 is to 16 and 100 to 21, while other methods give totally different results, one has very seriously to consider the value of these tests."

THE MANUFACTURE OF HIGH-SPEED TOOLS.

NOTES ON THE MANIPULATION OF HIGH-SPEED STEEL IN THE MANUFACTURE OF TOOLS.

O. M. Becker—Cassier's Magazine.

MR. O. M. BECKER, who begins on another page of this issue a series of articles on the nature and characteristics of high-speed steel, has contributed to *Cassier's Magazine* for December, 1908, a practical discussion of the manufacture of tools from high-speed stock. Most of the disappointment which has been experienced with the results of the introduction of high-speed steel has been caused, he says, by improper methods of treatment. The making of the common forms of tools is so simple, however, that it can be undertaken in almost any shop having tool dressing facilities, provided the smith is willing to forget a few of the things he has learned about carbon steels and is prepared to learn a number of new things concerning the new materials. A few of the more important points are noted in the following extracts from Mr. Becker's paper.

The use of annealed stock is usually preferable. If unannealed stock is used the tool has to be annealed to insure an even temper and the absence of strains. If annealed bars are used this annealing process may be avoided. Annealed stock is more easily separated into the proper lengths for tools, it is more convenient for forging, and it can be readily machined.

"For forging any good fire, a common

forge fire among the rest, will serve, though, indeed, here, as in other cases, the better results can be expected where the better appliances are used. The first essentials are to secure the required heat and to keep air currents away from the tool when heating. This is accomplished in part by keeping a deep and clean fire. Coke is better than the ordinary smith's soft coal.

"Very good results are often obtained with small tools thus heated in an open fire. More satisfactory results may be expected, however, if a fire-brick hood is built over the fire. This serves to prevent the radiation of heat and the circulation of air currents, and is a necessity in heating tools of any size in a common forge fire. It also makes it easier to conform to another prime essential, bringing the heat up gradually and evenly on all sides of the tool so as to penetrate uniformly throughout. This point is very important. Unless the mass to be forged is uniformly heated throughout it will work unevenly, with the result that internal strains are set up which may easily cause a failure of the tool when it is put to work, if not before. Furthermore if the heating be too rapid there is a liability that the same thing will happen; that is that internal cracks will be formed which will later ruin the tool.

"It does not follow, on the other hand, that the heating must be tediously slow. If heated too slowly the heat soaks up into the neck or shank, and when hardening takes place this important part of the tool loses part of its natural toughness, a thing to be avoided, as already pointed out. The fire should therefore be clean and well supported by good fuel. Care must be taken withal that the fire be not too keen, or it will not heat through properly. In that case the outside is likely to be white hot and the tool apparently well prepared for hammering, whereas in fact the interior may not be at all ready for working, only the outside being in proper condition. If the interior is not at least hot enough to be bright red, it is not ready for hammering. It is, of course, impossible to know the condition of the interior of a piece of heated steel except by its behavior under the hammer after removal from the fire, and it is therefore largely a matter of personal judgment based upon experience to determine the proper time during which a particular tool is to be heated. As a general guide it is safe to assume that a piece having a section not larger than one inch, if properly protected as advised above, or if heated in a good coke, oil or gas furnace, will be ready for forging when the exterior has reached a bright yellow. No hammering should be done under any circumstances when the steel is under a bright red, for fine cracks are almost sure to develop if nothing worse occurs. Quite often tools that have been forged at too low a temperature burst while being hammered or machined, and still more often while being hardened. Sometimes the damage does not appear until the tool suddenly fails in service.

"It is better to do all forging at an orange or canary yellow even than at a bright red, though different makes of high-speed steel vary more or less in this respect. The makers usually give explicit directions on this point. The temperature range, therefore, is a hundred or more degrees above 1000 degrees C. With this kind of fire, however, exact temperatures are a matter of no concern, since it is impracticable to measure them under these conditions with any degree of accuracy. Anyway, all that is necessary in the way of temperature regulation, no matter what kind of fire is used for forging, is to keep the heat above a bright red, and the eye is as good a guide as is necessary for that.

"Although it is possible, as has just been said, to obtain excellent results with a common forge fire when protected by a hood, and even without the hood if sufficient care be taken, it really does not pay to depend on such crude appliances for turning out tools which shall be uniformly satisfactory in their performances. Especially in a shop where considerable tool smithing is done, a suitably designed furnace is indispensable. A gas forge naturally is the most convenient. The temperature is very easily regulated, and the heating of the tool can be watched from beginning to end. The cost of fuel is greater than with other types of forges, though this is offset by the greater convenience and certainty of results. Oil forges are sometimes used but are not to be recommended. Where gas is not available or where it is thought to be too costly a fuel, a coke or anthracite furnace can be used to advantage, serving as well for the hardening heats as for the forging.

"The proper heat having been obtained, the forging is done in the customary manner, care being always taken that the temperature does not fall below a bright red, as has been already mentioned. It is well to shape the tool as closely to the required design as possible without over-refinement, in order to reduce the amount of grinding, and for this reason gauges for testing the form of the tool should be freely used during the progress of the work. In some cases, in forging the steel to the required shape, it is even desirable to use forms in connection with the anvil. There may be a combination gauge giving all the angles required in the tool, or, less conveniently, there may be a gauge for each. Mr. Taylor describes and illustrates a gauge consisting of a small surface plate with a hole in one corner, into which is fitted a cone, giving the angle made by the heel of the tool with the face of the plate. He also describes and illustrates a limit gauge, indicating the limits within which the nose of the tool must be forged. These limits may vary in different shops according to the opportunity for grinding. Where the facilities for automatic or semi-automatic grinding are excellent the forging may be less accurate. Hand grinding, however, is more expensive than forging, and where this is necessary the forging should be quite close to the required dimensions. A simple sheet-metal gauge is found very convenient and it is necessary to have a set of these, giving all the angles for the several tools to be made, each gauge giving all the angles for the tool for which it is intended.

"For testing the form and angles of the Taylor standard tools the limit gauge already mentioned would be used, or perhaps something more simple, such as a piece of sheet metal of suitable thickness to hold its shape permanently and having the exact shape of the top of the tool. At the end opposite the nose is the angle supplementing the angle at the heel of the tool, against which it is placed when testing, the base of the tool and of the gauge both resting on the surface plate.

"No tool should be forged, however, which can without prohibitory expense be machined from stock. This generalization practically limits forging to tools made entirely of high-speed steel for lathes, planers, shapers, and slotting machines. Even these tools, however, can in certain cases be made with the stock and supporting portions of machinery steel, while the cutters are of high-speed steel. In such cases the forging for these is eliminated, as in the case of milling cutters and other formed tools."

THE AUTOMOBILE ENGINE OF THE FUTURE.

A DISCUSSION OF THE PROBABLE PERSISTENCE OF THE PRESENT TYPE AND THE IMPORTANCE OF THE STUDY OF FUELS AND COMBUSTION PHENOMENA.

Thomas L. White—The Iron Age.

THE question of the ultimate internal-combustion motor for automobiles and its probable fuel is dealt with by Mr. Thomas L. White in an interesting review in *The Iron Age* for January 7. Mr. White believes that we are drawing to the close of a period of empirical construction and entering upon a period of systematic research, but he does not look for any radical changes in motor design. Further gains in thermal efficiency, he says, can only result from a more thorough study of the physical and chemical changes which occur in the working fluid from the moment that it enters the carburettor to the moment when it leaves the exhaust. We quote at length from his argument.

Mr. White first comments on the significance of the neglect of alcohol as an automobile fuel in Europe, although the alcohol motor has a thermal efficiency of over 30 per cent. and alcohol is cheaper on the Continent than gasoline. "The fact of the matter is that the present type of automobile motor is the outcome of a number of determining conditions of which the necessity of using gasoline was only one, and the current impression that it is the low pre-ignition temperature of gasoline and air mixtures that has prevented the use of high compressions is only partially correct. There are other reasons which are just as cogent. One of them is that the high pressure motor is not suited for lay use. In inexperienced hands the compression is apt to be lost, owing to the piston rings and valves giving out through want of attention. Another is that the high pressure motor is a violation of the accepted canon of automobile design that power must be sought in the direction of speed and not in the direction of weight. Still another objection, and, perhaps, the most important of all, is that it is difficult to the verge of impossibility to control the ignition of a high speed motor under conditions of varying load, unless the quality of the mixture can be depended on to be absolutely the same at all speeds. Where the fuel is vaporized by the ingoing air this condition is rarely attainable. The same trouble is experienced with the high compression suction producer engine. Here it is the percentage of free hydrogen in the producer gas which varies with the speed of the motor, and the opinion is held by many engineers that the presence of this hydrogen, in spite of its great fuel value, is a positive disadvantage.

"Engineering progress is not as a rule along the lines which are technically the most desirable, but along the lines which have been set by economic necessity, and as a reason, though not a technical one, for the conservation of the present type of motor must be reckoned the natural inertia of the existing order. This is inimical to revolutionary policies. From a business standpoint the introduction of a new fuel for use with the current equipment is a vastly better proposition than the introduction of a new type of motor to burn a new kind of fuel, no matter how good the latter may be. Also it must be remembered that gasoline will for many years be an alternative fuel. In fact, in some localities it will continue to be the only fuel obtainable, and as the automobile in its capacity as a long distance vehicle has no fixed base of supplies, it will be necessary for it to be able to get along on gasoline on occasion, at any rate until the coming fuel is so widely used that a supply of it can always be depended on.

"If, as seems to be the case, the long supremacy of gasoline, and other causes of a less ephemeral character, have left a permanent stamp on the design of the automobile motor, then it is to the chemist that we must look not only for aid in the fuel question, but also for information about the phenomena of combustion, to enable us to use the type of heat engine which we have to the best advantage. The time has come when physical and chemical research must supplement a too narrow devotion to the purely mechanical side of motor engineering. To quote Prof. Vivian B. Lewes in this connection, 'The engineer relies upon his indicator diagrams and tests of horsepower for information which could be much more easily obtained by analysis of the exhaust gases, and if this method of investigation were employed important advances would very soon follow. Analyses of the exhaust gases from motor engines are remarkably scarce. Indeed, I do not know of any in this country. But Mr. Sorel, in 1903, published in France some results in which he showed that with a motor running at 1061 revolutions per minute and using 382 grammes of gasoline per brake horse power hour, the products contained unburned compounds which represented 82 per cent. of the hydrogen and 42 per cent. of the carbon present in the original fuel, thus reducing the heat value of the gasoline used in the cylinder from 11,278 to 5085 calories.'"

"The analysis of the exhaust gases from the explosion motor, important though it may be, is, however, only a step.

It reveals the last stage of the complicated reactions which have occurred during the expansion stroke, but it affords little information as to the actual nature of these reactions or of the heat changes which accompany them. If carbon be slowly oxydized in the open air, as in the decay of wood, or almost instantly consumed behind the piston of an engine, the amount of heat liberated and the final product are the same. The difference is not in the process, but in the conditions under which it is conducted, and the final goal of the work of the chemical engineer is the determination of the how, why and when of those factors, which in the case of the decaying wood and of the burning fuel are so widely divergent.

"Some of the results which are coming to light in connection with the study of the energy transformations which occur in the motor are sufficiently startling. Thus it appears that carbon monoxide is absolutely inflammable in the absence of water, and, further, the velocity with which an explosion in a mixture of this gas with air is transmitted depends on the amount of aqueous vapor present. Again, there are reasons for believing that the propagation of the flame in the cylinder of a gas engine is not by direct inflammation, but by the adiabatic compression to pre-ignition point of successive layers of the mixture. It also seems that the old belief that carbon will burn to carbon dioxide in the presence of an excess of oxygen is not altogether well founded. Under certain conditions the lower oxide is just as likely to be formed as the higher.

"The fact is that the idea that during the expansion stroke of an explosion motor the carbon and hydrogen of the fuel simply burn up more or less quickly must be abandoned. What really happens is infinitely more complex. Thus every reaction which can occur in the cylinder is reversible within the temperature, pressure and concentration limits of the cycle. Moreover, it is probable that the combustion of the mixture is far from being of a uniform character throughout its mass at any given moment. There is reason for believing that different reactions may occur simultaneously at different points of the working fluid. It is possible, for instance, that water is being formed and decomposed at the same moment during the same explosion.

"As there seems to be little doubt that the fuel which will take the place of gasoline will be a blend with an alcohol base, it is becoming important to be able to trace the effect of each individual ingredient in a mixed fuel. It may be pointed out that the properties of a blend are far from being a mere statical average of the properties of its constituents, for each admixture has a functional as well as a quantitative effect on the behavior of the whole in the motor. Thus the addition of acetylene to alcohol by accelerating its combustion in the motor increases its efficiency. Lastly, it may be mentioned that the increase of the calorific value of a fuel by blending has no effect on the specific power of the motor in which it is burned. The maximum power of a given motor is independent of the calorific value of the fuel which is used in it, the popular belief to the contrary notwithstanding."

AN AUTOMATIC SYSTEM FOR FIRING OIL FUEL.

A DESCRIPTION OF A SYSTEM INVOLVING AUTOMATIC REGULATION OF FUEL, AIR AND STEAM SUPPLY.

C. R. Weymouth—American Society of Mechanical Engineers.

SOME details were given in these columns in the last number of THE ENGINEERING MAGAZINE of the results of extensive fuel-economy tests on the new oil-burning Redondo plant of the Pacific Light and Power Company, near Los Angeles, California. It was noted that for firing the six boilers of the 5,000 kilowatt unit on which the greater part of the tests were made an automatic system of regulation was employed, which controls the supply of oil to the burners, the supply of steam for atomizing purposes, and the supply of air for combustion. We abstract the following description of this system from an exhaustive paper on the subject read by Mr. C. R. Weymouth at the recent annual meeting of the American Society of Mechanical Engineers.

An automatic system of regulation is a marked departure from ordinary practice. Practically all stationary oil-fired boiler plants are subject to hand control throughout. "It is customary to maintain a uniform oil pressure at the oil pump and in the oil pressure main, and to throttle the supply of oil by hand at all of the individual burners. It is also customary to operate with full boiler steam pressure on the mains supplying steam to all the burners, and to regulate by hand the supply of steam for atomizing purposes, at each of the individual burners. Boiler dampers are also subject to hand control on the individual boilers."

With hand regulation, however, high plant efficiency is rarely attained. In a plant having twenty 500 horse-power boilers with 60 burners, working under a fluctuating railway or lighting load, there would probably be not more than two, or at most three, firemen to the shift. The rear boiler dampers would probably be clamped in fixed positions, wide open or nearly so. The supply of steam to the burners would receive little attention, but the supply of oil would be regulated for variations of load by throttling to the extent necessary for maintaining the desired steam pressure. There would be a more or less uneven rate of firing at the various boilers, and an excess of air for combustion at all loads, particularly at the lighter ones, corresponding to a nearly uniform rate of flow through the furnace. The attempt is frequently made to operate on a reduced air supply, with the result, if the dampers are set for mean or nominal load, that the chimneys will smoke excessively on overloads before the limited number of firemen can reach all the dampers to close them.

"As the lamentable result of these conditions, the average boiler plant efficiency with crude oil, even with the best types of boilers, averages much nearer 70 than 80 per cent, which is possible in large plants under proper methods of control. Probably it will always be impossible to instill into the mind of an ordinary fireman such knowledge of the principles of combustion and the losses due to excess air supply, as to obtain economical results in large stations where it is necessary to depend on hand firing. Improved conditions can be secured by the employment of a boiler room engineer whose duty it is to scrutinize all fires from time to time and to coach the firemen in their duties; but the only ideal method seems to be an automatic system of control, such as will be here described, where the various adjustments, having once been made for economical conditions, are automatically repeated for the various conditions of load, maintaining a high average economy from month to month. With well-designed oil furnaces and careful adjustment under uniform load conditions, carefully conducted tests have shown that it is possible to obtain high percentages of CO_2, indicating as low as 10 per cent excess air over the requirements for perfect combustion, with no unconsumed elements in the flue gases."

Data are given showing the relation of air supply to furnace efficiency in oil-fired boilers. The amount of air required for the complete combustion of the grade of oil used most extensively on the Pacific coast averages about 14 pounds per pound of oil. The average amount of steam required for atomizing in good performance is about 0.3 pound per pound of oil. In general an excess of about 10 per cent over the amount of air required for complete combustion gives the most economical results attainable. The waste of fuel with more excess air than 10 per cent is very great: at 50 per cent it is about 4.67 per cent, and at 100 per cent, about 10.68 per cent, of the oil actually burned. "Under the present systems of firing the amount of CO_2 present in the flue gases is often as low as 4 or 5 per cent. With an ample supply of labor and a careful and scientific adjustment of dampers by hand, the percentage of CO_2 under an ideal and uniform load can be maintained as high as 13 per cent. With automatic control and under variable load conditions it has been found possible to maintain a high percentage of CO_2 conforming very closely to ideal conditions."

The first improvement over the crude systems of hand firing was made at the plant of the Pacific Railway Company at Los Angeles. A plan was developed for firing 18 boilers, averaging three burners per boiler, with central hand control of oil pressure. "The operator was stationed near the oil pumps, which were run at a practically constant speed. In front of the operator were the oil pressure gauge connecting to oil main and the steam pressure gauge connecting to steam main. The operator's duty was to maintain a uniform steam pressure on the boilers by opening or closing a bleeder valve on the oil pump discharge line, thus increasing or decreasing the pressure in the oil main, and simultaneously the rate of firing of all of the boilers. The operating crew of the boiler room for each shift consisted of one operator controlling the oil pressure and one water tender, which is probably the record to date for the minimum of boiler room labor for any plant of this size. It was a simple matter to substitute automatic regulation for hand control, following which the writer conceived the idea of utilizing this variation in oil pressure as a secondary means for controlling the supply of steam to burners and the air supply for combustion."

The system is known as the Moore-Patent automatic fuel oil regulating system. It controls the supply of oil to all burners, the supply of steam to all burners and the supply of air for combustion, for any number of boilers, all from a central point. All individual burner valves, both steam and oil, are opened wide or nearly so, and all burners are operated under full pressure in the respective mains. In the larger plants all dampers are connected to a common rock shaft and move simultaneously.

"A slight variation in the steam pressure on the boilers, due to any variation in the demand for steam, is the primary means of control for a steam regulator or governor which varies the oil pressure at the oil pumps and in the oil main. Corresponding to an increased pressure in the oil main, there is an increase in the amount of oil fired and a rise in boiler steam pressure; and corresponding to a decrease of pressure in the oil main, there is a decrease in the rate of oil fired and a lowering of the boiler steam pressure; this regulator thus maintains a uniform steam pressure on boilers at all loads within the governing limits. The variation in pressure in the oil main is the secondary means for controlling the supply of steam for atomizing purposes and also for controlling the supply of air for combustion.

"The supply of steam to burners is controlled by regulating the pressure in a separate low-pressure main common to all burners, the pressure in this main bearing a certain predetermined relationship to the pressure in the oil main and being controlled by a ratio regulator. By means of a specially constructed diaphragm regulator, the opening of the boiler dampers is made to increase or decrease with a corresponding variation of pressure in the oil main, the change in damper opening in turn governing the supply of air for combustion."

Any reliable pump governor may be used to control the oil pressure in the oil main so as to maintain a uniform steam pressure, and it may be used to operate either a throttle in the steam supply or a bleeder valve in the oil discharge pipe. The Spencer damper regulator gives very satisfactory results when the movement of the power lever is used to control a bleeder valve. Regulation of the oil pressure by control of a bleeder valve is more satisfactory than by throttling the steam supply, on account of the liability of the oil pressure to surging due to alternate speeding up and slowing down of the pump in the latter system. The same difficulty exists in a measure in the bleeder-valve system if it is attempted to connect the regulator so as to control the boiler plant automatically through the entire range of load. At the Redondo plant it has been found most economical to limit the automatic regulation to about one-fourth to one-third of the range of the total variation required, regulation above and below the limits of automatic control being obtained by hand adjustment of the throttle of the oil pump. Except when passing over peak loads it is unnecessary to adjust the throttle more than once every two or three hours, the position of the regulator yard arm indicating when such adjustment is necessary.

Before the development of the regulator for the steam supply, tests were made to determine the relation between the steam required for atomizing oil and the amount of oil burned. It was found that for a variety of burners this relationship could be represented by a straight line, the required steam pressure being equivalent to the product of the oil pressure by a constant, plus a fixed pressure difference. It was, therefore, an easy matter to design a regulator of which the essentials were opposing steam and oil diaphragms of areas or leverages conforming to the observed ratio, and a weight element equivalent to the required difference in pressure. "In the latest development of this regulator the upward pressure is exerted on two diaphragms, one subject to the oil pressure in the oil main, the other to the steam pressure in the low pressure steam main connected to the burners.

"The fulcrum is adjustable for any desired ratio of leverages. The yard arm is counterbalanced at one side, and weighted at the other for the desired weight constant due to the pressure difference factor. Whenever equilibrium is disturbed by variation in oil pressure, the main yard arm will be compelled to move either up or down. This motion is communicated to a water cylinder or motor, such as used on the well known Spencer damper regulator. The movement of the water cylinder in turn operates a suitable lever and connecting rod and finally a rotary chronometer valve, which increases or decreases the supply of steam to the low pressure steam main in such a manner as to restore equilibrium, thereby providing the desired increase or decrease in the steam supply to the atomizers corresponding to the initial change in oil pressure."

Tests were also made previous to the design of the damper controller and it was found that the relationship between variations in the amount of damper opening and variations in the pressure of oil on the burner orifice could be represented approximately by a straight line. The regulator finally developed gives an oil supply at all loads but slightly in excess of theoretical requirements. "In this regulator a large diaphragm is subject to upward pressure corresponding to that in the oil main. The motion of the lever is opposed by a coil spring adjustable in position along the lever so as to obtain the required range of motion of the dampers corresponding to the given range of oil pressure. By means of a double-ported controlling valve, connected to the damper controller, the supply of water under pressure is admitted either to the top or the bottom of a hydraulic cylinder connected to the rock shaft. The control is on the principle of the well known differential lever, such as is used in a steering gear, and also common to many types of damper regulators.

"After being once properly adjusted for its entire range of motion, this regulator gives entire satisfaction. It is subject to variation from certain external influences, such as the temperature of the boiler furnace on approaching or receding from peak loads or in starting fires, and variations in the temperature and density of oil. Immediate adjustment and correction for these difficulties can be made by a slight turning of a handwheel on the coil spring, giving a constant change in the amount of opening or closing of all dampers. In actual experience, no adjustment of the damper controller has been necessary except at intervals of three or four hours, depending on the nature of the load carried, the frequency of peaks, etc."

The whole system has proved reliable in service and has resulted in a considerably higher economy than could be obtained with hand control. It is believed that a modification of the system would yield readily to the requirements of boiler plants using natural gas as fuel.

SULPHURIC ACID AS A BY-PRODUCT IN COPPER SMELTING.

THE UTILIZATION OF SULPHUR DIOXIDE FUMES BY THE TENNESSEE COPPER COMPANY.

John Sharshall Grasty—Manufacturers' Record.

THE destruction of vegetation by sulphur dioxide fumes in the neighborhood of copper smelting plants has led within recent years to a number of important legal actions to compel smelting companies to devise means of preventing the escape of noxious furnace gases into the atmosphere. A decision of the Supreme Court against the Tennessee Copper Company and the Ducktown Copper, Sulphur and Iron Company has resulted in the development by these two concerns of a process for the production of sulphuric acid from waste gases which in the case of the former company has given complete success and in connection with which a large fertilizer industry is to be established by a subsidiary of the smelting company. The following details of the production of sulphuric acid and the plans for the new fertilizer industry are taken from an article by Dr. John Sharshall Grasty in the *Manufacturers' Record* for January 7.

Construction work on the plant of the Tennessee Copper Company was begun in 1906. It was put in service about December 1, 1907, and has been in practically continuous operation ever since. The plant of the Ducktown Copper Company is now under construction and will be completed during the spring of the present year. The capacity of the latter plant will be about 320 tons per day. The present capacity of the Tennessee Copper Company's plant is 500 tons per day but this is to be doubled in the near future.

The Ducktown Copper Company experimented for some time with the contact method of manufacture of sulphuric acid but found it unsatisfactory. The lead-chamber process has been adopted for the plant now under construction. This is the process used by the Tennessee Copper Company. In its essential features the plant for the utilization of furnace gases is similar to the ordinary plants of the lead-chamber type, the main difference being the source of gas supply, which in this case is drawn from the concrete flue back of the blast furnaces. Although sulphur dioxide is the predominating gas in the flue gases, sulphur trioxide, carbon dioxide, oxygen and nitrogen are present in sufficient quantities to necessitate the provision of special methods of control for the supply of a suitable gas. The present Tennessee Company plant consists of two Glover towers, 12 chambers and four Gay-Lussac towers. The most serious difficulty met with in operation has been the failure of the original blast-furnace taps, due to the excessive heat to which they were subjected under the method of operation best suited to the acid plant. Changes in the furnaces which are expected entirely to remove this difficulty are now being made.

For the consumption of the sulphuric acid, interests connected with the Tennessee Copper Company have organized a subsidiary concern, known as the Independent Fertilizer Company, for the manufacture of artificial fertilizers. This company has acquired, it is said, a large number of the phosphate deposits from Maryland to Florida and has also come into possession of some of the larger deposits of Germany. It is rumored that Herman Schmidtmann, the phosphate king of Germany, is to be president of the new company. The sulphuric acid will be shipped from the smelter of the Tennessee Copper Company to various points in the south for the manufacture of acid phosphates. It is probable that the Ducktown Copper Company will follow the example of the Tennessee Company and organize a similar fertilizer company as soon as its acid plant is put in operation. The industry promises to be extremely profitable, and with an output of 1320 tons of acid per day the district should soon become one of the most important centres for the production of sulphuric acid and acid fertilizers in the world.

THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE"

The following pages form a descriptive index to the important articles of permanent value published currently in about two-hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end. where also the full titles of the principal journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

CIVIL ENGINEERING

BRIDGES.

Bascule.

A Heavy Strauss Bascule Bridge. Illustrated description of the double-track, single-leaf bascule over the Chicago River for the C. & N. W. Ry. 600 w. Ir Age—Dec. 17, 1908. No. 1035.

The Weights and Costs of Eight Lift Bridges. Data for a guide in making estimates. 1000 w. Engng-Con—Dec. 2, 1908. No. 803.

Blackwell's Island.

The Blackwell's Island Bridge Blunder. Editorial criticism. 2500 w. Engng-Con—Nov. 25, 1908. No. 711.

The Safety of the Blackwell's Island Bridge. Editorial discussion of the reports on the condition of this structure. 2000 w. Engng—Nov. 27, 1908. No. 867 A.

Drawbridges.

The Temporary Bridge Across the Cornwall Canal and the Permanent Repairs to the Canal Break. Describes a temporary drawbridge at Cornwall, Ont., having many interesting features, and also the permanent work on the canal. Ills. 2000 w. Eng News—Dec. 17, 1908. No. 982.

Floors.

Railway Bridge Floors—Old and New.

We supply copies of these articles. See page 904.

Conrad Gribble. An illustrated account of progress in the development of the floor systems of bridges. 5800 w. Cassier's Mag—Dec., 1908. No. 952 B.

Foundations.

Methods and Costs of Testing for Bridge Foundations. F. H. Bainbridge. General considerations, discussing the value of borings. Ills. 2000 w. Engng-Con—Nov. 25, 1908. No. 712.

Junction Curves.

A Note on Some Junction Curves (Note sur diverses Courbes de Raccordement). M. Auric. Shows the solution of several problems which arose during the construction of a bridge over the Rhone. Ills. 3000 w. Ann des Ponts et Chauss—1908 IV. No. 1309 E + F.

Manhattan.

See Suspension Cables, under BRIDGES.

Reinforced Concrete.

Lynhurst Bridge. A. Gillies. Illustrated description of a reinforced concrete span of 116 feet, built in St. Thomas, Canada. 1200 w. Can Engr—Dec. 4, 1908. No. 842.

The Gmünder Bridge, Switzerland (Die Gmünder Tobel-Brücke bei Teufen, Schweiz). A Sutter. Illustrated description of design and construction of this reinforced concrete arch of 79 metres span. Serial. 1st part. 1200 w. Deutsche Bau —Nov. 7, 1908. No. 1156 B.

See also Steel, under BRIDGES.

Steel.

The Protection of Steel Bridges (Sulla Conservazione die Ponti in Ferro). Discusses the problems of corrosion and protective coatings. Serial. 1st part. 3000 w. Ing Ferro—Nov. 1, 1908. No. 1138 D.

The Pitch of Rivets in Built-Up Girders (Ueber Nietteilung in Blechträgern). G. Kapsch. A mathematical discussion. Ills. 3000 w. Oest Wochenschr f d Oeff Baudienst—Nov. 7, 1908. No. 1181 D.

The City's Giant Bridges. Illustrated descriptions of the four large bridges crossing the East River at New York. 3500 w. Sci Am—Dec. 5, 1908. No. 813.

Steel Arch Bridge at Scranton, Pa. Illustrated description of a three-span bridge with reinforced concrete superstructure, massive steel pier columns filled with concrete and two lines of riveted deck trusses supporting a reinforced concrete floor. 2000 w. Eng Rec—Dec. 12, 1908. No. 959.

The McKeesport & Port Vue Bridge. Illustrated detailed description of this highway bridge across the Youghiogheny River. It has a steel superstructure and concrete floor. 1200 w. Eng Rec—Nov. 28, 1908. No. 692.

The Mercantile Bridge across the Monongahela River. Illustrated detailed description of a bridge 1857½ ft. long between abutments and a clear height of 54 ft. 1500 w. Eng Rec—Dec. 19, 1908. No. 1054.

Reconstruction of the Caledonian Railway Bridge, Stirling. Illustrated detailed description of recently completed work on a bridge over the River Forth. 1800 w. Engng—Dec. 4, 1908. Serial. 1st part. No. 1017 A.

Some Railway Bridges on the West Coast of Tasmania. James Bannatyne Lewis. Illustrates and describes the erection of bridges with limited resources. 3000 w. Inst of Civ Engrs—No. 3710. No. 888 N.

See also Bascule, Drawbridges and Junction Curves, under BRIDGES.

Suspension Cables.

Construction of the Manhattan Bridge Cables. Illustrates and describes methods used. 4000 w. Eng Rec—Dec. 5, 1908. No. 830.

CONSTRUCTION.

Boring.

Methods and Costs of Making Wash Borings on a Ship Canal Survey. A. W. Saunders. Illustrates the drills used and gives a report of the difficulties encountered. 1000 w. Engng Con—Dec. 9, 1908. No. 923.

See also Foundations, under BRIDGES.

Concrete.

The Relation of Temperature to the Removal of Concrete Forms. Editorial on the need of tests to establish some scientific basis for form removal. 900 w. Eng News—Dec. 3, 1908. No. 774.

Uses of Concrete on a Country Estate. Linn White. An illustrated article showing its architectural possibilities. 4000 w. Sci Am Sup—Dec. 26, 1908. No. 1296.

See also Regulations, under CONSTRUCTION.

Contractor's Plants.

The Contractor's Plant for Building a Triple Barrel Reinforced Concrete Sewer. Illustrates and describes the plant for building a reinforced concrete sewer on pile foundations, mostly over a marsh, in the Bronx, New York City. 2800 w. Eng. Rec—Nov. 28, 1908. No. 700.

Excavation.

Handling the Excavation and Concrete Materials for a Large Steel-Cage Building. Illustrates and describes methods used in the most congested district of Chicago. 2800 w. Eng Rec—Nov. 28, 1908. No. 693.

See also Rock Removal, under WATERWAYS AND HARBORS.

Fireproof.

Fire Tests of Concrete and Terra Cotta Tile. A comparison of the fireproof properties of the two materials as disclosed by recent fires. Ills. 3300 w. Cement Age—Dec. 1908. No. 1318.

Status of Reinforced Concrete from the Fireproof Standpoint. Emile G. Perrot. On the behavior, economy and efficiency of concrete, its proper construction, etc. Ills. 1800 w. Cement Age. Dec., 1908. No. 1319.

Floors.

Concrete Floor Construction. Illustrated description of a modern method of treating concrete as lumber—the Vaughan System of portable concrete joists. 1500 w. Cement Age—Dec., 1908. No. 1320.

Suspended Reinforced-Concrete Floors in the Grand Hôtel Royal, Lausanne (Planchers suspendus en Béton armé au Grand Hôtel Royal, a Lausanne). A. Paris. Illustrated description of their design and construction. 1400 w. Bul Tech d l Suisse Romande—Nov. 10, 1908. No. 1117 D.

Foundations.

Foundations for the New Singer Building, New York City. Discussion of the paper by T. Kennard Thomson. Ills. 2000 w. Pro Am Soc of Civ Engrs—Dec., 1908. No. 1356 E.

See also Excavation, under CONSTRUCTION.

Graphical Statics.

The Deflection Polygon of a Framed Structure as a Funicular Polygon. Myron S. Falk. Mathematical. 800 w. Sch of Mines Qr—Nov., 1908. No. 973 D.

High Buildings.

Tall Buildings of New York. Illustrations and information concerning some of the lofty office buildings recently erected. 2500 w. Sci Am—Dec. 5, 1908. No. 814.

Piling.

Shop-Made Reinforced-Concrete Piles. L. J. Mensch. Illustrates and describes work carried out at Oakland, Cal. 1200 w. Eng News—Dec. 3, 1908. No. 775.

Regulations.

General Regulations for the Preparation, Execution and Testing of Rammed Concrete Construction (Allgemeine Bestimmungen für die Vorbereitung, Ausführung und Prufung von Bauten aus Stampfbeton). An abstract and a discussion of the regulations adopted by the German Reinforced Concrete Commission. 4000 w. Beton u Eisen—Nov. 20, 1908. No. 1177 F.

Reinforced Concrete.

The Principles and Resources of Reinforced Concrete Construction (Le Béton armé actuel, ses Principes et ses Ressources). Charles Rabut. A general review. 3000 w. Ann d Ponts et Chauss—1908-IV. No. 1313 E + F.

The Employment of Reinforced Concrete Beams according to the Regulations of the Italian Government (Il Calcolo delle Travi inflesse in Cemento armato secondo le Normi Ministeriali Italiane). Mathematical. Ills. Serial. 1st part. 4000 w. Il Cemento—Oct., 1908. No. 1137 D.

Bending Moments in Continuous Reinforced Concrete Beam. A discussion by O. Gottschaer, in *Beton u. Eisen*, of the bending moments in a continuous beam over 3 supports, especially at the mid support. 1000 w. Cement—Nov., 1908 No. 899 C.

The Manufacture, Erection and Demolition of Forms for Concrete Work. Francis W. Wilson. A criticism of method generally used for the manufacture and erection of form work with discussion of an improved system. 3000 w. Eng News —Dec. 17, 1908. No. 980.

A Novel System of Concrete Construction. Day Allen Willey. Illustrated description of methods of construction at Camp Perry, Ohio. 1400 w. Sci Am—Dec 26, 1908. No. 1293.

The Employment of Reinforced Concrete in Public Works (L'Emploi du Béton Armé dans les Travaux publics). M. G. Espitallier. Reviews its many uses, in the construction of dams, breakwaters, foundations, piles, etc. Ills. 11000 w. Mem Soc Ing Civ de France—Oct., 1908 No. 1305 G.

See also Contractors Plants, Fireproof, Floors, and Piling, under CONSTRUCTION; Sewage Tanks and Sewers, under MUNICIPAL; Dams, Pipes and Water Towers, under WATER SUPPLY; Refrigeration, under MECHANICAL ENGINEERING, HEATING AND COOLING; and Flat Plates, under MECHANICAL ENGINEERING, MACHINE ELEMENTS AND DESIGN.

Retaining Walls.

A Large Retaining Wall at Tacoma, Louis P. Zimmerman. Brief illustrated description of one of the largest concrete retaining walls on the Pacific Coast. 1000 w. Eng Rec—Nov. 28, 1908. No. 697.

Stacks.

The Chimney of the Boston & Montana Consolidated Copper & Silver Mining Company. Illustrated detailed description of the largest and highest chimney in the world, and its construction. 5500 w. Eng Rec—Nov. 28, 1908. No. 691.

Steel.

Special Structural Steel Work in the La Salle Hotel, Chicago. Illustrates and describes special features in steel framing. 2200 w. Eng News—Dec. 3, 1908. No. 773.

Structural Details in the New Theatre, New York. Illustrated detailed description of floor girders, roof trusses, and other details. 2800 w. Eng Rec—Dec. 26, 1908. No. 1246.

Structural Details of the Carnegie Technical School, Pittsburgh. Illustrates and describes details of steel cage construction. 1600 w. Eng Rec—Dec. 5, 1908. No. 833.

Raising and Strengthening the Oversea Platforms of a Coaling Station at St. Vincent. Walter Sidney Harvey. Describes the construction of this coaling station on the Cape Verde Islands, and recent repairs. Ills. 2500 w. Inst of Civ Engrs—No. 3731. No. 886 N.

See also Water Towers, under WATER SUPPLY; and Docks, under WATERWAYS AND HARBORS.

Swimming Pools.

The Swimming Pool for the University of Minnesota. F. H. Constant. Illustrated description of a pool costing about $7,000, under construction. 2000 w. Minn Engr—Nov., 1908. No. 1359 C.

Tunnels.

Tunnels and Subways. Illustrations and information in regard to these interesting engineering works in New York City and some of the difficulties met. 3000 w. Sci Am—Dec. 5, 1908. No. 815.

Records of Driving Rock Tunnels and Some Comment on the High Cost of the Elizabeth Tunnel. Information relating to work on the tunnel that is to carry the waters of the Los Angeles aqueduct through the Coast Range. 1200 w. Engng Con—Dec. 9, 1908. No. 922.

The Reconstruction of a Portion of the Cwm Cerwyn Tunnel. Illustrates and describes method of reconstructing 180 ft. of a tunnel on the Port Talbot Railway, in South Wales, without interference of traffic. 2000 w. Engr, Lond—Dec. 4, 1908. No. 1022 A.

Waterproofing.

See Refrigeration, under MECHANICAL ENGINEERING, HEATING AND COOLING.

MATERIALS OF CONSTRUCTION.

Cement.

The Association of German Portland Cement Manufacturers; Summary of Proceedings for 1908. New German Cement Specifications. Robert W. Lesley and E. W. Lazell. Portion of a paper read before the Assn. of Am. Portland Cement Mfrs. 2000 w. Eng News—Dec. 24, 1908. No. 1239.

See also same title, under MINING AND METALLURGY, MINOR MINERALS.

Concrete.

Tests on the Effect of Electric Current on Concrete. U. James Nichols. Abstract of a paper presented for a degree at the Mass. Inst. of Tech. A report of the experimental work. Also editorial. 4500 w. Eng News—Dec. 24, 1908. No. 1237.

See also Concrete, under CONSTRUCTION; and Reinforced Concrete, under MATERIALS OF CONSTRUCTION.

Paints.

Rust Proof Coating for Steel. William Elsberg. Brief account of the process invented by George A. Goodson. Ills. 1200 w. Minn Engr—Nov., 1908. No. 1360 C.

Reinforced Concrete.

The Composition and Uses of Plain and Reinforced Concrete. Charles F. Marsh. Read before the Concrete Inst. Briefly discusses the mixing, aggregates, waterproofing, nature of reinforcement, etc. 2000 w. Surveyor—Nov. 20, 1908. No. 728 A.

Steel.

Nickel Steel for Bridges. Discussion of paper by J. A. L. Waddell. 6000 w. Pro. Am Soc of Civ Engrs—Dec., 1908. No 1357 E.

Steel Corrosion.

See Steel, under BRIDGES.

Terra Cotta.

See Fireproof, under CONSTRUCTION.

Timber.

An Analysis of Canada's Timber Wealth. Abstract of a study by B. E. Fernow. Information concerning the timber areas and their value. 5500 w. Can Engr—Dec. 4, 1908. No. 843.

Timber Preservation.

Preservation of Timber. F. H. Mason. General remarks, with details of the creosoting plant at Norfolk, Virginia. 4500 w. Min & Sci Pr—Dec. 19, 1908. No. 1260.

MEASUREMENT.

Surveying.

A New Precise Measurement Method with Special Line Clinometers and Tape Stretchers. Describes a method of measurement and novel instruments used. 1500 w. Eng News—Dec. 24, 1908. No. 1240.

The Rectangular System of Surveying. W. A. Truesdale. Information in regard to the development of this system. 9000 w. Jour Assn of Engng Socs—Nov., 1908. No. 1342 C.

Staking Out Curves in Rough Ground. Robert Laird. Read before the Ontario Land Surveyors' Convention. Explains method used. 2000 w. Engng-Con—Nov. 25, 1908. No. 713.

Telemeter.

A Telemeter with Micrometer Screw Adjustment. Fred Eugene Wright. Describes a simple, fairly accurate instrument. 1200 w. Am Jour of Sci—Dec., 1908. No. 777 D.

Testing Laboratories.

See same title, under MECHANICAL ENGINEERING, MEASUREMENT.

MUNICIPAL.

Drainage.

Hydraulic Diagrams. D. D. Bleich. Presents data and diagrams to facilitate computations of run-off and pipe flow. 2500 w. Sch of Mines Qr—Nov., 1908. No. 974 D.

Municipal Engineers.

The Municipal Engineer: His Duties and Responsibilities. F. J. Edge. Presidential address before the Newcastle-on-Tyne Assn. of Students of the Inst. of Civil Engrs. 3500 w. Surveyor—Nov. 20, 1908. No. 729 A.

Pavements.

Roads and Streets. Louis C. Kelsey. Reviews briefly the various pavements used, their construction and maintenance. 2500 w. Jour Assn of Engng Socs—Oct., 1908. No. 782 C.

Old and New Methods of Asphalt Paving. Guy B. Grant. A comparison of work done in Omaha, Neb., in 1882, with present-day methods. 2000 w. Munic Engng—Dec., 1908. No. 785 C.

The Value of Carbene Requirement in Asphalt Specifications. L. Kirschbaum. An investigation made to determine the value of the carbene test. 2000 w. Munic Engng—Dec., 1908. No. 784 C.

The Mineral Rubber Pavement. Linn White. Read before the Am. Soc. of Munic. Imp. Describes this form of pavement and states the advantages claimed for it. 2000 w. Munic Engng—Dec., 1908. No. 787 C.

The Blome Concrete Pavement. Harry S. Dewey. Read before the Am. Soc. of Munic. Imp. Describes this system of granitoid concrete blocked pavement. 2200 w. Munic Engng—Dec., 1908. No. 786 G.

Roads.

Effect of the Road Surface on Vehicles. C. S. Rolls. Read before the Int. Road Cong. Discusses improvements that would increase the life of the vehicle and the comfort of passengers. 1200 w. Surveyor—Dec. 4, 1908. No. 1012 A.

Improvements in Self-Propelled Vehicles for the Reduction of Road Wear. Col. R. E. Crompton. Read before the Int. Road Cong. Discusses some points in regard to their effect on roads, such as steel studded tires, diameter of driving wheels, etc. 1200 w. Surveyor—Nov. 20, 1908. No. 727 A.

Roads for Heavy Traffic. H. P. Maybury. Read before the Int. Road Cong. An account of work in the County of Kent, England. 1200 w. Eng Rec—Nov. 28, 1908. No. 699.

Examination of Tars for Use on Roads. Clayton Beadle and Henry P. Stevens. An experimental study with a view to determining the advantages of the different grades. 3000 w. Surveyor—Dec. 4, 1908. No. 1014 A.

Macadam Road Surfacing. Walter Wilson Crosby. Read before the Paris Int. Road Cong. Discusses the proper construction of macadam roads to meet present conditions. 2500 w. Surveyor—Nov. 27, 1908. No. 850 A.

General Figures in the Cost of Road Construction in Various Parts of the United States. Information from a report submitted by Maurice O. Eldridge to the Int. Road Congress at Paris, France. 2500 w. Engng Con—Dec. 23, 1908. No. 1290.

Road Construction and Maintenance in Gloucester County, England. Robert Phillips. Presented at the Int. Road Cong. Gives results of the experience of the writer. 3500 w. Engng-Con—Dec. 16, 1908. No. 1076.

Road Maintenance in France and Ireland. R. H. Dorman. Read before the Int. Road Cong. A comparison of roads and methods in the two countries, and suggests alterations that should be made in Irish laws relating to road maintenance. 1800 w. Surveyor—Dec. 4, 1908. No. 1011 A.

Systems of Highway Administration Compared: Their Influence on Cost and Efficiency. W. Rees Jeffreys. A comparative examination of the highway systems in the principal countries. 3000 w. Surveyor—Dec. 11, 1908. Serial. 1st part. No. 1202 A.

Sewage Disposal.

The Administrative Aspects of Sewage Disposal. Herbert T. Scoble. Paper read before the Surveyors' Inst. 7000 w. Surveyor—Nov. 27, 1908. No. 851 A.

The Hampton Doctrine in Relation to Sewage Purification. Dr. A. Lübbert. Trans. from the German. Discusses a paper by W. Owen Travis, showing that the Hampton doctrine cannot exist along with Dunbar's absorption theory. 3000 w. Surveyor—Dec. 4, 1908. Serial. 1st part. No. 1013 A.

The Hampton Doctrine in Relation to Sewage Purification. W. Owen Travis. Reply to the criticisms of Dr. A. Lübbert. 3500 w. Surveyor—Dec. 18, 1908. Serial, 1st part. No. 1385 A.

Some Observations of Methods, Cost and Results of Sewage Purification Abroad. H. W. Clark. Discusses the kind of sewage plants that are being built and operated in England and elsewhere, and matters relating to them. General discussion. Ills. 14000 w. Jour Assn of Engng Socs—Nov., 1908. No. 1343 C.

On Percolation Beds. William Clifford. An account of experiments relating to the physical conditions obtaining in sewage filter-beds, with special reference to percolation beds. 4500 w. Inst of Civ Engrs—No. 3751. No. 883 N.

Experimental Treatment of Effluents of Sprinkling Sewage Filters. Notes from the annual report of the Massachusetts Board of Health on the results of experiments made at the Lawrence Experiment Station. 1700 w. Eng Rec—Nov. 28, 1908. No. 696.

The Lawrence Experiments Regarding the Distribution of Sewage over Sprinkling Filters. From the report of H. W. Clark describing the researches of the Massachusetts Board of Health. 6000 w. Eng Rec—Dec. 26, 1908. No. 1247.

An Unhampered Cesspool—A True Short Story of Domestic Sanitation. Robert Fletcher. Describes the conditions and discusses the principles for a small disposal plant. 2200 w. Eng News—Dec. 17, 1908. No. 986.

The Application of Small-Scale Biological Purification (Le Applicazioni della Depurazione biologia agli Edifici isolati). Illustrates and describes various systems of sewage treatment for isolated houses. 4200 w. Monit Tech—Nov. 20, 1908. No. 1136 D.

A Scientific Scheme for Sewage Disposal by Dilution in New York Harbor. Editorial discussion of the plan of the Passaic Valley Sewerage District, and the discharge of sewage into New York harbor. 2000 w. Eng News—Dec. 17, 1908. No. 984.

Sewage Pumping.

See Pumping Plants, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

Sewage Tanks.

A Concrete Sewage Tank Reinforced Against External Pressure. Explains conditions and gives an illustrated description of the storage tank. 1500 w. Eng Rec—Dec. 19, 1908. No. 1056.

Sewers.

Sewer Construction in Chicago. Illustrated description of the concrete sewer work of the Ninety-fifth Street system. 3000 w. Munic Jour & Engr—Dec. 2, 1908. No. 748 A.

Some Details of the Design and Construction of the Baltimore Sewerage System. Illustrates and describes the outfall sewer, siphon culvert, weir in force main sewer and other details. 3000 w. Eng Rec—Dec. 19, 1908. No. 1059.

The New Sewerage System of Baltimore, Md. Explains the problems and describes the system. Ills. 3500 w. Eng Rec—Dec. 5, 1908. No. 834.

Street Cleaning.

The Automobile in Street Cleaning (Der automobile Antrieb für Zwecke Strassenreinigung). D. Nier. Gives comparative cost of street sprinkling with horse-drawn and self-propelled sprinklers. 2500 w. Gesundheits-Ing—Nov. 7, 1908. No. 1170 D.

WATER SUPPLY.

Analysis.

The Determination of Carbonic Acid in Water (Beitrag zur Bestimmung der Kohlensäure im Wasser). Dr. F. Guth. A discussion of the various methods. 6000 w. Gesundheits-Ing—Nov. 21, 1908. No. 1172D.

Croton.

Development of the Croton Watershed. An illustrated review of the system of reservoirs developed in the valley of the Croton River for the supply of New York City. 3000 w. Sci Am—Dec. 5, 1908. No. 812.

Dams.

Experimental Investigations of the Stresses in Masonry Dams Subjected to Water Pressure. Paper 3674, by Sir John Walter Ottley and Arthur William Brightmore; Paper 3705, by John Sigismund Wilson and William Gore; Paper 3583, by Ernest Prescot Hill, discussed together. Also correspondence. Plates. 50000 w. Inst of Civ Engrs—No. 889 N.

A Successful Low Timber Dam for Broad, Sandy River Channels. O. K. Parker. Illustrations, with description of methods of construction. 1200 w. Eng Rec—Dec. 5, 1908. No. 832.

Economical application of Water Power in Tasmania. James B. Lewis. Gives the cost and method of construction of dams. 2000 w. Aust Min Stand—Nov. 18, 1908. No. 1093 B.

A Report on the Foundations and Construction of the Gatun Dam. From the recent report of C. M. Saville giving results of the investigations. 1200 w. Eng News—Dec. 24, 1908. No. 1241.

Experimental Hydraulic-Dredge-Fill Dams at Gatun, made for the Isthmian Canal Commission. C. M. Saville. From Appendix E, Report of the Isthmian Canal Commission. Illustrated description. 6500 w. Eng News—Dec. 24, 1908. No. 1242.

Reconstruction of the Roanne Water-Supply Dam (Reconstruction du Barrage de Prise d'Eau en Loire à Roanne). M. Mazoyer. Describes reinforced-concrete caisson construction. Ills. 6500 w. Ann d Ponts et Chauss—1908-IV. No. 1310 E + F.

Fish Ways in Dams (Fischwege in Stauanlagen). Dr. H. Löschner. A practical discussion of their arrangement. Ills. 3300 w. Oest Wochenschr f d Oeff Baudienst—Nov. 14, 1908. No. 1182 D.

The Caméré System of Fish Ways installed in the Dams of the Rivers l'Hyères and l'Aulne (Note sur les Echelles à Poissons du Système Caméré établies aux Barrages verticaux des Rivières l'Hyères et l'Aulne). M. le Guillier. Illustrated description. Plate. 3000 w. Ann d Ponts et Chauss—1908-IV. No. 1312 E + F.

Discharge Coefficients.

On Coefficients of Discharge Through Sluice-Gates and over Weirs. H. F. Labelle. Gives results of experimental investigations, especially those of Prof. Chatterton, on the Kistna River, India. 2500 w. Eng Rec—Dec. 26, 1908. No. 1249.

Dover, England.
The Dover Watershed and Water Supply. Henry Edward Stilgoe. Describes the physical features of this watershed with a view to ascertain where the largest supplies may be obtained. Plates. 5000 w. Inst of Civ Engrs—No. 3730. No. 884 N.

Fish Ways.
See Dams, under WATER SUPPLY.

Irrigation.
See Meters, under WATER SUPPLY.

Meters.
Automatic Devices for Measuring Water used for Irrigation. F. W. Hanna. A summary of the methods most generally in use and discussion of some of the best American devices invented for this purpose. 3000 w. Eng News—Dec. 17, 1908. No. 981.

Newton, Mass.
Newton's Water Supply System. A. W. King. Illustrates and describes a supply in Massachusetts of underground water obtained through pipe wells. 200 w. Munic Jour & Engr—Dec. 23, 1908. No. 1069.

Pennsylvania.
The Quality of Some Pennsylvania Waters. R. B. Dole. Read before the Eastern Ice Assn. Presents results of recent investigations into the mineral composition of the large rivers. 2500 w. Ice & Refrig—Dec., 1908. No. 996 C.

Pipe Flow.
See Drainage, under MUNICIPAL.

Pipes.
Reinforced Concrete Pipe with Reinforced Joint. Illustrated description of a reinforcement utilized also for making the joint between lengths. 700 w. Eng News—Dec. 10, 1908. No. 941.

Purification.
The Purification of Ground Waters Containing Iron and Manganese. Robert Spurr Weston. Considers the theory and practice of the iron-removal process in use in Europe and America. 18500 w. Pro Am Soc of Civ Engrs—Dec., 1908. No. 1353 E.

The Purification of Bubbly Creek, Chicago Stock Yards. A summary of the report by George A. Johnson of tests made of the filter plant for purifying the water. Ills. 4500 w. Eng Rec—Dec. 12, 1908. Serial. 1st part. No. 955.

The Results of an Examination of the Water Purification Plant at Marietta, Ohio. Philip Burgess gives a description of the plant and its operation, with report of its examination and the recommendations. 4000 w. Eng Rec—Dec. 19, 1908. No. 1058.

Notes Concerning the Water Purification Plant now under Construction for the City of Toledo, Ohio. William G. Clark. Describes the filtration plant. 3000 w. Ohio Soc of Mech Elec & Steam Engrs, No. 142—Nov., 1908. No. 905 N.

The Water Purification Plant at Toledo. William G. Clark. Read before the Ohio Soc. of Mech., Elec. & Steam Engrs. Describes methods used to purify the river water. 3000 w. Eng Rec—Nov. 28, 1908. No. 695.

An Ozone Purification Plant at Chartres (Usine de Clarification et d'Ozonation des Eaux de la Ville de Chartres). Augustin Witzig. Illustrated description of a plant serving a city of 23,000 inhabitants. 1000 w. Génie Civil—Nov. 28, 1908. No. 1126 D.

Rates.
See Water Works, under WATER SUPPLY.

Reservoirs.
The Construction of the Croton Falls Reservoir. Describes new features and methods developed in the course of recent work on this great reservoir for the supply of New York City. 4500 w. Eng Rec—Dec. 12, 1908. No. 961.

See also Croton, under WATER SUPPLY.

Softening.
See Locomotive Feed Water, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Springfield, Mass.
The Construction of the Little River Water Supply for Springfield, Mass. Illustrated description of important features of work now in progress, including intake dam and tunnel, filter plant and settling basin; reservoirs, pipe lines, etc. 5500 w. Eng Rec—Dec. 12, 1908. No. 954.

Water Towers.
The Steel and Concrete Water Tower at Grand Rapids, Mich. Illustrated detailed description of a 885,000-gal. water tower recently erected. 2000 w. Eng Rec—Dec. 12, 1908. No. 956.

Water Works.
Montreal Water-Works Improvements. Map and illustrated description of work in progress. 1200 w. Engr, London—Dec. 11, 1908. No. 1220 A.

Water-Works Valuation and Fair Rates, in the light of the Main Supreme Court Decisions in the Waterville and Brunswick Cases. Discussion of paper by Leonard Metcalf on this subject. 3500 w. Pro Am Soc of Civ Engrs—Dec., 1908. No. 1355 E.

Weirs.
A Segmental Rolling Weir built in 1886 on the Rhone Canal at Cette (Note sur un Système de Fermeture à Segment exécuté en 1886-87 sur le Canal du Rhone à Cette). M. Guibal. Illustrated description. 5600 w. Ann d Ponts et Chauss—1908-IV. No. 1311 E + F.

Rolling Weir and Hydro-Electric Plant of the Lauffen Portland Cement Works at Neckarwestheim, Württemberg (Das Walzenwehr und die Wasserkraftanlage des Württembergischen Portlandzementwerkes Lauffen bei Neckarwestheim am Neckar). Herr Nauffer. Gives some details of all the weirs of this type in existence and describes this special installation. Ills. 4400 w. Zeitschr d Ver Deutscher Ing—Nov. 21, 1908. No. 1194 D.

Wells.

See Newton, Mass., under WATER SUPPLY.

Youngstown, O.

An Industrial Water Supply for the Youngstown District. Explains conditions and illustrates and describes the project carried out which will impound two billion gallons in three lakes, giving a head of 160 feet. 1800 w. Ir Trd Rev—Dec. 17, 1908 No. 1037.

WATERWAYS AND HARBORS.

Antwerp.

The Antwerp Harbor Works (Note sur les Travaux du Port d'Anvers). A Alby. Illustrated description of recent work. 5300 w. Mem Soc Ing Civ de France—Oct., 1908. No. 1306 G.

Barcelona.

The Port of Barcelona (Le Port de Barcelone). M. Batard Razelière. Discusses its status, works in progress and projected, administration, facilities for handling freight, etc. Ills. 26000 w. Ann des Ponts et Chauss—1908-IV. No. 1308 E + F.

Canal Haulage.

See same title, under STREET AND ELECTRIC RAILWAYS.

Canals.

The Relation of Railways to Canals. John F. Stevens. Extract from a paper read before the Atlantic Deeper Waterways Assn. Gives arguments favoring a canal system constructed by the National Government. 1200 w. Eng News—Dec. 10, 1908. No. 938.

See also Drawbridges, under BRIDGES.

Detroit River.

The Improvement of the Detroit River for Navigation. Map and illustrated description of work in progress. 4000 w. Eng News—Dec. 17, 1908. No. 979.

Docks.

Harbor and Dock Improvements. Illustrates and describes recent work at the port of New York. 1000 w. Sci Am—Dec. 5, 1908. No. 816.

New Colman Dock at Seattle. H. Cole Estep. Illustrated description of a new dock 700 ft. long, costing about $1,000,000. 2000 w. Marine Rev—Dec. 3, 1908. No. 822.

A Structural-Steel Ore Dock at Two Harbors, Minn. Illustrated detailed description of a 50000-ton ore dock, the first of its kind to be erected in the United States. 2200 w. Eng Rec—Dec. 5, 1908. No. 831.

Keyham Dockyard Extension. Sir Whately Eliot. Brief review of the history of this dockyard, with illustrated description of works constructed since 1896. Keyham Dockyard and Extension; Temporary Works, and Plant and Appliances Used in Construction. George Hall Scott. Two papers discussed together. Plates. 38500 w. Inst of Civ Engr—Papers 3701 & 3728. No. 890 N.

Dredging.

Bucket Dredging and Pump Sluicing. H. Herman. Considers their applicability and costs. 2000 w. Aust Min Stand—Nov. 18, 1908. No. 1096 B.

Fremantle.

The New Fremantle Harbor (Le Nouveau Port de Fremantle). Paul Privat-Deschanel. Describes recent improvements. Map. 1500 w. Génie Civil—Nov. 7, 1908. No. 1120 D.

Georgian Bay Canal.

The Georgian Bay Ship Canal. J. G. G. Kerry. Reviews the history of this project and gives an outline of the projected route. 4000 w. Engineering Magazine—Jan., 1909. No. 1326 B.

Harbors.

The Influence of Recent Developments in Size and Speed of Steamships on Port and Harbour Accommodation. Brysson Cunningham. A discussion of some of the problems affecting modern shipbuilding and port accommodations. Ills. 3500 w. Cassier's Mag—Dec., 1908. No. 950 B.

Locks.

See Cranes, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Ohio River.

Silt in the Proposed Reservoirs of the Ohio Basin. Herman Stabler. Gives estimates of the sediment accumulation and discusses its effect. 3500 w. Eng News—Dec. 10, 1908. No. 943.

The Permanent Improvement of the Ohio River. P. S. Bond. An account of the project undertaken by the United States Government, including a system of locks and movable dams designed to maintain a least depth of 9 feet. 5500 w. Eng Rec—Dec. 26, 1908. Serial. 1st part. No. 1244.

Panama Canal.

Extracts from the Annual Report of the Isthmian Canal Commission. Report of progress of work for year ending June 30, 1908. Ills. 6000 w. Eng News—Dec. 3, 1908. No. 772.

The Commercial Prospects of the Panama Canal. G. A. Ballard. An outline of its commercial prospects leading to the conclusion that it is unlikely to prove a commercial success. 5500 w. Contemporary Rev—Dec., 1908. No. 1297 D.

Analysis Showing that the Panama Canal is Certain to Cost at Least $210,000,000, or 50 Per Cent. More Than Originally Estimated. Editorial. 2500 w. Engng-Con—Dec. 2, 1908. No. 802.

The Present Condition of Work on the Panama Canal. An illustrated account of the present situation based on the latest report of Col. George W. Goethals, recent issues of the *Canal Record,* and information from other sources. 9500 w. Eng Rec—Dec. 5, 1908. No. 829.

See also Dams, under WATER SUPPLY; and Cranes, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

River Improvement.

See Detroit River, under WATERWAYS AND HARBORS.

River Regulation.

See Ohio River, under WATERWAYS AND HARBORS.

Rock Removal.

Removal of Submarine Rock at the Entrance to Port Phillip, Victoria. Charles William Maclean. Describes work to provide adequate depth of water for deep-draught vessels entering or leaving the Port of Melbourne. (Abstract) Ills. Inst of Civ Engrs—No. 3545. No. 887 N.

Shore Protection.

River Improvement: The Continuous Woven Mattress Revetment Compared to the David Neale System. A critical letter concerning an article by Charles H. Miller, with reply by Mr. Miller. 5000 w. Eng News—Dec. 10, 1908. No. 942.

Water Powers.

Water Power Possibilities, at Muscle Shoals, on Tennessee River. S. Mays Ball. Map and description of power being developed. 1500 w. Elec World—Dec. 26, 1908. No. 1287.

See also Isolated Plants, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

MISCELLANY.

Strain Models.

Models for Illustrating the Strain on Structures. Dr. Alfred Gradenwitz. Illustrated description of models used by E. Carlipp, of Erlangen, Germany. 1800 w. Sci Am—Dec. 26, 1908. No. 1291.

ELECTRICAL ENGINEERING

COMMUNICATION.

Radio-Telegraphy.

Post-Graduate Lectures on Radiotelegraphy and Radiotelephony. Prof. J. A. Fleming. Brief review of Prof. Fleming's fifth and sixth lectures delivered at University College. 2000 w. Engng—Dec. 4, 1908. No. 1020 A.

Post-Graduate Lectures on Radiotelepraphy and Radiotelephony. J. A. Fleming. Reviews the seventh and eighth lectures on the above subject. 2200 w. Engng—Dec. 18, 1908. No. 1373 A.

The Bolt Head Wireless Telegraph Station of the General Post Office. Illustrated description of this recently opened English station for communicating with ships at sea. 2200 w. Elec Engng—Dec. 17, 1908. No. 1390 A.

Radio-Telephony.

See Radio-Telegraphy, under COMMUNICATION.

Telephone Cables.

New Observation on Long Distance Submarine Cables. F. Breisig. Abstract from *Electrotechnische Zeit.* Describes experience with submarine telephone cables in which the copper conductors are wound for their entire length with fine iron wire. 2000 w. Elect'n, Lond—Nov. 27, 1908. No. 860 A.

Telephone Transmitters.

Raymond Barker's Multi-Tone Vibrating Transmitter. Illustrated description of a novel instrument exhibited at the Physical Society's Exhibition. 1500 w. Elect'n, Lond—Dec. 18, 1908. No. 1394 A.

Telephony.

The Influence of Terminal Apparatus on Telephonic Transmission. Louis Cohen. Discusses this phase of the problem, showing the distortion produced by terminal apparatus, and considering certain improvements. Mathematical. 1500 w. Bul Bureau of Stand—Nov., 1908. No. 1346 N.

See also Communication, under STREET AND ELECTRIC RAILWAYS.

DYNAMOS AND MOTORS.

A. C. Dynamos.

The Parallel Operation of Direct Connected Alternators. A. E. Buchenberg. Discusses the conditions necessary for parallel operation, and the problems in connection. 1500 w. Elec Wld—Dec. 5, 1908. No. 808.

A. C. Motors.

The Current and Output of Alternating Current Motors. Paul C. Percy. Explanation of method of determining the relation between the current and output. 1200 w. Power—Dec. 22, 1908. No. 1078.

The Separation of Stator Losses in Three-Phase Motors by Means of the Hysteresis Angle (Die Trennung der Statorverluste des dreiphasigen Motors durch Ermittlung des Hysteresiswinkels). Hermann Zipp. Describes a simple means of separating the hysteresis and eddy-current losses. Ills. 1600 w. Elektrotech u Maschinenbau—Nov. 8, 1908. No. 1185 D.

D. C. Motors.

Design of a One-Sixth Horse-Power Motor. F. C. Mason. Drawings and description of a motor designed to operate a window display machine. 1200 w. Elec Wld—Dec. 5, 1908. No. 811.

See also Railway Motors, under DYNAMOS AND MOTORS.

Economy.

Output and Economy Limits of Dynamo-Electric Machinery. J. C. Macfarlane and H. Burge. Considers present day practice and the directions in which extensions may be expected. 9500 w. Inst of Elec Engrs—Dec. 10, 1908. No. 1206 N.

Induction Motors.

Magnetizing and Potential Coefficients of Polyphase Windings. R. E. Hellmund. Gives results obtained by the writer's method, with data relating to fractional-pitch windings. 800 w. Elec Wld—Dec. 19, 1908. No. 1269.

Investigation and Determination of the Additional Iron Losses in Induction Motors (Untersuchung und Berechnung der zusätzlichen Eisenverluste in asynchronen Motoren). O. S. Bragstad and A. Fraenckel. Mathematical. Ills. Serial. 1st part. 2100 w. Elektrotech Zeitschr—Nov. 5, 1908. No. 1198 B.

Railway Motors.

Features of Continuous-Current Railway Motor Design. E. V. Pannell. The limiting dimensions for these motors is explained and features discussed. 1500 w. Elec Rev, Lond—Dec. 4, 1908. No. 1007 A.

The Development and Construction of Motors and Driving Gears for Electric Cars (Entwicklung und Beschaffenheit der Triebmotoren und Triebwerke elektrischer Eisenbahnfahrzeuge). Dr. W. Kummer. Ills. Serial. 1st part. 3000 w. Schweiz Bau—Nov. 7, 1908. No. 1157 B.

Regulation.

Shunt Regulation by the "Potential Slide" Method. Thomas Carter. Notes on shunt regulators for motors and dynamos with abnormally high ranges of regulation. 2500 w. Elec Engr, Lond—Nov. 20, 1908. No. 731 A.

Repulsion Motors.

Commutation of the Compensated Series Repulsion Motor. A. R. Dennington. Describes this alternating-current commutator motor, and states the advantages of the arrangement. 2500 w. Elec Wld—Dec. 12, 1908. No. 928.

Alternating Current Commutator Motors. Dr. Rudolf Goldschmidt. Discusses the theory of the repulsion motor, the methods of operation, and the determination of losses. Diagrams. 2200 w. Elect'n, Lond—Nov. 27, 1908. Serial. 1st part. No. 861 A.

Turbo-Generators.

Tests of Turbo-Generators (Ueber Untersuchungen an Turbogeneratoren). Gives results of efficiency tests of Zoelly, Parsons and Curtis turbo-generators of various sizes. 2000 w. Glückauf—Nov. 21, 1908. No. 1153 D.

ELECTRO-CHEMISTRY.

Cells.

See Standard Cells, under MEASUREMENT.

Electrochemical Equivalents.

The Electrochemical Equivalent of Silver (L'Equivalent électrochimique de l'Argent). P. Janet, F. Laporte and P. de la Gorce. Report from the Laboratoire central d'Electricité. Describes apparatus and methods used in a new determination and gives results. Ills. 3500 w. Bul Soc Int d Elecns—Aug.-Oct., 1908. No. 1103 F.

Electro-Metallurgy.

Heat Conductance Through Walls of Furnaces. Carl Hering. Read before the Am. Elec.-Chem. Soc. On the calculation of the heat conducted from the interior to the outside of an electric furnace through its walls. 4000 w. Elec-Chem & Met Ind—Dec., 1908. No. 760 C.

Electro-Plating.

Warner's Method of Electroplating Flowers. Illustrated detailed description. 2500 w. Brass Wld—Dec., 1908. No. 1323.

Nitric Acid.

The Electric Discharge and the Production of Nitric Acid. William Cramp and Bertram Hoyle. Summarizes methods employed for the fixation of nitrogen, describing an experimental apparatus and the results obtained with it, etc. Ills. 13000 w. Inst of Elec Engrs—Dec., 1908. No. 1389 N.

ELECTRO-PHYSICS.

Alternating Currents.

The Production of Small Variable Frequency Alternating Currents Suitable for Telephonic and Other Measurements. B. S. Cohen. Abstract of a paper read before the Physical Soc. Describes various methods of producing such currents, including a new method. 1200 w. Elect'n, Lond—Dec. 4, 1908. No. 1010 A.

Currents.

Direct and Alternating Currents. S. A. Fletcher. The difference between the two simply explained. 2200 w. Sci Am Sup—Dec. 26, 1908. No. 1295.

Current Surge.

Current Surge in Closing an Inductive Circuit. J. E. Fries. Discusses the causes and factors of this phenomenon. 2000 w. Elec Age—Nov., 1908. No. 880.

Electrons.

The Discharge of Electricity from Glowing Bodies. Prof. E. Rutherford. Abstract of a lecture before the Manchester Sec. of Inst. of Elec. Engrs. A study of the effect of high temperatures in producing ionization. 1000 w. Elect'n, Lond—Dec. 11, 1908. No. 1211 A.

Induction.

The Induction Law (Des Induktionsgesetz). Fritz Emde. An extensive theoretical discussion. Ills. Serial. 1st part. 3200 w. Elektrotech u Maschinenbau. Nov. 15, 1908. No. 1186 D.

Radiation.

The Luminous Equivalent of Radiation. P. G. Nutting. A discussion of the problem and of the functions involved, aiming to establish a precise relation between light and radiation. 11000 w. Bul Bureau of Stand—Nov., 1908. No. 1348 N.

Selective Radiation from Various Solids. W. W. Coblentz. A qualitative proof of Kirchhoff's law of proportionality between emission and absorption. An examination of the emission spectra of electrical insulators. 7500 w. Bul Bureau of Stand—Nov., 1908. No. 1344 N.

Radio-Activity.

Radio-Active Elements. A. T. Cameron. Information concerning their number and their properties. 3000 w. Sci Am Sup—Dec. 19, 1908. No. 1234.

Resistance.

The Variation of Manganin Resistances with Atmospheric Humidity. F. E. Smith, in the *Phil. Mag.* Describes tests carried out at the Nat. Phys. Laboratory, showing that coils, coated with a varnish which does not absorb moisture, have an advantage over shellac-coated coils. 1700 w. Elect'n. Lond—Nov. 20, 1908. No. 733 A.

Skin Effect.

The Increase in Resistance through the Skin Effect (Ueber die Widerstandszunahme durch Skinwirkung). Dr. F. Rusch. Mathematical. Ills. 2500 w. Elektrotech Zeitschr—Nov. 5, 1908. No. 1199 B.

GENERATING STATIONS.

Accumulators.

The Operation and Maintenance of Storage Batteries. T. P. Strickland. Describes the system in use at the Sydney, N. S. W., Tramway Department. 3000 w. Aust Min Stand—Nov. 18, 1908. Serial. 1st pat. No. 1097 B.

Lead Accumulator Electrolyte. A. Henrick Jackson. Read before the Elec. Assn. of Vic. Considers the nature, density and amount of the electrolyte, its function, purity, etc. 2500 w. Aust Min Stand—Nov. 11, 1908. No. 1088 B.

Accumulators for Peak Loads. A. M. Taylor. Considers the comparative costs and working expenses of steam plant and accumulators, showing the decided advantage of the latter. 2500 w. Elect'n, Lond—Dec. 4, 1908. No. 1009 A.

See also Rotary Converters, under TRANSMISSION.

Central Stations.

The Columbus Municipal Lighting Plant. G. H. Gamper. Illustrated detailed description of this turbine plant. 6500 w. Ohio Soc of Mech, Elec & Steam Engrs, No. 141—Nov., 1908. No. 904 N.

The Power Plant and Transmission System of Castelnuovo-Valdarno, Italy. An illustrated description of a steam power plant installed at lignite mines, generating electrical energy which is transmitted to surrounding cities and towns. 2200 w. Elec Rev, N Y—Dec. 12, 1908. No. 935.

The Electric Power Supply of Marseilles (L'Alimentation de Marseille en Energie électrique). J. Izart. An illustrated description of the Saint-Giniez station. Serial. 1st part. 2800 w. L'Elecn —Nov. 21, 1908. No. 1114 D.

The Electric Plants of the Lauchhammer Company (Die elektrischen Anlagen der Aktiengesellschaft Lauchhammer). Herr Krumbiegel. Illustrated description of an extensive power plant for a manufacturing works. 5500 w. Zeitschr d Ver Deutscher Ing—Nov. 7, 1908. No. 1189 D.

See also Gas Power Plants, under MECHANICAL ENGINEERING, COMBUSTION MOTORS.

Cost Systems.

A System of Cost and Time Keeping in Use at the Columbus, O., Municipal Electric Lighting Plant. G. H. Gamper. Extract from a paper read before the Ohio Soc. of Mech., Elec. & Steam Engrs. 1500 w. Eng News—Dec. 3, 1908. No. 776.

Economics.

Domestic Electricity Supply (Including Heating and Cooking) is Affected by Tariffs. W. R. Cooper. Considers the importance of so adjusting tariffs that electric heating and cooking may be encouraged. 8500 w. Inst of Elec Engrs—Nov. 26. 1908. No. 863 N.

Great Britain.

Some Comparisons of the Electrical Industry in This Country and Abroad. W. M. Mordey. Inaugural address before the Institution of Electrical Engineers on Nov. 19. 5000 w. Engng—Dec. 11, 1908. No. 1218 A.

Hydro-Electric.

A Low-Head Hydro-Electric Development at Berrien Springs, Michigan. Illustrated description of a development on the St. Joseph River. 4000 w. Eng Rec—Dec. 26, 1908. No. 1248.

Some Problems in Designing the Kern River No. 1 Hydro-Electric Power Plant. F. C. Finkle. An illustrated account of very important problems in hydro-mechanics solved successfully in the design and construction of this power development for the Los Angeles Edison Co. 6500 w. Eng News—Dec. 24, 1908. No. 1236.

The Swedish State Electric Power-Station at Trollhättan. Plan and description of a development on the Göta River, in Sweden. 2500 w. Engng—Dec. 18, 1908. No. 1370 A.

See also Weirs, under CIVIL ENGINEERING, WATER SUPPLY; Water Powers, under CIVIL ENGINEERING, WATERWAYS AND HARBORS; and Turbine Plants, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

Isolated Plants.

Natural and Artificial Conservation of Water Power for Electrical Purposes. Edward R. Taylor. Illustrates and describes a number of small plants and power applications on farms, and shows the great amount of power still unused, discussing related questions. 6000 w. Jour Fr Inst—Dec., 1908. No. 968 D.

Parallel Operation.

See A. C. Dynamos, under DYNAMOS AND MOTORS.

Records.

Plans and Records for Electrical Distribution Systems. J. W. Beauchamp. Read before the Leeds Loc. Sec. of the Inst. of Elec. Engrs. General remarks with description of the system developed for Sheffield, England. 2000 w. Elec Engr, Lond—Dec. 18, 1908. Serial. 1st part. No. 1391 A.

Taxation.

Proposal for a Tariff on Electricity and Gas (Entwurf eines Elektrizitäts- und Gassteuergesetzes). Text of a bill before the German Reichstag to establish a tax on electricity and gas undertakings. 2000 w. Elektrotech Zeitschr—Nov. 12, 1908. No. 1302 B

LIGHTING.

Circuits.

See Voltage Regulation, under TRANSMISSION.

Illumination.

The Mechanical Equivalent of Light. J. S. Dow. A résumé of this subject by C. V. Drysdale is reviewed and reference made to other investigators, and to the author's study. Also editorial. 4500 w. Elec Wld—Dec. 12, 1908. No. 927.

Incandescent Lamps.

The Luminous Efficiency of Metal Filament Lamps. W. W. Coblentz. Investigation of the factors producing this efficiency, especially the so-called radiation constant σ. 1200 w. Elec Wld—Dec. 19, 1908. No. 1271.

New Incandescent Lamps. Francis E. Cady. Discusses the new metallic filament lamps, their manufacture, physical and electrical properties, etc. 3000 w. Cent Sta—Dec., 1908. No. 934.

Photometry.

The Determination of the Mean Spherical Intensity of a Source of Light. E. W. Weinbeer. Describes a slide-rule for its direct determination. 600 w. Elec Wld—Dec. 26, 1908. No. 1286.

POWER APPLICATIONS.

Agriculture.

Applications of Electricity in Agriculture (Aplicaciones de la Electricidad á la Agricultura). D. Hermenegildo Gorria. A general review. Serial. 1st part. 4000 w. Energia Elec—Nov. 10, 1908. No. 1139 D.

See also Isolated Plants, under GENERATING STATIONS.

Brakes.

See same title, under MECHANICAL ENGINEERING, MACHINE ELEMENTS AND DESIGN.

Heating.

Commercial Electric Heating. John Roberts. Considers a change in methods of distribution necessary and gives suggestions. 3500 w. Inst of Elec Engrs—Nov. 26, 1908. No. 864 N.

See also Economics, under GENERATING STATIONS.

Machine Tools.

See Electric Driving, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

Marseilles Congress.

The International Congress on the Applications of Electricity (Le Congrès international des Applications de l'Electricité). Paul Janet. A general outline of the proceedings. 7200 w. Rev Gen d Sci—Nov. 30, 1908. No. 1113 D.

Mining.

See Electric Power, under MINING AND METALLURGY, COAL AND COKE, and under MINING.

Refrigerating Machines.

See Refrigeration, under MECHANICAL ENGINEERING, HEATING AND COOLING.

Welding.

See same title, under MECHANICAL ENGINEERING, MACHINE WORKS AND FOUNDRIES.

MEASUREMENT.

Dynamo Testing.

The Testing of Alternators. Stanley P. Smith. Abstract of paper before the Birmingham Sec. of the Inst. of Elec. Engrs. Discusses methods and their defects. 3500 w. Elec Engr, Lond—Nov. 27, 1908. No. 859 A.

The Practical Testing of Dynamos and Motors. H. E. Mellor. Read before the Owens College Engng. Soc. States principles, describing tests for short circuits, bad connections, etc., in armatures for d. c. machines; stators for induction motors, alternators, synchronous motors; rotors for induction motors; magnet coils for d. c. machines and alternators. 4500 w. Mech Engr—Nov. 27, 1908. No. 856 A.

Electrodynamometers.

A New Absolute Electrodynamometer and the Determination of the Electromotive Force of a Weston Cell (Nouvel Electrodynamomètre absolu et Détermination de la Force électromotrice de l'Elément du Type Weston). H. Pellat. Report from the Laboratoire central d'Electricité. Ills. 21000 w. Bul Soc Int d Elecns—Aug.-Oct., 1908. No. 1106 F.

Determination of the Constant of an Absolute Electrodynamometer by an Induction Phenomenon (Détermination de la Constante d'un Electrodynamomètre absolu par un Phénomène d'Induction) A. Guillet. Report from the Laboratoire central d'Electricité. Describes the Lippmann method, the apparatus and calculations involved and the application of the results to the determination of the electromotive force of a cadmium cell. Ills. 9000 w. Bul Soc Int d Elecns—Aug.-Oct., 1908 No. 1104 F.

See also Standard Cells, under MEASUREMENT.

Frequency.

Stroboscopic Measurements of Alternating-Current Frequency with Electric Lamps. A. E. Kennelly. An account of measurements to about one-tenth of 1 per cent, with no other apparatus than a permanent magnet and an incandescent lamp, with the aid of a stroboscopic fork. 1500 w. Elec Wld—Dec. 26, 1908. No. 1284.

Laboratories.

The New Laboratory of the Electrical Engineering Department at the Ohio State University. F. C. Caldwell. Illustrated detailed description of the building and its equipment. 3000 w. Ohio Soc of Mech, Elec, & Steam Engrs, No. 146—Nov., 1908. No. 908 N.

Magnetic Testing.

Errors in Magnetic Testing with Ring Specimens. M. G. Lloyd. Discusses the inaccuracy of the apparent values of mean gilberts per centimeter, and of the mean hysteretic power obtained from ring test pieces, owing to the differences of perimeter at the inside and outside of the ring. Gives a correction factor. 1500 w. Elec Wld—Dec. 26, 1908. No. 1285.

Meters.

The Measurement of Energy in Single-Phase Three-Wire Systems (Energiemessung in Wechselstrom-Dreileiteranlagen durch Elektrizitätsmesser). Rudolf Kopp. Shows the use of the induction meter for this purpose. Mathematical. Ills. 3700 w. Elektrotech Zeitschr—Nov. 12, 1908. No. 1301 B.

Meter Testing.

The Use of a Phase-Shifting Transformer for Wattmeter and Supply Meter Testing. C. V. Drysdale. An illustrated description of the instrument and its use. 1500 w. Elect'n, Lond—Dec. 11, 1908. No 1210 A.

Motor Testing.

See Dynamo Testing, under MEASUREMENT.

Oscillographs.

The Oscillograph. A. H. Forman. Brief discussion of examples of three general types. 2000 w. Sib Jour of Engng—Nov., 1908. No. 835 C.

Photometry.

See same title, under LIGHTING.

Standard Cells.

The Standard Cadmium Cell (L'Elément étalon au Cadmium). P. Janet and R. Jouaust. Report from the Laboratoire central d'Electricité. A general discussion and results of researches. Ills. 16000 w. Bul Soc Int d Elecns—Aug.-Oct., 1908. No. 1101 F.

The Temperature Formula of the Weston Standard Cell. F. A. Wolff. Describes investigations made, discussing results and stating conclusions. 7500 w. Bul Bureau of Stand—Nov., 1908. No. 1349 N.

Determination by an Absolute Electrodynamometer of the Electromotive Force of Cadmium Cells (Détermination par un Electrodynamomètre absolu de la Force électromotrice des Eléments au Cadmium). P. Janet, F. Laporte and R. Jouaust. Report from the Laboratoire central d' Electricité. Describes the instrument and methods of tests and gives results. Ills. 18000 w. Bul Soc Int d'Elecns—Aug.-Oct., 1908. No. 1102 F.

See also Electrodynamometers, under MEASUREMENT.

Standards.

The Construction of Standards of the International Ohm (Note sur la Construction d'Etalons de l'Ohm international). J.-René Benoit. Report from the Laboratoire central d'Electricité. Describes the method. 3300 w. Bul Soc Int d'Elecns—Aug.-Oct., 1908. No. 1105 F.

Units.

The Principles Involved in the Selection and Definition of the Fundamental Electrical Units to Be Proposed for International Adoption. F. A. Wolff. 6500 w. Bul Bureau of Stand—Nov., 1908. No. 1347 N.

TRANSMISSION.

Cables.

Cost of High-Tension Underground Cables. Henry Floy. Discusses methods of estimating cost. 1500 w. Elec Wld—Dec. 12, 1908. No. 929.

The Short-Period Carrying Capacity of Cables. William A. Del Mar. Develops a corresponding formula and table for cables in such a manner as to determine their over-load time-current curves. Describes investigations. Also editorial. 2000 w. Elec Wld—Dec. 12, 1908. No. 926.

Conduits.

Underground Construction. H. B. Gear and P. F. Williams. A review of the various systems developed, illustrating and describing present practice. 4500 w. Elec Age—Nov., 1908. No. 881.

High Tension.

Some Features of European High-Tension Practice. Frank Koester. Illustrates and describes especially the features uncommon in American practice. 3300 w. Elec Age—Dec., 1908. No. 1227.

Insulators.

Flash-Over Voltages. J. Lustgarten. The effects of high-voltages on the air, the nature and properties of the gaseous ion, explaining the mechanism of the brush, spark and arc discharges, etc. 5000 w. Elect'n, Lond—Dec. 18, 1908. No. 1393 A.

Lightning.

New Discoveries About Lightning. James Cooke Mills. A report of the experiments made by Alex Larsen, with comments. 2000 w. Sci Am—Dec. 12, 1908. No. 930.

Lightning Arresters.

Recent Progress in the Study of Atmospheric Discharges and of Lightning Arresters (Progrès Récents réalisés dans l'Etude des Décharges atmosphériques et des Parafoudres). A. R. Garnier. Ills. 2000 w. L'Elecn—Nov. 21, 1908. No. 1115 D.

The Testing of Lightning Arresters (Sulla Prove dei Parafulmini). Illustrated description of an electrical method. 3200 w. Elettricita—Nov. 19, 1908. No. 1130 D.

Line Design.

Errors in Some Methods of Calculating Alternating-Current Transmission Lines. L. W. Rosenthal. Points out the practical conditions under which these solutions may lead to undesirable errors. 700 w. Elec Wld--Dec. 19, 1908. No. 1270.

Permutator.

The Permutator. A description of this current-changing device, with editorial comment. 6000 w. Elec Age—Nov., 1908. No. 879.

Poles.

The Strength of Wood Poles (Sulla Rottura dei Pali di Legno nelle Linee elettriche). Salvatore Spera. Mathematical discussion of the stresses in transmission line poles. Ills. 2500 w. Industria—Nov. 15, 1908. No. 1132 D.

Rotary Converters.

Discussion on "Voltage Ratio in Synchronous Converters, with Special Reference to the Split Pole Converter," and on "Applications of Storage Batteries to Regulation of Alternating-Current Systems." Atlantic City, N. J., July 1, 1908. Papers by Comfort A. Adams, and by J. L. Woodbridge are discussed. 10800 w. Pro Am Inst of Elec Engrs—Jan., 1909. No. 1364 F.

Transformers.

Transformers: Some Theoretical and Practical Considerations. A. P. M. Fleming and K. M. Faye Hansen. Abstract of a paper read before the Manchester Local Sec. of the Inst. of Elec. Engrs. Gives in full the remarks on the practical side. Ills. 4000 w. Elec Engr, Lond—Dec. 4, 1908. No. 1006 A.

Three-Phase—Two-Phase Transmission by Standard Transformers. L. A. Starrett. Presents methods of transforming which have proved satisfactory. 1000 w. Elec Jour—Dec., 1908. No. 978.

Transformer Connections. Considers some of the most common problems. 1500 w. Prac Engr—Dec. 11, 1908. Serial. 1st part. No. 1200 A.

The Parallel Connection of Three-Phase Transformers. A method to aid in correct inter-connection, given by K. Faye-Hansen, in the E T. Z. 800 w. Elec Rev, Lond—Dec. 11, 1908. No. 1208 A.

Star and Delta Transformer Interconnections. W. T. Ryan. Discusses the various types of interconnection, considering disturbances that may arise in a three-phase system. 600 w. Elec Wld—Dec. 5, 1908. No. 809.

Troubles.

Lessons from Some Recent Electrical Troubles. Cites a number of accidents due to improper operation. 1700 w. Elec Wld—Dec. 5, 1908. No. 810.

Underground.

Discussion on "High-Potential Underground Transmission." New York, Oct. 9, 1908. Discussion of paper by P. Junkersfeld and E. O. Schweitzer. 10500 w. Pro Am Inst of Elec Engrs—Jan., 1900. No. 1366 F.

We supply copies of these articles. See page 904.

Underground Cable and Service Distribution, Edison System. Ralph W. Krass. Deals with the underground installations of the various systems, and describes the method of connection with overhead feeders for outlying districts. 2500 w. Sib Jour of Engng—Dec., 1908. No. 1352 C.

Voltage Regulation.

Conditions Affecting Stability in Electric Lighting Circuits. Elihu Thomson. Discusses mainly the constant-current series circuits containing arc lamps, reviewing the methods tried during the last 30 years to obtain stability. 7500 w. Pro Am Inst of Elec Engrs—Jan., 1909. No. 1362 F.

Protection and Safety from Excess Voltages (Gesichtspunkte hinsichtlich Schutz und Sicherheit gegen Ueberspannungen). Karl Kuhlmann. Mathematical discussion of the possible causes of excess voltages. Ills. Serial. 1st part. 2800 w. Elektrotech Zeitschr—Nov. 12, 1908. No. 1300 B.

Excess-Voltage Protective Devices of the Société Générale des Condensateurs Electriques, Freiburg (Ueberspannungssicherungen nach dem System der Société Générale des Condensateurs Electriques, Freiburg). Illustrated description and report of tests. Serial. 1st part. 2400 w. Elektrotech u Maschinenbau—Nov. 22, 1908. No 1187 D.

MISCELLANY.

Aluminium.

See same title, under MINING AND METALLURGY, MINOR MINERALS.

Problems.

The Technical and Social Problems of the Distribution of Electrical Energy (Il Problema tecnico e sociale della Distribuzione di Energia elettrica). C. Coltri. Refers particularly to conditions in Italy. Serial, 1st part. 3000 w. Industria—Nov. 29, 1908. No. 1135 D.

INDUSTRIAL ECONOMY

Accounting.

Electric Manufacturing Companies' Accounts. Discusses matters in connection with the affairs of such companies, outlining a system. 2000 w. Elec Rev, Lond —Dec. 18, 1908. No. 1392 A.

Co-partnership.

Co-partnership and Unemployment. Sir Benjamin C. Browne. Reviews some of the schemes that have been tried. 3000 w. Engr, Lond—Dec. 4, 1908. No. 1021 A.

Cost Systems.

Systematic Foundry Operation and Foundry Costing. C. E. Knoeppel. This fourth article of a series discusses the apportionment of various elements to production. 4000 w. Engineering Magazine—Jan., 1909. No. 1329 B.

See also same title, under ELECTRICAL ENGINEERING, GENERATING STATIONS; and Time Keeping, under INDUSTRIAL ECONOMY.

Education.

Discussion on "A New Method of Training Engineers," and "The Relation of the Manufacturing Company to the Technical Graduate," Atlantic City, N. J., July 2, 1908. Papers by Magnus W. Alexander, and by David B. Rushmore are discussed. 7000 w. Pro Am Inst of Elec Engrs—Jan., 1909. No. 1363 F.

The Commercial Training of the Engineer (L'Instruction commerciale de l'Ingénieur). Maurice Bellom. Discusses the need for training engineers in economic principles, languages, etc. 3000 w. Génie Civil—Nov. 21, 1908. No. 1124 D.

See also same title, under MARINE AND NAVAL ENGINEERING.

Engineering Opportunities.

Some Opportunities on the Shop Side in the Engineering Industries. C. B. Auel. Discusses the specialization of modern manufacturing establishments. 3000 w. Elec Jour—Dec., 1908. No. 977.

Inland Navigation.

Utility of Waterways as a Factor in Transportation. J. A. Ockerson. An address before the River and Harbor Convention. 4000 w. Eng Rec—Dec. 19, 1908. No. 1055.

Inventions.

Salient Points for Inventors—Making and Preserving Records. John D. Morgan. Suggestions for recording evidence of first invention. 2000 w. Am Mach—Vol. 31. No. 52. No. 1278.

Management.

Efficiency as a Basis for Operation and Wages. Harrington Emerson. The location and elimination of wastes is discussed in this seventh article of a series. 3000 w. Engineering Magazine—Jan., 1909. No. 1333 B.

See also Time Keeping, under INDUSTRIAL ECONOMY; and Management, under RAILWAY ENGINEERING, MISCELLANY.

Marine Transport.

Comprehensive Report on Waterway and Maritime Conditions Throughout the World—Strong Plea for American Ships. C. M. Chester. Special report to National Rivers and Harbor Congress. 3000 w. Naut Gaz—Dec. 24, 1908. No. 1259.

Natural Resources.

The Need for Conserving the Mineral Wealth of the United States. Report submitted by the Minerals Section of the National Conservation Commission to the Conference on Dec. 9. 2000 w. Eng News—Dec. 17, 1908. No. 985.

Patents.

Our Antiquated Patent System. Ludwig Gutmann. A critical discussion of features of the patent laws of the United States. 2000 w. Elec Wld—Dec. 26, 1908. No. 1288.

Purchasing.

The Purchase of Pattern Lumber. Oscar E. Perrigo. Suggestions for effecting economies in the purchase and care of raw material for the pattern shop. Ills. 5000 w. Foundry—Dec., 1908. No. 758.

Tariff.

Tariff Hearings at Washington. A summary of the statements on the metal schedule. 33000 w. Ir Age—Nov. 26, 1908. Serial. 1st part. No. 788.

Time Keeping.

Something New in Machine-Shop Time-Keeping. Illustrates and describes a system where the data are telephoned to the office and recorded by aid of the calculagraph, without the workman leaving his machine. 1200 w. Am Mach—Vol. 31. No. 52. No. 1276.

See also Cost Systems, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

MARINE AND NAVAL ENGINEERING

Ammunition.

The Progressive Decomposition of Gun-Cotton During Its Storage. M. M. O. Silberrad and R. C. Farmer. Gives results of researches on the decomposition of gun-cotton. 2500 w. Jour Fr Inst—Dec., 1908. No. 971 D.

British Navy.

The Two Power Standard for the Navy. Sir William H. White. An examination of the reasons advanced for the new shipbuilding programme in England, explaining the present naval situation. 8500 w. Nineteenth Century—Dec., 1908. No. 1267 D.

Compass Deviation.

Change in Deviation of the Compass Due to Change in Trim. Lloyd H. Chandler. An investigation of the effect of an abnormal trim. Mathematical. 2000 w. Pro U S Naval Inst—Dec., 1908. No. 1336 F.

Education.

Naval Engineering Education in Great Britain. Sir William H. White. Address before the Royal Society of Arts. An account of the methods adopted for the education of naval architects in Great Britain during the past century. 10000 w. Jour Soc of Arts—Nov. 20, 1908. No. 725 A.

Electric Power.

The Lighting and Power Arrangements and Other Uses of Electricity in a Modern Steamship. Louis P. Zimmerman. Illustrated description of the equipment of the "Minnesota," a combined passenger and freight-carrying vessel, 630 feet in length. 2500 w. Elec Rev, N Y—Dec. 19, 1908. No. 1061.

Floating Cranes.

Description of a 140-Ton Floating Crane with a Test Capacity for Lifting 200 Tons. H. Prime Keffer. Illustrates and describes a new and interesting type built at Duisburg, Germany. 1400 w. Int Marine Engng—Dec., 1908. No. 750 C.

Gas Engines.

Gas vs. Steam for Marine Motive Power. A. B. Willits. Discusses the present standing of the suction-gas producer and gas engine, showing that until changes are made, it will be unavailable for high-power marine work. 12000 w. Pro U S Naval Inst—Dec., 1908. No. 1334 F.

Motor Boats.

See Ignition, under MECHANICAL ENGINEERING, AUTOMOBILES.

Shipbuilding.

Messrs. Yarrow's New Works on the Clyde. Illustrated detailed description of the Scotstoun works, Glasgow, and their equipment. 7500 w. Engng—Dec. 11, 1908. No. 1213 A.

The Determination of the Dimensions of Building Slips (Die Bestimmung der Hellingabmessungen für den Fall kostspieliger Hellinganlagen). Albert Lincke. Gives tables of averages showing the most satisfactory and useful proportions. Ills. Serial, 1st part. 4000 w. Schiffbau—Nov. 11, 1908. No. 1164 D.

See also Cableways, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Ship Design.
Fast Steamers Built on "Tetrahedral" Lines. Otto Kretschnaer. Discusses the advantages of such a model. 900 w. Sci Am—Dec. 26, 1908. No. 1294.

Ship Repairing.
Facilities for Repairing Ships in Italian Harbors (I Mezzi di Raddobbo per Navi esistenti nei Porti Italiani). Luigi Luiggi. Illustrates and describes the docking facilities of the more important harbors. 3000 w. Ann d Soc d Ing e d Arch Ital—Nov. 1, 1908. No. 1129 F.

Ship Rolling.
The Dynamics of Rolling of a Ship. Sir G. Greenhill. An explanation of the mathematical theory of the motion of a ship, with remarks on the effect of design, storage of coal and cargo, etc. 2000 w. Engr, Lond—Dec. 11, 1908. No. 1219 A.

Ship Sanitation.
The Sanitation of Modern Passenger Ships. F. M. Williams. Discusses the Peninsular and Oriental Co., trading to the east, and the Cunard vessels in the Atlantic service and the successful arrangements. Also discussion. 3500 w. Jour Roy San Inst—Dec., 1908. Serial, 1st part. No. 999 A.

Steam Engineering.
Steamship Engineering Economies. Discusses possible economies in marine practice. 2000 w. Int Marine Engng—Dec., 1908. No. 751 C.

Steam Engines.
The Reciprocating Marine Engine. Abstract of a paper by D. Gibson, before the Manchester Assn. of Engrs. Discusses its present and future standing. 1800 w. Engr, Lond—Dec. 18, 1908. No. 1375 A.

The Propelling Engines of H. M. Cruiser "Defence." Plate and description. 1000 w. Engng—Dec. 18, 1908. No. 1374 A.

James P. Allaire and the Allaire Works. Edward P. Buffet. Gives facts concerning an early steam engine industry and its founder. 2500 w. Power—Dec. 8, 1908. No. 878.

Steamships.
The White Star Liner Megantic. Illustrated description. 600 w. Engr, Lond—Dec. 18, 1908. No. 1378 A.

A Modern Floating Hotel. Julius Grundmann. Illustrated description of the North German Lloyd liner "Kronprincessin Cecilie." 2500 w. Cassier's Mag—Dec., 1908. No. 948 B.

The Mallory Line Steamship Brazos. Sidney Graves Koon. Illustrated detailed description of this new steel twin-screw steamer. 3500 w. Int Marine Engng—Dec., 1908. No. 749 C.

Some Features of the Propelling Machinery and Result of Performance of the New Mallory Line Steamship Brazos. 3000 w. Naut Gaz—Dec. 10, 1908. No. 914.

The Steamship "George Washington." Illustrated description of the latest type of passenger and freight-carrying steamship. 1000 w. Sci Am Sup—Dec. 19, 1908. No. 1232.

Submarine Signalling.
Protection Against Fog Dangers at Sea. J. Erskine Murray. An illustrated account of the development of submarine signalling. 4500 w. Cassier's Mag—Dec., 1908. No. 946 B.

Torsion Meters.
See same title, under MECHANICAL ENGINEERING, MEASUREMENT.

United States Navy.
A Short Account of Legislative Action in Regard to the United States Navy Up to the War of 1812, and Notes Concerning the Histories of Naval Vessels During That Period. A. Farenholt. 7000 w. Pro U S Naval Inst—Dec., 1908. No. 1337 F.

Reuterdahl's Criticism of the Ships of the American Navy (Le Critiche di Reuterdahl alle Navi della Marina Americana). L. Barberis. A general discussion. Ills. 7500 w. Riv Marit—Nov., 1908. No. 1128 E + F.

MECHANICAL ENGINEERING

AUTOMOBILES.

Bugatti.
The Bugatti Automobile (Automobiles Bugatti). A. Heller. Illustrated description of this car built by the Gasmotorenfabrik at Deutz. 2000 w. Génie Civil—Nov. 7, 1908. No. 1122 D.

Commercial Vehicles.
Twelve Years' Progress in Commercial Vehicles. E. Shrapnell Smith. Read before the Royal Auto. Club, London. A review of progress, cost, performance, etc. 3500 w. Automobile—Dec. 17, 1908. No. 1029.

The Evolution of the Industrial Vehicle (L'Evolution du Véhicle industriel). M. G. Lumet. Report of the 1908 commercial-vehicle competition of the Automobile Club of France. Ills. 7000 w. Mem Soc of Ing Civ de France—Oct., 1908. No. 1303 G.

Automobile Fire Apparatus (Feuerwehr-automobile). Illustrated description of German models of hose wagons, ladder trucks, etc. 3500 w. Zeitschr d Mit Motorwagen-Ver—Nov. 15, 1908. No. 1175 D.

Motor Ambulances (Automobil-Krankenwagen). Illustrated description of German models. 2200 w. Zeitschr d Mit Motorwagen-Ver—Nov. 15, 1908. No. 1173 D.

See also Street Cleaning, under CIVIL ENGINEERING, MUNICIPAL.

Corbin.

New Corbin Makes Its Bow for 1909. Charles B. Hayward. Illustrated description of new features. 1500 w. Automobile—Dec. 10, 1908. No. 916.

Crank Shafts.

See same title, under MACHINE ELEMENTS AND DESIGN.

Driving.

Some Pertinent Hints for the American Autoist. Calls attention to important points to be considered by autoists. 2500 w. Automobile—Dec. 10, 1908. No. 917.

Exhibitions.

Lessons from the Motor-Car Show at Olympia. A general review of the progress shown. 3500 w. Engng—Dec. 4, 1908. No. 1019 A.

Motor-Car Exhibition at Olympia. Illustrates and describes interesting exhibits of pleasure cars and accessories. 1500 w. Engr, Lond—Nov. 20, 1908. Serial. 1st part. No. 743 A.

Explosions.

The Danger of Explosion in Automobiles (Zur Frage der Explosionsgefahr bei Automobilen). Herr Effenberger. Discusses the explosions to which the automobile is liable and means of lessening the dangers, giving results of tests. Ills. 5500 w. Zeitschr d Mit Motorwagen-Ver—Nov. 15, 1908. No. 1174 D.

Fuels.

See Coking By-Products, under MINING AND METALLURGY, COAL AND COKE.

Garages.

The Heating of Motor Houses. Illustrates and describes various devices. 1800 w. Autocar—Dec. 5, 1908. No. 1003 A.

Gears.

Toughened Gears for Automobiles. J. M. Howe. Describes process of hardening and tempering used in Europe with "Mangano Siliceux" steel. 1000 w. Am Mach—Vol. 31. No. 51. No. 1075.

Gregoire.

The 14-H.P. Gregoire Petrol Car. Illustrated description of a low-priced French car. 1000 w. Auto Jour—Dec. 19, 1908. No. 1384 A.

Headlights.

The Bleriot "No Glare" Headlight. Illustrated description of a "No-glare" automobile lamp. 700 w. Auto Jour—Dec. 19, 1908. No. 1383 A.

Ignition.

The Bosch Magnetic Igniter. Illustrated description of this system. 1500 w. Auto Jour—Dec. 12, 1908. No. 1098 A.

Getting Acquainted with Make and Break Ignition. Herbert L. Towle. An illustrated explanation of the make and break system. 2500 w. Rudder—Dec., 1908. No. 900 C.

Lanchester.

The New Wheel-Steering Lanchester Car at Olympia. Illustrates and describes a 6-cylinder vehicle equipped with wheel steering and gate control. 1700 w. Auto Jour—Nov. 28, 1908. No. 849 A.

Motors.

Comparing Long and Short Stroke Motors. E. A. Myers. Showing the desirability of the long stroke. 1800 w. Automobile—Dec. 24, 1908. No. 1266.

Combustion Motors of Large Power Per Unit of Weight (Les Moteurs à Mélange tonnant à grande Puissance massique). M. G. Lumet. Discusses the factors which influence the relation between weight and power and gives the results of some tests carried out by the Automobile Club of France. Ills. 6000 w. Mem Soc Ing Civ de France—Oct., 1908. No. 1304 G.

N. A. G.

The 12-14-H.P. N.A.G. Car. Illustrated description of a German Chassis. 1200 w. Auto Jour—Dec. 5, 1908. No. 1005 A.

Pierce.

Pierce Arrows for 1909. Illustrates and describes the new features introduced and new types. 3000 w. Automobile—Dec. 17, 1908. No. 1031.

Pullman.

Pullman in Several 1909 Models. Brief illustrated descriptions. 1600 w. Automobile—Dec. 24, 1908. No. 1264.

Regal.

Regal in 1909 Form. Charles B. Hayward. Illustrates and describes new features. 1200 w. Automobile—Dec. 24, 1908. No. 1265.

Testing.

The Use of Electricity in Testing Automobiles. Dr. Alfred Gradenwitz. Illustrated description of the dynamometer plant used by the Am. Auto. Club. 1500 w. Elec Rev, Lond—Dec. 11, 1908. No. 1207 A.

Tires.

The Alley Tyre Manipulator. Illustrated description of a device for facilitating the dismounting and fitting of tyres. 1000 w. Autocar—Dec. 5, 1908. No. 1004 A.

About the Auto's Indispensable Footwear. Suggestions from a book by C. A.

Shaler relating to care, repairs, etc. 2500 w. Automobile—Dec. 17, 1908. No. 1030.

Transmissions.

Manly Hydraulic Variable Speed Transmission. Thomas J. Fay. Illustrates and describes this system. 1000 w. Automobile—Dec. 10, 1908. No. 915.

COMBUSTION MOTORS.

Gas Analysis.

Moisture in Producer Gas. J. MacFarlane. Explains methods used by the writer for the determination of moisture. Plate. 1500 w. Jour W of Scotland Ir & Steel Inst—Oct., 1908. No. 895 N.

Gas-Engine Governing.

Governing Gas Engines. L. B. Lent. Discusses the proper action of the governor and related matters. 1500 w. Power—Dec. 22, 1908. No. 1079.

Gas Engines.

Reminiscences of a Gas Engine Designer. L. H. Nash. Describes some ideas that have been tried, and principles of engine construction. Ills. 4000 w. Jour Am Soc of Mech Engrs—Dec., 1908. No. 840 F.

The Waste Heat of the Gas Engine. Cecil P. Poole. Gives a brief analysis of methods of utilizing waste heat, showing the fallacy of assuming that all the waste heat is available. 1600 w. Power—Dec. 8, 1908. No. 876.

A New Gas-Engine Cycle. Robert Miller. Describes the cycle devised by the writer, explaining its advantages, and illustrating the Miller single-crank, double-acting gas engine. 2500 w. Int Marine Engng—Dec., 1908. No. 752 C.

The Griffin Enclosed Gas-Engine. Illustrated description of a two-cylinder three-cycle engine. 800 w. Engng—Dec. 4, 1908. No. 1018 A.

The Influence of Large Gas Engines on Steel-Works Development (Einfluss der Grossgasmaschine auf die Entwicklung der Hüttenwerke). A. Bonte. A general review of the use of gas power in steel works with special reference to Germany. 5000 w. Zeitschr d Ver Deutscher Ing—Nov. 28, 1908. No. 1197 D.

See also Refrigeration, under Heating and Cooling; and Gas Engines, under MARINE AND NAVAL ENGINEERING.

Gas-Engine Testing.

Testing Gas Engines and Motors. E. S. Frash. On the prony brake and indicator tests in internal combustion work. 1200 w. Power—Dec. 29, 1908. No. 1317.

See also Testing Laboratories, under Measurement.

Gas Power Plants.

The Reliability of the Producer Gas Plant. Godfrey M. S. Tait. A discussion of recent reliability tests. 900 w. Cassier's Mag—Dec., 1908. No. 953 B.

A Clean Cut Factory Gas Power Plant. Cecil P. Poole. Illustrated description of a 60-cycle plant operating in parallel, at Swissvale, Penn. 2000 w. Power—Dec. 8, 1908. No. 873.

A Notable Producer Gas Power Station. Cecil P. Poole. Illustrated description of a railway and lighting plant at Charlotte, N. C., in which 60-cycle alternators are driven in parallel by gas engines supplied by bituminous producers. 1500 w. Power—Dec. 22, 1908. No. 1077.

The New Gas Power Plant of the Union Switch & Signal Company. Illustrated detailed description of the plant at Swissvale, near Pittsburg, Pa. 2000 w. Eng Rec—Dec. 12, 1908. No. 958.

See also Rolling Mills, under MINING AND METALLURGY, Iron and Steel.

Gas Producers.

Vital Points in Producer Construction. F. C. Tryon. Criticism and suggestions. 3000 w. Power—Dec. 1, 1908. No. 722.

Ignition.

The Lodge "B" Spark High-Tension Ignition. Describes a new type brought out by Sir Oliver Lodge. Ills. 1000 w. Sci Am Sup—Dec. 5, 1908. No. 819.

Oil Engines.

Oil Engines. W. A. Tookey. Abstract of a paper read before the Manchester Assn. of Engrs. Considers the differences in the methods of treatment adopted by makers, and the salient features. Ills. 3000 w. Mech Engr—Nov. 20, 1908. No. 730 A.

Tests of a Diesel Motor (Versuche an einem Dieselmotor). Dr. Karl Kobes. An elaborate mathematical discussion of a number of tests of a 70 horse-power oil motor belted to a dynamo. Ills. Serial. 1st part. 3500 w. Zeitschr d Oest Ing u Arch Ver—Nov. 20, 1908. No. 1180 D.

HEATING AND COOLING.

Electric Heating.

See Heating, under ELECTRICAL ENGINEERING, Power Applications.

Heat Losses.

Evolution in Heating. J. M. W. Kitchen. Introductory to a series of articles illustrating the theories on which the writer bases his arguments in regard to heat losses. Ills. 2000 w. Heat & Vent Mag—Nov., 1908. Serial. 1st part. No. 903.

The Effect of Wind on Heating and Ventilation. H. W. Whitten. A study of heat losses and means of lessening them, window construction and related matters. General discussion. Ills. 6000 w. Pro Engrs' Soc of W Penn—Nov., 1908. No. 779 D.

Hot-Air Heating.

Theoretical Considerations in the Design of Residence Furnace Heating Systems. James D. Hoffman. Mentions the advantages and disadvantages of such a system, and considers points to be calculated in the design. 2500 w. Met Work—Dec. 26, 1908. No. 1258.

Recent Investigations in Hot-Air Heating and Ventilating (Sopra recenti Studi di Ventilazione e Riscaldamento ad Aria calda). Luigi Boldrocchi. Illustrates and describes recent systems and appliances. Serial. 1st part. 1800 w. Industria—Nov. 15, 1908. No. 1133 D.

See also Ventilation, under HEATING AND COOLING.

Refrigeration.

Reinforced Concrete Freezing Tanks. William M. Torrance. Read before the Am. Soc. of Refrig. Engrs. Describes the construction and gives the author's experience. Ills. 1500 w. Cold Storage & Ice—Dec., 1908. No. 990 C.

Waterproofing in Refrigerating Work. Edward W. De Knight. Read before the Am. Soc. of Refrig. Engrs. Discusses the rigid method of treatment and the elastic or membrane method. 5500 w. Cold Storage & Ice—Dec., 1908. No. 988 C.

The Refrigerating Machine and the Gas Engine. Joseph H. Hart. Analogy between the ammonia absorption machine and the internal combustion motor. 2500 w. Cassier's Mag—Dec., 1908. No. 949 B.

Single and Double-Acting Ammonia Compressors. Thomas Baker. Brief discussion of the comparative advantages. 900 w. Ohio Soc of Mech, Elec, & Steam Engrs, No. 143—Nov., 1908. No. 906 N.

Performance of Ammonia Compression Machines. Charles Edward Lucke. Read before the Am. Soc. of Refrig. Engrs. An illustrated article reporting tests, giving results, and describing methods. Also reply by Thomas Shipley. 16800 w. Cold Storage & Ice—Dec., 1908. No. 991 C.

Standard Method of Testing Refrigerating Machines. D. S. Jacobus. Read before the Am. Soc. of Refrig. Engrs. Reviews the work in this field by the A.S. M.E. and states points that should be considered. 2000 w. Cold Storage & Ice—Dec., 1908. No. 989 C.

Electricity in Refrigeration. R. Louis Lloyd. Describes electrical refrigerating machines in operation in Philadelphia, giving costs. Ills. 4000 w. Jour Fr Inst—Dec., 1908. No. 970 D.

Ethyl Chloride Refrigeration. C. C. Palmer. Read before the Am. Soc. of Refrig. Engrs. Gives results of experiences with ethyl chloride as a refrigerating agent. 2000 w. Cold Storage & Ice—Dec., 1908. No. 987 C.

See also Dry-Air Blast, under MINING AND METALLURGY, IRON AND STEEL; and Refrigeration, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Steam Heating.

Installing Heating Systems in Close Quarters. Illustrates and describes the installations at the Importers' and Traders' National Bank, and at the New York Law School, in New York City. 2000 w. Heat & Vent Mag—Dec., 1908. No. 1325.

Textile Mills.

Heating, Cooling, Moistening and Renewing the Air of Textile Mills (Die Erwärmung, Kühlung, Befeuchtung und Erneuerung der Raumluft in der Textilindustrie). E. Stadelmann. A practical discussion of methods. Ills. 5500 w. Gesundheits-Ing—Nov. 14, 1908. No. 1171 D.

Ventilation.

Single Fan vs. Double Fan Systems of Heating and Ventilation. H. L. Williams. Discusses and compares the efficiency of these two systems. 2500 w. Heat & Vent Mag—Nov., 1908. No. 901.

Fan and Heater Arrangements. Charles L. Hubbard. Shows different methods of placing the important parts of a ventilating plant to meet various conditions. Ills. 1000 w. Heat & Vent Mag—Nov., 1908. No. 902.

See also Heat Losses, under HEATING AND COOLING; and Mechanical Plants, under POWER AND TRANSMISSION.

HYDRAULIC MACHINERY.

Centrifugal Pumps.

Kinematics of One Form of Rotary Pump or Blower. Samuel W. Balch. Presents some elements in the design of one of the earliest forms of rotary pump or blower. 1500 w. Sch of Mines Qr—Nov., 1908. No. 972 D.

Balancing the Thrust in Centrifugal Pumps. L. Roedel. Explains the cause of "axial pressure," and how it affects devices designed to equalize this thrust. 2000 w. Power—Dec. 8, 1908. No. 874.

Pressure Regulators.

See Turbine Pressures, under HYDRAULIC MACHINERY.

Pumping Engines.

Slip of Pumping Engines. The importance of considering it in waterworks calculations is shown, results of tests given, and methods for measuring it described. 2000 w. Munic Jour & Engr—Dec. 16, 1908. No. 1040.

Triple-Expansion Engines and Pumps for Burma Oil Pipe-Line. Illustrated description. 600 w. Engng—Dec. 18, 1908. No. 1372 A.

Pumping Plants.

The Repairs to the Evansville, Indiana, Pumping Station. Illustrates and describes extensive repairs recently completed. 2200 w. Eng Rec—Dec. 26, 1908. No. 1245.

The Intake Tunnel and Crib of the Lawrence Avenue Pumping Station, Chicago. Illustrated description of this portion of Chicago's sewerage system and its construction. 2500 w. Eng Rec—Dec. 19, 1908. No. 1053.

See also Pumping, under MINING AND METALLURGY, Mining.

Pump Valves.

Researches on the Motion of Automatic Pump Valves (Untersuchung der Bewegung selbsttätiger Pumpenventile). K. Korner. Gives time diagrams for a number of recent types. Ills. 2000 w. Zeitschr d Ver Deutscher Ing—Nov. 14, 1908. No. 1193 D.

Rams.

Hydraulic Rams for Isolated Water Supply. J. S. Lane. An illustrated discussion of hydraulic rams for isolated water supply, their setting, performance, etc. 2500 w. Met Work—Dec. 12, 1908. No. 933.

Turbine Governing.

The Control of the Turbine Under Varying Load (Das Verhalten der Turbine bei verschiedener Belastung). J. Barth. An extensive theoretical and mathematical discussion. Ills. Serial. 1st part. 3500 w. Zeitschr d Oest Ing u Arch Ver—Nov. 6, 1908. No. 1179 D.

Turbine Plants.

Economic Considerations in the Design of Water-Power Plants (Wirtschaftliche Gesichtspunkte beim Veranschlagen von Wasserkraftmaschinen). R. Camerer. A general discussion of a number of important points influencing economy in construction and operation. Ills. 7400 w. Zeitschr d Ver Deutscher Ing—Nov. 28, 1908. No. 1196 D.

Turbine Pressures.

Pressure Fluctuations in Turbine Pipe Lines. Prof. A. Budau. A discussion of devices for pressure regulation and theoretical investigations necessary for safety, with some experiences with long pipe lines. Ills. 9000 w. Jour Assn of Engng Socs—Oct., 1908. No. 781 C.

Surge-Tank Problems (Wasserschlossprobleme). Franz Prásil. Exhaustive mathematical discussion of their design and operation for turbine plants. Ills. Serial. 1st part. 4500 w. Schweiz Bau—Nov. 21, 1908. No. 1158 B.

Turbines.

Absolute Clearance Pressure in Turbines (Das Wesen des Spaltüberdruckes bei Turbinen). N. Baashuus. Mathematical discussion. Ills. 1500 w. Zeitschr f d Gesamte Turbinenwesen—Nov. 30, 1908. No. 1163 D.

Turbine Testing.

Water Measurement in the Turbine Testing Laboratory of the Berlin Technical High School (Watermessungen in der Versuchsanstalt für Wassermotoren an der Königl Techn. Hochschule zu Berlin). Ernst Reichel. Illustrated description of the devices used. 3300 w. Zeitschr d Ver Deutscher Ing—Nov. 14, 1908. No. 1192 D.

MACHINE ELEMENTS AND DESIGN.

Brakes.

Electrically Operated Brakes for Industrial Purposes. H. A. Steen. Considers typical modern designs. Ills. 4000 w. Pro Engrs' Soc of W Penn—Nov., 1908. No. 778 D.

Circle Division.

Table for Spacing Holes in Circles. F. W. Seidensticker. A useful table for dividing circles into parts up to five hundred. 1000 w. Am Mach—Vol. 31. No. 51. No. 1073.

Clutches.

Variable Speed Clutch for Machine Tools. Illustrated description of a clutch to be used as a substitute for cone pulleys and other speed-varying devices. 1000 w. Am Mach—Vol. 31. No. 50. No. 912.

Crank Shafts.

Automobile Motor Crankshafts Discussed. Thomas J. Fay. The present number considers the materials used. Ills. 1500 w. Automobile—Dec. 17, 1908. Serial. 1st part. No. 1028.

The Graphical Design of Crank Shafts (Graphische Berechnung von Kurbelwellen). Adolf Knelles. Mathematical. Ills. 2000 w. Elektrotech Rundschau—Nov. 7, 1908. No. 1184 D.

Flat Plates.

Researches on the Distorsion and Strength of Flat Plates (Versuche über die Formänderung und die Widerstandsfähigkeit ebener Wandungen). C. Bach. Reports extensive tests, the results of which are applicable to both steel and reinforced-concrete construction. Ills. Serial. 1st part. 3800 w. Zeitschr d Ver Deutscher Ing—Nov. 7, 1908. No. 1188 D.

Gear Boxes.

An Eighteen-Speed-Gear Box. C. A. Legge. Line engravings with description. 700 w. Am Mach—Vol. 31. No. 52. No. 1280.

Gears.

The Hindley Worm and Gear. John Edgar. An explanation of the theory of this worm gear. Ills. 2500 w. Mach, N Y—Dec., 1908. No. 761 C.

Generating Gear Teeth of Increased Strength and Standard Hobs. H. T. Miller. Illustrated explanation of modified teeth and the conditions of contact. 1200 w. Am Mach—Vol. 31. No. 49. No. 770.

Journals.

On Journal Friction. H. P. Jordan. A critical discussion of assumptions in a paper by W. H. Scott. 2000 w. Mech Wld—Dec. 4, 1908. No. 1016 A.

The True Principles of Mechanics. Sidney A. Reeve. Discusses the present insufficiency of the mechanical concepts based on Newton's laws. 3000 w. Engr, Lond—Dec. 18, 1908. No. 1376 A.

Riveted Joints.

See Boiler Design, under STEAM ENGINEERING.

Rope Drums.

Proportions of Rope Drums Without Mathematics. George E. Barrett. Gives a diagram and explains its use. 500 w. Am Mach—Vol. 31. No. 52. No. 1277.

Slide Rules.

The "Eichhorn" Trigonometric Slide Rule. Illustrated description of a new slide rule intended for the solution of triangles. 800 w. Am Mach—Vol. 31. No. 49. No. 771.

How to Use the Slide Rule. Frederic R. Honey. Explains the principle of this invention for rapid computations, and some useful applications. 1200 w. Sci Am—Dec. 19, 1908. No. 1231.

Speed Changing.

See Gear Boxes, under MACHINE ELEMENTS AND DESIGN.

Springs.

Spring Formulae Simplified. Chester B. Albree. An attempt to simplify existing formulae and to render the solution of helical spring problems easy for anyone having standard tables of areas and decimal equivalents at hand. General discussion. 4000 w. Pro Engrs' Soc of W Penn—Nov., 1908. No. 780 D.

Stuffing Boxes.

A New High-Pressure Packing for Rotating Shafts (Eine neue Hochdruckdichtung für rotierende Wellen). Alfred Vontobel. Illustrated description of a type especially adapted for use on turbines. 1600 w. Zeitschr f d Gesamte Turbinenwesen—Nov. 10, 1908. No. 1161 D.

MACHINE WORKS AND FOUNDRIES.

Aluminium Castings.

Production of Aluminum Castings. Illustrates and describes the working of this metal in the foundry. 2500 w. Foundry—Dec., 1908. No. 753.

Boring.

Boring a Connecting-Rod End Brass in a Jig. Henry Munro. Shows a method requiring but three operations. Ills. 1000 w. Am Mach—Vol. 31. No. 51. No. 1071.

Brass Founding.

Observations on the "Spotting-Out" of Lacquered Work, and the Cleaning of Metal for Lacquering. W. A. Jones. Remarks on troubles encountered and their remedies. 2000 w. Brass Wld—Dec., 1908. No. 1324.

Castings.

The Prevention of Waster Castings. Joseph Horner. A discussion of the causes of defective castings. Ills. 2500 w. Foundry—Dec., 1908. No. 755.

Warped or Distorted Castings—Methods of Prevention. Jabez Nall. Suggestions for prevention and for treatment. Ills. 2000 w. Foundry—Dec., 1908. No. 756.

Cupolas.

Cupola Linings. Walter J. May. Directions for setting fire-bricks in a cupola. Ills. 700 w. Prac Engr—Dec. 11, 1908. No. 1201 A.

Latter-Day Cupola Practice. E. E. Riepen. Read before the Detroit Found. Assn. Methods of manipulating and operating the melting furnace of the gray iron foundry. 4500 w. Foundry—Dec., 1908. No. 754.

Drawing-Press Tools.

Press Tools Used in Typewriter Manufacture. Illustrated description of sectional dies employed, and other tools. 1500 w. Am Mach—Vol. 31. No. 52. No. 1279.

Drilling Machines.

German Portable Electric Drilling Machines. Illustrated description of a machine adapted to many uses. 1500 w. Am Mach—Vol. 31. No. 52. No. 1281.

Facing Sands.

Facing Sands and Their Use. Walter J. May. From *Eng. Mech. & Wld. of Sci.* How to obtain variations in faces. 1200 w. Sci Am Sup—Dec. 5, 1908. No. 820.

File Making.

Making Files in a Modern Plant. Illustrates and describes the methods and machinery used by Henry Disston & Sons, Philadelphia. 1200 w. Am Mach—Vol. 31. No. 51. No. 1074.

Foundries.

The Plant of the Standard Cast Iron Pipe & Foundry Co., Bristol, Pa. Illustrated description of a new plant. 2000 w. Eng Rec—Nov. 28, 1908. No. 698.

Foundry Furnaces.

The Air Required for Foundry Furnaces. Walter J. May. Its effect on the efficiency of fuel, with suggestions for securing the best results. 1500 w. Prac Engr—Dec. 4, 1908. No. 1015 A.

Foundry Management.

See Management, under INDUSTRIAL ECONOMY.

Foundry Materials.

See Steel Making, under MINING AND METALLURGY, IRON AND STEEL.

Foundry Practice.

Moulding and Casting (Formen und Giessen). G. Weigelin. A discussion of practical means of producing sound castings. Ills. 3200 w. Stahl u Eisen—Nov. 18, 1908. No. 1146 D.

Grinding.

Grinder Kinks. Paul W. Abbott. Illustrates and describes a number of tools and fixtures for use on grinding machines. 1500 w. Mach, N Y—Dec., 1908. No. 763 C.

Lathes.

A New Automatic Multiple Spindle Lathe. Illustrates and describes the features of interest. 1500 w. Ir Trd Rev—Dec. 3, 1908. No. 792.

A Heavy 36-In. American Lathe. Illustrated description of a large lathe built at Cincinnati. 1600 w. Ir Age—Dec. 24, 1908. No. 1250.

Precision Lathe for the Finishing of Steam Turbine Rotors (Präzisions-Drehbank zur Fertigbearbeitung von Dampfturbinen-Laufwalzen). Illustrated description with detailed plates of a lathe built for the Vulkan works, Stettin, by Wagner & Co. 500 w. Schiffbau—Nov. 25, 1908. No. 1165 D.

Machine Tools.

Highly Developed Special Machine Tools. Illustrates and describes tools used at the plant of the Hersey Mfg. Co. 2500 w. Am Mach—Vol. 31. No. 49. No. 769.

Messrs. Drummond Brothers' Machine-Tools at Olympia. Illustrated description, especially of the radial foot-drill built by this firm. 2500 w. Engng—Nov. 20, 1908. No. 738 A.

See also Clutches, under MACHINE ELEMENTS AND DESIGN.

Milling Machines.

Vertical Milling Machine. Illustrated description of a new pattern brought out by Messrs. Albert Herbert, Ltd. 800 w. Engng—Dec. 11, 1908. No. 1215 A.

Molding.

The Use of Strickles and Sweeps. James F. Buchanan. A summary of the advantages of these tools in the making of molds and cores. Ills. 2500 w. Foundry—Dec., 1908. No. 757.

Pattern Materials.

See Purchasing, under INDUSTRIAL ECONOMY.

Pipe Tools.

A Group of Useful Pipe-Working Tools. Philip Bellows. Illustrated description of appliances for laying out, heating, bending, testing and inspecting pipe-fittings. 1500 w. Am Mach—Vol. 31. No. 51. No. 1070.

Riveting Machines.

Portable Electro-Hydraulic Riveting Machine (Transportable elektro-hydraulische Nietmaschine). H. Spellmann. Illustrated description of a new electro-hydraulic riveter built by the Maschinenfabrik Oerlikon. 1600 w. Schiffbau—Nov. 25, 1908. No. 1166 D.

Shears.

See Electric Driving, under POWER AND TRANSMISSION.

Shop Appliances.

Details of Manufacturing Equipment. Foundry, machine shop, testing, storage and general details are described and illustrated. 2500 w. Am Mach—Vol. 31. No. 51. No. 1072.

Shop Furniture.

Metallic Shop and Store Room Furniture. Illustrated description of fireproof furniture. 1500 w. Am Mach—Vol. 31. No. 50. No. 909.

Shop Heating.

The Problem of Heating Mills. A. S. Atkinson. Suggestions for the installation of heating systems in factories. 2000 w. Dom Engng—Dec. 19, 1908. No. 1039.

Shop Lighting.

Some Notes on Shop Lighting. W. S. Giele. Discusses the relative advantages of various methods. 1200 w. Wood Craft—Dec., 1908. No. 821.

Shop Practice.

Modern Workshop Practice. R. E. L. Maunsell. Read before the Engng. & Sci. Assn. of Ireland. Briefly discusses changes due to high-speed machine tools and use of high-speed steel. 3000 w. Mech Wld—Dec. 18, 1908. No. 1387 A.

Machining Automobile Pistons. Gives sequence of operations, reviewing the essential points. Ills. 1500 w. Prac Engr—Dec. 18, 1908. No. 1386 A.

Tool Rooms.

Tool Room Methods in a Typewriter Factory. F. A. Stanley. Illustrates and describes special machines used for the construction and maintenance of jigs, fixtures and other tools. 3000 w. Am Mach—Vol. 31. No. 50. No. 911.

Tools.

Metal Cutting Tools Without Clearance. James Hartness. Describes a turning tool that is intended to cut without clearance, stating its advantages. Plates. 4500 w. Jour Am Soc of Mech Engrs—Dec., 1908. No. 837 F.

See also Tool Steel, under MATERIALS OF CONSTRUCTION.

Welding.

Welding. James Cran. Deals principally with welding as it should be done at the forge. Ills. 2500 w. Mach, N Y—Dec., 1908. No. 764 C.

Electric Welding. A. E. Buchenberg. Presents the advantages of the electric welding machine over the forge operation. 2000 w. Elec Wld—Dec. 19, 1908. No. 1272.

The Application of Autogenous Welding to the Repair of Marine Boilers (Emploi de la Soudure autogène pour la Réparation des Chaudières Marines). André Le Chatelier. A general discussion and a description of methods of repairing certain common failures. Ills. 8300 w. Rev de Métal—Nov., 1908. No. 1107 E + F.

MATERIALS OF CONSTRUCTION.

Alloy Steels.

See Gears, under AUTOMOBILES.

Aluminium.

See Aluminium Castings, under MACHINE WORKS AND FOUNDRIES.

Copper.

Copper and Copper Alloys. J. T. Milton. Abstract of paper read before the Inst. of Metals. Discusses points in relation to these metals, about which reliable information is desired. 4500 w. Mech Engr—Nov. 27, 1908. No. 855 A.

Heat Insulation.

Underground Insulation of Steam and Hot Water Pipes. Harry Gillett. A brief discusson of pipe-coverings. 1200 w. Ohio Soc of Mech, Elec, & Steam Engrs, No. 144—Nov., 1908. No. 907 N.

Metallography.

Microscopic Metallography and Its Employment in French Industries. Jacques Boyer. An illustrated detailed description of the practice followed in the leading establishments. 5500 w. Engineering Magazine—Jan., 1909. No. 1332 B.

Krupp Cemented Armor Plate Under the Microscope (La Corazza "Krupp cementata" esaminata al Microscopio). Ugo F. Gregoretti. A metallographic study. Ills. 5000 w Riv Marit—Nov., 1908. No. 1127 E + F.

See also Cooling Curves, under MEASUREMENT.

Steel.

Heat Treatment of Carbon Steel. J. H. Gill. Describes method and its application. 1200 w. Am Mach—Vol. 31. No. 50. No. 910.

High-Tensile Steel Compared with Mill Steel. Extracts from report of Prof. Archibald Barr concerning an extensive series of experiments recently carried out to determine the relative qualities. 2000 w. Ir & Coal Trds Rev—Dec. 18, 1908. Serial, 1st part. No. 1381 A.

Tool Steels.

The Manufacture and Use of High-Speed Steel. O. M. Becker. Illustrated description of methods of making high-speed tools. 3000 w. Cassier's Mag—Dec., 1908. No. 951 B.

MEASUREMENT.

Calorimetry.

See Steam Calorimeters, under STEAM ENGINEERING.

Cooling Curves.

On Methods of Obtaining Cooling Curves. G. K. Burgess. Explains methods of thermal analysis, the apparatus used, describing experimental arrangements, the characteristics of cooling curves, etc. 7500 w. Bul Bureau of Stand—Nov., 1908. No. 1345 N.

Hardness.

Ballentine's Process of Testing the Hardness and Density of Metals. Report of the Franklin Institute on the process devised by William I. Ballentine. 1200 w. Jour Fr Inst—Dec., 1908. No. 969 D.

Impact Test.

The Resistance of Materials to Impact. T. E. Stanton and L. Bairstow. A report of research work. Ills. 6000 w. Inst of Mech Engrs—Nov. 20, 1908. No. 852 N.

Different Methods of Impact Testing on Notched Bars. F. W. Harboard. A report of experiments made to compare results obtained by different methods of impact testing, and to see whether such tests detected any irregularity in steel not revealed in ordinary tests. 5500 w. Inst of Mech Engrs—Nov. 20, 1908 No. 853 N.

Lubricant Testing.

The Mechanical Testing of Oil (Ueber mechanische Oelprüfung). Dr. H. Hoffmann. Describes methods used in the laboratory of the Westphalian Mining Company and gives some of the results obtained. Ills. Serial. 1st part. 4500 w. Glückauf—Nov. 7, 1908. No. 1151 D.

Testing Laboratories.

The Work of the Reichsanstalt in 1907. Information based upon the official report and on publications of special researches. 3000 w. Engng—Dec. 18, 1908. Serial 1st part. No. 1371 A.

Materials-Testing and Gas-Engine Laboratories of the Darmstadt Technical High School (Die Materialprüfungsanstalt und das Gasmaschinenlaboratorium der Technischen Hockschule zu Darmstadt). O. Berndt. A brief description of their equipment. Ills. 2500 w. Zeitschr d Ver Deutscher Ing—Nov. 21, 1908. No. 1195 D.

Torsion Meters.

Torsion Meters. Frederick T. Edgecombe. Gives some torsion diagrams of marine engines, and results hitherto unpublished. 1300 w. Engr, Lond—Nov. 27, 1908. No. 868 A.

POWER AND TRANSMISSION.

Air Compression.

A Cheap, Efficient Method of Compressing Air. Jos. H. Hart. Discusses mechanical refrigeration as an aid to air compression for mining purposes. 3500 w. Min Wld—Dec. 4, 1908. No. 845.

Air Compressors.

Compressed Air for Mining in Cobalt District. Alex. Gray. Information concerning the Taylor hydraulic air compressor system. Ills. 2500 w. Min Wld —Dec. 12, 1908. No. 1032.

Centrifugal Compressors (Ueber Turbogebläse). C. Regenbogen. Discusses their design, operation, efficiency, etc. Ills. 6300 w. Stahl u Eisen—Nov. 25, 1908. No. 1147 D.

Belt Driving.

Leather Belting Compared to Rope Drives. John H. Damon. A critical review of paper on this subject by Harrington Emerson. 3500 w. Power—Dec. 22, 1908. No. 1083.

Leather Belting Compared to Rope Drives. Harrington Emerson. Read before the Leather Belting Mfrs. Assn. A comparison of claims made, and discussion of rope and belt transmission. 3500 w. Power—Dec. 1, 1908. No 724.

Electric Driving.

Individual Motor Drive. W. B. Komvenhoven. Some of the advantages of the individual drive are stated and types of motors discussed. 2500 w. Ry & Loc Engng—Dec., 1908. No. 795 C.

Electric Driving of Machine Tools. A. G. Seaman. Abstract of a paper read before the Coventry Engng. Soc. The advantages, efficiency, etc., are discussed. 1500 w. Elect'n, Lond—Dec. 11, 1908. No. 1212 A.

The Application of Motors to Machine Tools. Dexter S. Kimball. Discusses how far the individual drive may be carried with advantage, group driving and matters relating to it, speed control, etc. 4500 w. Mech Engr—Nov. 27, 1908. No. 858 A.

Characteristics of Motors for Large Shears. Brent Wiley. Outlines the conditions which the motor speed characteristics should meet, showing the importance of properly choosing so that the fly-wheel may do the cutting work. 3000 w. Pro Am Inst of Elec Engrs—Jan., 1908. No. 1365 F.

Lubricants.

See Lubricant Testing, under MEASUREMENT.

Mechanical Plants.

Mechanical Power in Country Houses. Illustrated description of an installation near Godalming, giving water supply and electrical equipment. 2200 w. Engng—Dec. 11, 1908. No. 1214 A.

City Investing Building's Power Plant. Thomas Wilson. Illustrated description of a modern plant for a 33-story building having many features of interest. 3500 w. Power—Dec. 15, 1908. No. 1041.

Power Plant and Heating System at U. S. Naval Hospital, New Fort Lyon, Col. A. P. Ball. Brief illustrated description of a plant for a group of buildings. 1200 w. Elec Wld—Dec. 19, 1908. No. 1268.

Power Plant of St. Luke's Hospital, Chicago. Osborn Monnett. Illustrates and describes a plant containing special heating and ventilating features. 2500 w. Power—Dec. 15, 1908. No. 1044.

The Heating, Sanitary and Power Equipment of a Large Office Building. E. B. Lennig. Illustrated description of the systems installed in the eighteen-story Humboldt Savings Bank, San Francisco. 1000 w. Dom Engng—Dec. 5, 1908. No. 872.

Design of a New Heating and Power Plant for the University of Minnesota. Presents the general layout of machines and apparatus for a plant to heat a group of buildings. 2000 w. Minn Engr—Nov., 1908. No. 1361 C.

Power Plants.

The Reorganization of Factory Power Plants. Describes points of importance in such work. 1500 w. Mech Wld—Dec. 18, 1908. Serial. 1st part. No. 1388 A.

Rope Driving.

Rope Driving. Snowden B. Redfield. Considers method of determining the size of rope and other matters relating to rope-driving. 1500 w. Power—Dec. 8, 1908. No. 875.

See also Belt Driving, under POWER AND TRANSMISSION.

Wind Power.

Utilization of Wind Power for Driving Dynamos (Utilisation du Vent comme Force motrice pour Actionner des Dynamos). J. A. Montpellier. A general review of the subject. Ills. 3700 w. L'Elecn—Nov. 28, 1908. No. 1116 D.

STEAM ENGINEERING.

Air Pumps.

Experiments on Air-Pumps. Dr. J. Morrow and J. T. Dixon. Describes experiments made. 2000 w. Engng—Nov. 20, 1908. No. 739 A.

Boiler Design.

Reinforced Openings in Boiler Shells. S. F. Jeter. Directions for calculating manhole reinforcements. Ills. 4000 w. Power—Dec. 22, 1908. No. 1080.

Strength of Riveted Joints. J. W Rausch. From a lecture at Baltimore, Md. Gives a mathematical determination of the efficiency of various kinds of riveted joints. Ills. 2000 w. Boiler Maker—Dec., 1908. No. 766.

The Strength of Riveted Joints. J. W. Rausch. Explains different causes of failure in lap and butt joints; how to find the pitch, and to estimate the efficiency of plate and joint. 2500 w. Power—Dec. 15, 1908. No. 1042.

Diagram for Finding Efficiency of Riveted Joints. J. P. Morrison. Gives chart and examples illustrating its use. 1700 w. Boiler Maker—Dec., 1908. No. 768.

See also Flat Plates, under MACHINE ELEMENTS AND DESIGN.

Boiler Fittings.

Boiler Fittings. William J. Ranton. Considers only the necessary fittings. 2500 w. Boiler Maker—Dec., 1908. No. 767.

Boiler Inspection.

Steam Boiler Inspection. C. M. Hansen. Gives reasons for the enacting of an engineer's license law, and the required construction and inspection of boilers. Ills. 2200 w. Boiler Maker—Dec., 1908. No. 765.

Boiler Management.

See Smoke Prevention, under STEAM ENGINEERING.

Boilers.

The Jacobi Boiler and Superheater (Der Jacobi-Kessel und Jacobi-Ueberhitzer). C. Forst. Illustrated description. Serial. 1st part. 1500 w. Die Turbine—Nov. 20, 1908. No. 1159 D.

Boiler Tests.

Tests on Boiler Evaporation at Broken Hill, Block 10. E. F. Stanley Low. Experimental tests to show to what extent the evaporative efficiency could be increased by stoking in such a manner as to increase the percentage of carbon dioxide in the flue gases. Diagrams. 3000 w. Aust Min Stand—Nov. 18, 1908. No. 1094 B.

Boiler Waters.

See Locomotive Feed Water, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Condensers.

Condensers and the Economy of Their Use. Charles L. Hubbard. Discusses the action and economy of the usual types as compared with a non-condensing plant using exhaust steam for heating. Ills. 5000 w. Power—Dec. 22, 1908. No. 1081.

Surface-Condensers for Steam Turbines. An editorial review of a paper by Prof. E. Josse, before the Schiffbautechnische Gesellschaft, on "Surface-Condensation for Steam-Turbines, Especially for Ships." 5000 w. Engng—Dec. 11, 1908. No. 1358 A.

Engine Governing.

Governors and the Speed Regulation of Steam Engines. Prof. G. F. Charnock. Deals particularly with pendulum governors. 2500 w. Mech Engr—Nov. 27, 1908. Serial. 1st part. No. 857 A.

Engine Relief Valves.

Relief Valves. Remarks on their Design. Ills. 1000 w. Mech Wld—Nov. 20, 1908. No. 726 A.

Engines.

The Lanz Locomobile. Illustrated description of an engine exhibited at Olympia which has many unusual features. 1500 w. Engr, Lond—Dec. 4, 1908. No. 1024 A.

See also Steam Engines, under MARINE AND NAVAL ENGINEERING; and Hoisting Engines, under MINING AND METALLURGY, MINING.

Entropy.

The Question of Entropy. A paper by J. Swinburne, replying to a previous paper by Prof. S. A. Reeve, with also a reply by Prof. Reeve to Mr. Swinburne's paper. 6000 w. Harvard Engng Jour—Nov., 1908. No. 1322 D.

Feed-Water Heating.

Means and Methods of Heating the Feed Water of Steam Boilers. Reginald Pelham Bolton. Discusses the economy of heating by live steam, in this second article of a series. Ills. 2000 w. Engineering Magazine—Jan., 1909. No. 1331 B.

Fuel Oil.

Unnecessary Losses in Firing Fuel Oil and an Automatic System for Eliminating Them. C. R. Weymouth. Explains the principle of operation, details of construction, and results in trial of the Moore-Patent automatic fuel oil regulating system. Ills. 6500 w. Jour Am Soc of Mech Engrs—Dec., 1908. No. 839 F.

Fuels.

See Mine Sampling, under MINING AND METALLURGY, COAL AND COKE.

Indicators.

The Hopkinson Flashlight Indicator. Illustrated description of an indicator for high speeds. 800 w. Engng—Dec. 11, 1908. No. 1216 A.

Smoke Prevention.

A Practical Study in Smoke Prevention. H. S. Knowlton. Gives results of recent tests made on a large New England plant, and the remedies suggested. 2200 w. Power—Dec. 29, 1908. No. 1315.

Smokeless Combustion. Charles L. Hubbard. Considers firing and furnace construction in their relation to the prevention of smoke. 2000 w. Elec Rev, N Y—Dec. 5, 1908. Serial. 1st part. No. 823.

Steam Calorimeters.

Steam Calorimeters. Charles N. Cross. Illustrated description of the Barrus "Universal" steam calorimeter and its working. 1200 w. Power—Dec. 29, 1908. No. 1316.

Steam Pipes.

Selection and Safety of Pipe Fittings. A. J. Dixon. Discusses the effect on the safety factor of faulty fittings to steam pipes. 1800 w. Power—Dec. 15, 1908. No. 1043.

The Theory of the Design of Pipes for the Transmission of Saturated and Superheated Steam (Zur Theorie der Berechnung von Rohrleitungen für gesättigte und überhitzte Dämpfe). Dr. M. Wierz. Mathematical. 3000 w. Gesundheits-Ing—Nov. 7, 1908. No. 1169 D.

Steam Properties.

Banki's Steam Diagram (Diagramme de M. Banki pour la Vapeur d'Eau). Translated from *Zeitschrift für das Gesamte Turbinenwesen.* Gives a diagram showing the temperature drop in calories in adiabatic expansion with explanation of its use. Ills. 2500 w. Rev de Mécan—Nov., 1908. No. 1110 E + F.

Stoking.

Firing Stationary Boilers Economically. F. R. Wadleigh. Suggestions on methods of firing, regulation of air supply; cleaning, kindling and banking fires, and smoke prevention. 7000 w. Power—Dec. 8, 1908. No. 877.

Superheaters.

See Boilers, under STEAM ENGINEERING.

Turbines.

Oerlikon Steam Turbines. Illustrated detailed description of the latest type of these machines. 2200 w. Elect'n, Lond—Dec. 4, 1908. No. 1008 A.

The Development of the Small Steam Turbine. Charles A. Howard. This second, and concluding part discusses the service applications to which this type of prime mover is particularly adapted. 4000 w. Engineering Magazine—Jan., 1909. No. 1327 B.

The Development of Steam Turbines, Particularly of the Impulse Type (Du Développement des Turbines a Vapeur et particulièrement de la Turbine à Action). M. Reuter. Translation from *Zeitschrift des Vereines Deutscher Ingenieure.* Ills. 5000 w. All Indus—Nov., 1908. No. 1118 D.

Steam Turbines of Low Power (Einiges über Dampfturbinen für geringe Leistung). R. Roskowetz. A discussion of their development, types, design, etc. Ills. Serial. 2200 w. Zeitschr f d Gesamte Turbinenwesen—Nov. 10, 1908. No. 1160 D.

See also Stuffing Boxes, under MACHINE ELEMENTS AND DESIGN; Condensers, under STEAM ENGINEERING; and Turbo-Generators, under ELECTRICAL ENGINEERING, DYNAMOS AND MOTORS.

Valve Gears.

Setting the Valves of a Russell Engine. Hubert E. Collins. A study of valve movement of four-valve engine with Meyer cutoff and separate exhaust valves of rotative type. Ills. 3500 w. Power—Dec. 1, 1908. No. 721.

Valves.

Locating and Adjusting Valves. W. H. Wakeman. Remarks concerning gate valves and other types. 1200 w. Power—Dec. 22, 1908. No. 1082.

TRANSPORTING AND CONVEYING.

Auto Trucks.

Application of the Storage Battery to Auto Trucks. Illustrated detailed description of the system in use in the Westinghouse machine shops, Pittsburg. 1800 w. Ir Trd Rev—Dec. 3, 1908. No. 791.

Cableways.

The Employment of Suspension Railways in Ironworks. Illustrates and describes applications showing the adaptability of this system. 1500 w. Engr, Lond—Dec. 18, 1908. No. 1377 A.

A Dock Cableway at the Reiherstieg Shipbuilding and Machine Works, Hamburg (Die Hellingseilbahnanlage der Reicherstieg-Schiffswerft und Maschinenfabrik in Hamburg). Anton Böttcher. Illustrated description of a unique dock installation. 4000 w. Zeitschr d Ver Deutscher Ing—Nov. 14, 1908. No. 1191 D.

Cableway Chariots (Die Klemmapparate der Drahtseilbahnen). A. Pietrokowski. A historical and critical review of various types. Ills. 3500 w. Stahl u Eisen—Nov. 18, 1908. No. 1144 D.

Coal Handling.

Handling Coal by Electric Shovels. Edgar H. Wallington. Illustrates and describes electric cranes of different types. 1200 w. Sib Jour of Engng—Dec., 1908. No. 1350 C.

English Practice in Coal Handling Plants. James A. Seager. General outline of methods employed in Great Britain, with illustrated descriptions of certain devices. 3000 w. Power—Dec. 29, 1908. No. 1314.

Coal-Loading Plant for Japan. Illustrates and describes a novel plant for loading a ship with coal, at the rate of 500 tons per hour. 700 w. Col Guard—Dec. 18, 1908. No. 1367 A.

Conveyors.

Handling Crushed Rock on San Francisco Bay. F. K. Blue. Illustrated description of the belt conveyors and bucket elevators which convey the material to and from bins and load and discharge the hopper barges. 1500 w. Eng & Min Jour—Dec. 12, 1908. No. 965.

Cranes.

The Construction Plant for the Pacific Locks of the Panama Canal. Illustrated description of cantilever cranes. 1200 w. Eng Rec—Dec. 19, 1908. No. 1057.

See also Coal Handling, under TRANSPORTING AND CONVEYING.

Dock Machinery.

See Cableways, under TRANSPORTING AND CONVEYING.

Elevators.

The Operation of Passenger Elevators. Reginald Pelham Bolton. A study of conditions of operation and the effect on service. 3000 w. Pro Am Soc of Civ Engrs—Dec., 1908. No. 1354 E.

Ice Handling.

Ice-Handling Machinery in Ice-Manufacturing Plants. Frank H. Abbey. Illustrates and describes methods and machines. 3000 w. Ice & Refrig—Dec., 1908. No. 997 C.

Industrial Railways.

A Successful Investment in an Industrial Railway. John M. Bruce. Illustrated description of a plant in Newark, N. J., for handling gypsum from steamer to storage yard. 1500 w. Engng-Con—Nov. 25, 1908. No. 714.

Narrow-Gauge Railway for a Gas-Works. Illustrated detailed description of the recently completed line connecting Harrogate with the Northeastern Ry. Co.'s lines at Bilton. 1200 w. Engr, Lond—Nov. 20, 1908. No. 744 A.

MISCELLANY.

Aeronautics.

Fundamental Principles in the Design of Aeroplanes (Grundzüge für den Bau des Drachenfliegers). Josef Hofmann. An exhaustive discussion. Ills. Plates. Serial. 1st part. 5500 w. Oest Wochenschr f d Oeff Baudienst—Nov. 21, 1908. No. 1183 D.

Mechanical Flight. Herbert Chatley. Indicates points in which improvement is desired, reviewing prevailing types. Ills. 4500 w. Soc of Engrs—Dec. 7, 1908. No. 1339 N.

Mechanical Flight. Eric Stuart Bruce. Reviews the work of different experimenters in this field, recent achievements, and related matters. General discussion. 9000 w. Jour Soc of Arts—Dec. 4, 1908. No. 998 A.

Aerial Propellers. Sidney H. Hollands. Discusses old and new forms. 1500 w. Sci Am Sup—Dec. 11, 1908. No. 1233.

The Influence of Combustion Motors on Transport (Influenza dei Motori ad Essenza nell' Industria dei Trasporti). Giuseppe Colombo. Refers principally to their use in airships and aeroplanes. 5500 w. Industria—Nov. 1, 1908. No. 1131 D.

Some Light Engines for Aeroplanes. Illustrates and describes models. 2000 w. Auto Jour—Dec. 12, 1908. No. 1099 A.

Power Generation and Transmission in Aeroplanes. W. F. Bradley and H. W. Perry. An illustrated article discussing the mechanical features of the best-known types. 3000 w. Engineering Magazine—Jan., 1909. No. 1330 B.

Aeroplane-Type Flying Machines. Harry Wilken Perry. Illustrated review of what has been accomplished. 3000 w. Mach, N Y—Dec., 1908. No. 762 C.

The Wright and Vorsin Types of Flying Machine: A Comparison. F. W. Lanchester. Read before the Aërnautical Soc. of Gt. Britain. An account of the performance of both machines, comparing the two systems. 5500 w. Engr, Lond—Dec. 18, 1908. No. 1379 A.

Recent Progress in Aviation (Les Progrès récents de l'Aviation). G. Espitallier. Reviews the work of Wright, Farman and Blériot. Ills. Serial. 1st part. 2800 w. Génie Civil—Nov. 21, 1908. No. 1123 D.

Floating and Flying Navies. J. C. Bayles. An informal discussion of the military value of aerial navigation. 8000 w. Cassier's Mag—Dec., 1908. No. 945 B.

The Possibility of Making Use of Balloons and Motor Air-Ships in the Navy. Trans. from an article by Captain Neumann, in *Marine-Rundschau*. A study of what balloons and motor air-ships are capable of performing, with special reference to their use for naval purposes. 7000 w. Jour Roy United Serv Inst—Nov., 1908. Serial. 1st part. No. 891 N.

The Present Status of Military Aëronautics. George O. Squier. An outline of the present state of mechanical flight. Appendices, bibliography, and 25 plates 28000 w. Jour Am Soc of Mech Engrs—Dec., 1908. No. 836 F.

The Vacuum Airship. G. J. Derb. Calls attention to a possible method of dispensing with hydrogen. 1000 w. Sci Am—Dec. 19, 1908. No. 1230.

Safety Devices.

Safety Appliances on Cotton-Scutchers and Lap-Machines. Explains the dangers to workmen and illustrates and describes appliances for their protection. 2500 w. Engng—Dec. 18, 1908. No. 1369 A.

The Prevention of Accidents in Mechanical Workshops (Contributo alla Prevenzione degli Infortuni nelle Officine meccaniche). F. Massarelli. The first part begins a discussion of hand labor. Ills. Serial. 1st part. 2500 w. Industria—Nov. 22, 1908. No. 1134 D.

MINING AND METALLURGY

COAL AND COKE.

Accidents.

Fatal Acicdents in Coal Mines of America. Frederick L. Hoffman. Statistics showing that over 3000 persons were killed in 1907. 3500 w. Eng & Min Jour—Dec. 19, 1908. No. 1051.

Analysis.

The Ultimate Analysis of Coal. Lionel S. Marks. The hydrogen, total carbon, oxygen and nitrogen contents are expressed in curves based on the Government analyses of coal. 1500 w. Power—Dec. 1, 1908. No. 723.

Coal Cutters.

Coal Cutting in Northern Coalfield, England. George R. Dixon. Gives comparison of mining costs and shows that mining machines have increased the earning power and lessened labor. 1800 w. Eng & Min Jour—Dec. 5, 1908. No. 827.

Coking By-Products.

The Production of Benzol in the Coking of Bituminous Coal (Steinkohlenverkokung und Benzolgewinnung). Dr. Fritz Hönigsberger. Discusses benzol as an automobile fuel and the method of its production in by-product coking. Ills. 5000 w. Zeitschr d Mit Motorwagen-Ver —Nov. 30, 1908. No. 1176 D.

Coking Plants.

Jones & Laughlin's Coke Plant. William L. Affelder. Illustrated description of an installation of 1500 coke ovens in Pittsburg. 3500 w. Mines & Min—Dec., 1908. No. 715 C.

Colorado.

Routt County, Colorado, Coals. R. L. Herrick. A compilation from various sources concerning the geology, deposits, qualities, etc. Ills. 5000 w. Mines & Min —Dec., 1908. No. 719 C.

Electric Power.

Some Applications of Electric Power in Belgium (Quelques Applications de l'Electrotechnique en Belgique). Alfred Lambotte. The fifth part describes the installations of the Société des Charbonnages de Courcelles-Nord. Ills. 6000 w. Soc Belge d Elecns—Nov., 1908. No. 1100 E.

England.

Our Steam Coal and Its Uses. Sir Lees Knowles. From presidential address before the Manchester Geol. & Min. Soc. 4000 w. Col Guard—Dec. 18, 1908. No. 1368 A.

Explosions.

Prevention of Coal Dust Explosions in Mines. William N. Page. Gives reducing the velocity of ventilating currents as an effective remedy. 1500 w. Min Wld—Nov. 28, 1908. No. 710.

Facts Concerning the Marianna Explosion. Floyd W. Parsons. An illustrated discussion of the cause of the accident at this model mine in Pennsylvania. The fan indicator diagram shows that ventilation stopped 25 minutes before the explosion. Also editorial. 4500 w. Eng & Min Jour —Dec. 12, 1908. No. 967.

Germany.

The Geological Structure between Menden and Witten (Beiträge zur Kenntnis des Schichtenaufbaus zwischen Menden und Witten). Herr Kokuk. Illustrated description of the formation in this coal district. 3300 w. Glückauf—Nov. 21, 1908. No. 1152 D.

Mine Dust.

British Coal-Dust Experiments. Gives results of 26 experiments with coal and stone dust at Altofts. Ills. 4500 w. Mines & Min—Dec., 1908. No. 720 C.

Dust as a Factor in Mine Explosions. William N. Page. Considers the watering of mines to be dangerous, and gives recommendations. 1500 w. Eng & Min Jour—Dec. 5, 1908. No. 828.

Mine Fires.

An Underground Fire Disaster. James Ashworth. An account of the disaster which occurred at Hamstead colliery, England. 2500 w. Eng & Min Jour—Nov. 28, 1908. No. 707.

Fighting a Mine Fire at Close Range with Oxygen-Breathing Apparatus. F. W. Gray. Illustrates and describes experience at Sydney No. 1 Mine, Nova Scotia. 1600 w. Mines & Min—Dec., 1908. No 717 C.

Mine Sampling.

Mine Sampling and Chemical Analyses of Coal Tested at the United States Fuel Testing Plant, Norfolk, Va., in 1907. John Shober Burrows. A report of tests. 4000 w. U. S. Geol Surv—Bul. 362. No. 1338 N.

Mine Ventilation.

The Ventilation of Mines. Abstract of a lecture by W. H.. Hepplewhite. Considers the splitting of the air current, its vagaries, circulation, etc. 2500 w. Ir & Coal Trds Rev—Dec. 11, 1908. No. 1226 A.

Mining.

The Working of the Inclined Seams in the St. Etienne Coalfield, at the Montrambert and La Beraudiere Collieries. Hugh Clarkson Annett. Abstract of a paper before the N. of England Inst. of Min. & Mech. Engrs. Describes methods of working. 2200 w. Ir & Coal Trds Rev —Dec. 18, 1908. No. 1380 A.

Some Experiments and Improvements in Mining in Austria (Einige Versuche und Verbesserungen beim Bergbau in Oesterreich). Discusses recent practice in coal mining. Ills. Serial, 1st part. 2500 w. Oest Zeitschr f Berg u Hüttenwesen—Nov. 21, 1908. No. 1149 D.

See also Coal Cutting, under COAL AND COKE; and Pumping, and Timber Drawing, under MINING.

Oklahoma.

The Coal Resources of Oklahoma. Charles N. Gould. Information in regard to these deposits. 1200 w. Min Wld—Dec. 12, 1908. No. 1033.

Philippines.

Philippine Coals. Alvin J. Cox. Abstract of a paper in "The Mineral Resources of the Philippine Islands." Gives analyses, steaming tests, and other information. 1200 w. Eng & Min Jour—Nov. 28, 1908. No. 706.

Rescue Appliances.

See Mine Fires, under COAL AND COKE.

Safety Lamps.

The Various Methods of Lighting Safety Lamps (Ueber die verschiedenen Arten der Sicherheitslampen-Zündung). Herr Beyling. Describes the methods and devices used and discusses their utility and safety. 4500 w. Glückauf—Nov. 28, 1908. No. 1155 D.

Storage.

Storage of Coal Under Water and Tests of the Weathering of Coal. Reports results of experiments and tests. 1200 w. Eng News—Dec. 24, 1908. No. 1243.

Washing.

The Operation of a Coal Washery in Colorado. W. F. Murray. Describes old and new methods. Ills. 1500 w. Eng & Min Jour—Dec. 26, 1908. No. 1275.

Weathering.

See Storage, under COAL AND COKE.

West Virginia.

Coal Fields of West Virginia. H. H. Stoek. The geology of the region with description of the coals, and analyses from different seams. Maps. 3500 w. Mines & Min—Dec., 1908. Serial, 1st part. No. 718 C.

COPPER.

Costs.

Calumet & Hecla Costs. L. S. Austin. Information taken from testimony given in a suit in 1907. 1500 w. Min & Sci Pr—Dec. 19, 1908. Serial, 1st part. No. 1262.

Germany.

Mansfield Electrically Operated Copper Mines. Frank C. Perkins. Illustrated description of German mines where furnace gases are utilized for generating electric power. 2200 w. Min Wld—Dec. 26, 1908. Serial, 1st part. No. 1254.

New Mexico.

Mining and Milling Near Silver City, New Mex. Robert B. Brinsmade. Illustrated description of the development of a district producing gold, silver, copper, lead and zinc. 3500 w. Min Wld—Dec. 26, 1908. No. 1257.

Reduction.

A New Method of Extracting Copper from Its Ores (Ein neus Kupfergewinnungs-Verfahren). Dr. O. Frölich. Describes a leaching process with ferric chloride with subsequent precipitation of copper on iron. Ills. 3300 w. Elektrochem Zeitschr—Nov., 1908. No. 1140 D.

Smelter Stacks.

See Stacks, under CIVIL ENGINEERING, CONSTRUCTION.

Smelting.

Copper-Gold Smelting at Magistral. Robert Linton. Illustrated description of this plant and practice in Mexico, where copper is used as a collector for the precious metals. 2000 w. Min & Sci Pr—Dec. 19, 1908. No. 1261.

Tennessee.

Mines and Works of the Tennessee Copper Co. B. Britton Gottsberger. Illustrated description of the mines and methods. 3500 w. Bul Am Inst of Min Engrs—Nov., 1908. No. 1064 C.

Mining and Smelting in the Ducktown District. Edwin Higgins. Copper and sulphuric acid produced from ore averaging 2 per cent. copper. Ills. 2500 w. Eng & Min Jour—Dec. 26, 1908. No. 1273.

Utah.

Ore Occurrence at Fortuna Mine, Bingham, Utah. Edward R. Zalinski. Illustrated description of the topography, geology, vein system, etc., of this copper mine. 4500 w. Eng & Min Jour—Dec. 19, 1908. No. 1047.

Yukon.

Copper Deposits of White Horse. T. A. Rickard. Information concerning these deposits in the Yukon Territory, and their development. Map. 1400 w. Min & Sci Pr—Dec. 5, 1908. No. 920.

GOLD AND SILVER.

Alaska.

See Placers, under GOLD AND SILVER.

Amalgamation.

Amalgamation Methods. H. W. MacFarren. Discusses methods of different amalgamators. 3000 w. Min & Sci Pr—Dec. 12, 1908. No. 1068.

Australia.

Metallurgical Practice in the Gold Fields of West Australia. Arthur Selwyn-Brown. Gives a summary of the crushing and cyaniding processes adopted for the treatment of difficult ores. Ills. 5000 w. Engineering Magazine—Jan., 1909. No. 1328 B.

Deep Mining at Kalgoorlie, Western Australia. Percy Ifould. Discusses the prospects and possibilities. Ills. 2000 w. Aust Min Stand—Nov. 18, 1908. No. 1091 B.

The Geology of Victorian Gold Occurrence. T. S. Hart. The present number describes the geology of the containing rocks. 3000 w. Aust Min Stand—Nov. 18, 1908. Serial, 1st part. No. 1092 B.

The Deepest Gold Mine in the World. Donald Clark. Information concerning the Victoria Quartz mines, being tested at a depth of 4,525 ft. 2000 w. Aust Min Stand—Nov. 18, 1908. No. 1089 B.

Walhalla and District Mines (V.). Information concerning these auriferous mines with treatment chart. 3500 w. Aust Min Stand—Nov. 11, 1908. No. 1087 B.

The Oaks Goldfield. An illustrated description of the latest auriferous discovery in Queensland. 1200 w. Queens Gov Min Jour—Nov. 14, 1908. No. 1086 B.

Bolivia.

See Peru, under GOLD AND SILVER.

California.

See Hydraulic Mining, under GOLD AND SILVER.

Colorado.

La Plata Mountains, Colorado. R. H. Toll. Describes a mining region attracting attention, giving information concerning the gold and silver ores. 3300 w. Min & Sci Pr—Nov. 28, 1908. No. 790.

Cyaniding.

See Australia, under GOLD AND SILVER.

Dredging.

Gold-Dredging and Hydraulic Sluicing in Victoria. D. B. Sellars. A report of the work. 2000 w. N Z Mines Rec—Oct. 16, 1908. No. 1001 B.

Dredging on the Seward Peninsula. T. A. Rickard. An account of experience with a number of dredges, discussing the probability of its being profitable. Ills. 5000 w. Min & Sci Pr—Nov. 28, 1908. No. 789.

Gold Value.

Has the Value of Gold Depreciated? Walter Renton Ingalls. Discusses the effect of the cheaper production of gold. 5500 w. Eng & Min Jour—Nov. 28, 1908. No. 703.

Hydraulic Mining.

Practical Methods of Examining and Fitting Up a Hydraulic Mine. H. A Brigham. A review of the methods of hydraulic mining as practiced in California. Ills. 16000 w. Jour Assn of Engng Socs—Oct., 1908. No. 783 C.

San Antonio de Poto Hydraulic Mine, Peru. W. E. Gordon Firebrace. An illustrated account of this famous placer mine. 1200 w. Min & Sci Pr—Dec. 5, 1908. No. 921.

See also Dredging, under GOLD AND SILVER.

Mexico.

See Labor, under MINING.

Nevada.

The Goldfield Type of Ore Occurrence. Robert T. Hill. Describes the peculiar occurrence, said to be due to the action of acidic non-ferruginous vapors incidentally causing alunitization. Ills. 4000 w. Eng & Min Jour—Dec. 5, 1908. No. 825.

Camp Alunite, a New Nevada Gold District. Robert T. Hill. Illustrates and describes a new camp, situated and mineralized like the Goldfield district. 2500 w. Eng & Min Jour—Dec. 19, 1908. No. 1050.

See also Prospecting, under MINING.

New Mexico.

Sylvanite, New Mexico, the New Gold Camp. Fayette A. Jones. Gives the history of a district that has been worked for turquoise, lead, and copper, and now for gold. Ills. 1500 w. Eng & Min Jour—Dec. 5, 1908. No. 826.

See also same title, under COPPER.

New Zealand.

The Future of New Zealand's Alluvial Goldfields. Considers the available ground and its value, methods and machinery, and the personal factor. 4000 w. Min Jour—Nov. 21, 1908. No. 734 A.

See also Dredging, under GOLD AND SILVER.

Patio Process.

The Patio Process. C. Perez Duarte. An explanation of the theory of this Mexican amalgamation process. 5000 w. Jour Chem, Met, & Min S of S Africa—Oct., 1908. No. 1084 E.

Peru.

The Goldfields of Eastern Peru and Bolivia. Sir W. Martin Conway. Map and description, with general discussion. 8000 w. Jour Soc of Arts—Nov. 27, 1908. No. 848 A.

See also Hydraulic Mining, under GOLD AND SILVER.

Placers.

Mining Methods in the North. T. A. Rickard. Traces the evolution of methods of mining gold-bearing gravel in Alaska. Ills. 3000 w. Min & Sci Pr—Dec. 12, 1908. Serial, 1st part. No. 1067.

See also Prospecting, under MINING.

Wyoming.

The South Pass Gold Mining District, Wyoming. Henry C. Beeler. History of the early mining and development, describing the ores and treatment. 3500 w. Min Wld—Dec. 26, 1908. No. 1256.

IRON AND STEEL.

Alabama.

Iron Operations of the Birmingham District. Edwin Higgins. Describes the deposits and the methods of mining, the smelting, and the economic and industrial conditions. Ills. 4000 w. Eng & Min Jour—Nov. 28, 1908. No. 704.

Iron Operations in Northeastern Alabama. Edwin Higgins. Illustrated description of practice in mining the thin red-ore seams and brown-ore banks, and of features of iron blast-furnace operation. 2500 w. Eng & Min Jour—Dec. 5, 1908. No. 824.

Analysis.

A Rapid Method for the Analysis of Tin and Terne Plate. R. S. Hiltner, in *West. Chem. & Met.* Gives specifications and methods of analysis, with details of the recommended method. 2500 w. Min Jour—Dec. 12, 1908. No. 1204 A.

The Standardization of Potassium Permanganate Solution and Its Subsequent Use in Titrating Iron. Cornelis Offerhaus and Ernest H. Fischer. An account of the writers' experience with standards for this solution. 1200 w. Sch of Mines Qr—Nov., 1908. No. 975 D.

Bessemer Process.

The Basic Bessemer Plant at the Burbach Works (Das neue Thomasstahlwerk der Burbacher Hütte). F. Schroeder. Illustrated description. Plates. 11000 w. Stahl u Eisen—Nov. 11, 1908. No. 1142 D.

The New Basic-Bessemer Steel Plant at the Burbach Works. F. Schröder, in *Stahl und Eisen*. Illustrated detailed description of the plant and its equipment. 2500 w. Ir & Coal Trds Rev—Dec. 11, 1908. Serial, 1st part. No. 1224 A.

China.

The Iron Industry in the Yangtse-Kiang Valley. Information concerning the mineral wealth and of the works of the Hanyang Iron & Steel Co. 1200 w. Ir & Coal Trds Rev—Nov. 20, 1908. No. 747 A.

Dry-Air Blast.

Gayley's Invention of the Dry Blast. Rossiter W. Raymond. Read at Chattanooga meeting of the Am. Inst. of Min. Engrs. Discusses the value of this invention and its commercial economy. 4000 w. Eng & Min Jour—Dec. 19, 1908. No. 1049.

Refrigeration Applied to Air Supply for Blast Furnaces. Bruce Walter. Read before the Am. Soc. of Refrig. Engrs. Describes the refrigerating apparatus for the Isabella Plant of the U. S. Steel Corporation, and states the advantages. 2500 w. Cold Storage & Ice—Dec., 1908. No. 992 C.

Electro-Metallurgy.

The Electro - Metallurgy of Iron (L'Electrosiderurgie). Charles Le Chatelier. Comments on, and abstracts of, recent publications on the purification of steel in the electric furnace and on the general progress of the electro-metallurgy of iron. Ills. 6500 w. Rev de Métal—Nov., 1908. No. 1109 E + F.

Progress in the Electro-Metallurgy of Iron and Steel (Die weiteren Fortschritte der elektrischen Eisen- und Stahlgewinnung). Dr. Albert Neuburger. A review of progress in electric-furnace design and applications. Ills. Serial, 1st part. 4700 w. Glasers Ann—Nov. 15, 1908. No. 1168 D.

See also same title, under ELECTRICAL ENGINEERING, ELECTRO-CHEMISTRY.

Harmet Process.

The Harmet Process Applied to Open-Hearth Steel at the "Deutscher Kaiser" Works, Bruckhausen (Das Harmetverfahren im Martinbetriebe der Gewerkschaft "Deutscher Kaiser" in Bruckhausen). Illustrated description of methods, appliances and results. 6500 w. Stahl u Eisen—Nov. 4, 1908. No. 1141 D.

Italy.

The Iron and Steel Industries of Italy. Abstract of a paper by M. P. Nicou. A review of deposits, production, imports, exports, etc. 2500 w. Ir & Coal Trds Rev—Dec. 11, 1908. No. 1225 A.

New York.

Stripping Clinton Iron Ore in New York State. Edwin Higgins. Describes these hematite beds and their development. Ills. 2000 w. Eng & Min Jour—Dec. 12, 1908. No. 964.

Open Hearth.

See Harmet Process, under IRON AND STEEL.

Rolling Mills.

The Continuous Sheet Mill Patents. The decision in the Donner-Bray infringement case. 4000 w. Ir Age—Dec. 17, 1908. No. 1036.

New Gas-Driven Rolling-Mill Plant at Mossend Works. Illustrated description of the gas plant for new rolling-mill engines and furnaces, at these large works near Glasgow. 4000 w. Engng—Nov. 27, 1908. No. 865 A.

Electrically - Driven Reversing Roll Trains (Ueber elektrische Umkehr-Walzenstrassen). B. K. Lambrecht. An exposition of driving methods. Ills. 2000 w. Stahl u Eisen—Nov. 18, 1908. No. 1143 D.

New Portable Roll Ways (Neuere fahrbare Hebetische). Illustrated description of recent conveying devices for rolling mills. 2400 w. Stahl u Eisen—Nov. 18, 1908. No. 1145 D.

See also Gas Engines, under MECHANICAL ENGINEERING, COMBUSTION MOTORS.

Sheets.

See Rolling Mills, under IRON AND STEEL.

Steel Making.

Steel by the Direct Process. Oscar Stromborg. Describes a method of charging carbon below the surface of the molten bath. 2500 w. Ir Age—Dec. 24, 1908. No. 1251.

The Manufacture of Steel for Castings. Dr. Bradley Stoughton. Read before the Pittsburg Found. Assn. A discussion of the different processes of making steel for castings, comparing them as to quality, cost, etc. Ills. 5000 w. Ir Trd Rev—Dec. 17, 1908. No. 1038.

Steel Works.

New Steel Works in the United States. The present number gives an illustrated description of the Saucon Works of the Bethlehem Steel Co. 3500 w. Engr, Lond—Nov. 20, 1908. Serial, 1st part. No. 742 A.

The Keystone Works of the Jones & Laughlin Steel Company. A new plant at Pittsburg, Pa., is illustrated and described. 1600 w. Eng Rec—Dec. 12, 1908. No. 960.

See also Bessemer Process, under IRON AND STEEL.

Tariff.

See same title, under INDUSTRIAL ECONOMY.

Trade.

Progress of the Iron and Steel Industry. P. N. Cunningham. Presidential address reviewing the progress of the iron and steel industry in the West of Scotland for the last 30 years. Plate. 7500 w. Jour W of Scotland Ir & Steel Inst—Oct., 1908. No. 894 N.

The World's Export Trade in Iron and Steel and Its Regulation. Harold Jeans. Read before the Staffordshire Iron & Steel Inst. Discusses the internal working in the various countries in the present number. 6500 w. Ir & Coal Trds Rev—Nov. 27, 1908. Serial, 1st part. No. 871 A.

LEAD AND ZINC.

Lead Smelting.

Smelting Practice at Granby Works, Missouri. Evans W. Buskett. Scotch hearth furnaces are used to smelt lead concentrates. Treatment of smelter fumes with recovery of lead in quantity. 1700 w. Min Wld—Dec. 19, 1908. No. 1065.

New Mexico.

See same title, under COPPER.

MINOR MINERALS.

Aluminium.

Aluminium as a Factor in the Electrical Industry. The present number briefly considers its use both for electrical purposes and in other ways. 2500 w. Elect'n, Lond—Nov. 27, 1908. Serial. 1st part. No. 862 A.

Cement.

I. Manufacture of Portland Cement from Materials High in Magnesia. Richard K. Meade. II. The Effect of Magnesia on Portland Cement. Dr. Rudolph Dyckerhoff. Two important articles on the permissible quantity of magnesia. 3000 w. Cement Age—Dec., 1908. No. 1321.

Diamonds.

Researches in Diamond Making. F. H. Mason. An account of the experimental work of Richard Threlfall. 1200 w. Min & Sci Pr—Dec. 5, 1908. No. 919.

Manganese.

Manganese Ore in Arkansas. E. C. Harder. Brief description of the deposits and their development. 3500 w. Min Wld—Dec. 26, 1908. No. 1255.

Manganese Deposits of Morro da Mina, Brazil. Joquim Lustosa and J. C. Branner. Brief illustrated description of these deposits and their development. 1500 w. Eng & Min Jour—Dec. 19, 1908. No. 1048.

A Manganese Deposit in Southern India. R. O. Ahlers. Describes particularly the deposits of the State of Sandur, Bellary District, in the north of Madras Presidency. 4000 w. Inst of Min & Met, Bul. No. 50—Nov. 12, 1908. No. 893 N.

Nickel.

Notes on Nickel. Prof. A. Humboldt Sexton. Considers its properties, compounds, minerals, etc., in the present number. 2000 w. Mech Engr—Nov. 27, 1908. Serial. 1st part. No. 854 A.

Oil.

Oil Field at Follansbee, W. Va. Frank W. Brady. Gives the location of the wells, with history of the development, production, etc. 3000 w. Mines & Min—Dec., 1908. No. 716 C.

Notes on the Oil and Gas Industry. Describes the geology of the deposits, giving the history and development of the industry. Map. 2400 w. Min Wld—Nov. 28, 1908. No. 708.

Mexican Petroleum: The Tuxpan Oil Well Fire. Henry Floy. Information in regard to the oil situation in Mexico, and account of the fire which burned without intermission for three months. 1800 w. Eng News—Dec. 10, 1908. No. 937.

The Petroleum-Bearing Zone of Northern Peru. V. F. Masters. The geology of the region and conclusions from the study are given in the present number. 2500 w. Min Jour—Nov. 21, 1908. Serial. 1st part. No. 735 A.

Phosphate.

Phosphate Mining in Florida (L'Exploitation des Phosphates de la Floride). A general review of methods of mining and ore treatment, production, etc. Ills 2100 w. Génie Civil—Nov. 21, 1908. No. 1125 D.

Salt.

Magnitude of the Salt Industry. Gives graphical illustrations, and calculations of salt production. 1800 w. Sci Am—Dec. 26, 1908. No. 1292.

The Pumping of Brine, and the Manufacture of Common Salt. Philip Morris Pritchard. Describes the more usual methods of obtaining brine and of manufacturing white salt. Ills. 6500 w. Inst of Civ Engrs—No. 3725. No. 885 N.

Tantalum.

The Properties, Metallurgy and Uses of Tantalum (Propriétés, Métallurgie et Emploi du Tantale). Pierre Breuil. The first part discusses the tantalum minerals. Serial. 1st part. 2000 w. Génie Civil—Nov. 7, 1908. No. 1121 D.

Tin.

The Red River, Cornwall. Brief account of trouble due to tailings from the tin mines. 1000 w. Min & Sci Pr—Dec. 19, 1908. No. 1263.

The Occurrence of Stannite in Australasia. Hartwell Conder. Information, with analysis and methods of treatment. 1800 w. Aust Min Stand—Nov. 18, 1908. No. 1095 B.

See also same title, under ORE DRESSING AND CONCENTRATION.

Tungsten.

Wolfram Ores—Occurrences and Uses. Charles Bogenrieder. Discusses their importance in Australia and to commerce in general. 1000 w. Aust Min Stand—Nov. 18, 1908. Serial. 1st part. No. 1090 B.

Tungsten Ore Deposits of the Coeur d'Alene. Herbert S. Auerbach. Undeveloped deposits carrying 25% tungsten trioxide are described. Schulite occurs associated with gold, silver, lead, iron, and copper. 2000 w. Eng & Min Jour—Dec. 12, 1908. No. 963.

MINING.

Accidents.

See Law, under MINING.

Air Compression.

See same title, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

Blasting.

The Theory of Blasting with High Explosives. E. M. Weston. Gives results of the writer's study of this subject. 8000 w. Jour Chem, Met, & Min Soc of S Africa—Oct., 1908. No. 1085 E.

Costs.

See same title, under COPPER.

Drilling.

See Prospecting, under MINING.

Electric Power.

See Germany, under COPPER.

Haulage.

Haulage with Compressed-Air Locomotives in the Emo Mine of the Cologne Mining Company (Die Druckluft-Lokomotivförderung unter Tage auf den Emscherschächten des Kölner Bergwerks-Vereins). D. Winkhaus. Describes the equipment and methods and gives costs of operation and maintenance. Ills. 2500 w. Glückauf—Nov. 28, 1908. No. 1154 D.

Hoisting Engines.

A Twin Tandem-Compound Drop-Valve Winding Engine. Illustrated description of engine built in Germany. 1200 w. Engr, Lond—Dec. 11, 1908. No. 1222 A.

Hoisting Ropes.

Stresses on Winding and Conducting Ropes as Used in Mine Shafts. Joseph Hindley and John Stoney. Read before the Manchester Geol. & Min. Soc. Gives plan and description of a stress indicator. 1500 w. Ir & Coal Trds Rev—Dec. 18, 1908. No. 1382 A.

Hydraulic Mining.

See same title, under GOLD AND SILVER.

Labor.

Mine Labor and Supplies in Mexico. Mark R. Lamb. An explanation of labor conditions and description of how the work is done. Ills. 2000 w. Eng & Min Jour—Dec. 26, 1908. No. 1274.

Law.

Assessment Work on Mining Claims. William E. Colby. A brief explanation of the nature of the annual labor required by the U. S. mining laws. 2000 w. Min & Sci Pr—Dec. 12, 1908. No. 1066.

Prevention of Mine Accidents. Investigations made by a committee appointed by the Am. Min. Cong. shows that only four states have comprehensive laws regulating metalliferous mining. 13000 w. Eng & Min Jour—Dec. 5, 1908. No. 913.

Locomotives.

Compressed Air Mine Locomotives. Illustrated description of a locomotive introduced by the Berliner Maschinenbau-Actiengesellschaft, to be driven by compressed air. 700 w. Ir & Coal Trds Rev—Dec. 4, 1908. No. 1027 A.

See also Haulage, under MINING.

Miners' Clubs.

The Cactus Club at the Newhouse Mines, Utah. Lafayette Hanchett. An account of a coöperative organization controlled by the mine employees which has proved successful. Ills. 800 w. Eng & Min Jour—Dec. 19, 1908. No. 1046.

Mine Waters.

Methods Used in Sealing Off Underground Water. Edmund B. Kirby. Method of injecting clay, or other solid, into flowing water is described. 1800 w. Min Wld—Nov. 28, 1908. No. 709.

Prospecting.

Prospectors and Prospecting in Nevada. Robert T. Hill. Suggestions for aids in prospecting are given in the present article. 1500 w. Eng & Min Jour—Nov. 28, 1908. Serial. 1st part. No. 705.

A Scientific Search for a New Goldfield. Robert T. Hill. An illustrated account of scientific prospecting which led to the discovery of a new gold district in Nevada. 2500 w. Eng & Min Jour—Dec. 12, 1908. No. 966.

The Hand Drill in Prospecting Placer Deposits. John Power Hutchins. Discusses the advantages and disadvantages as compared with steam-drill prospecting, the methods of drilling, especially with rotation of casing. 4000 w. Eng & Min Jour—Dec. 12, 1908. No. 962.

Pumping.

The Arrangement of Pumps for Modern Collieries. J. S. Barnes. Illustrates and describes the Hathorn-Davey pumps and the general arrangement of a recent plant. 2800 w. Ir & Coal Trds Rev—Dec. 4, 1908. Serial. 1st part. No. 1026 A.

Shaft Sinking.

Vertical Shaft Sinking—Buckets v. Skips. Charles B. Saner. Discusses both systems, favoring the latter. General discussion. 4000 w. Jour S African Assn of Engrs—Oct., 1908. No. 1002 F.

Method of Refrigeration in the Sinking of Shafts. Samuel K. Patterson. Describes a method used in England in sinking a 490-ft. shaft through quick-sand, without the aid of pumps. 1500 w. Min Wld—Dec. 5, 1908. No. 844.

Surveying.

A Note on Running Levels Underground (Ein Beitrag zur Ausführung von Nivellements in der Grube). Viktor Kadainka. Illustrates and describes a new device for approximate work. Serial. 1st part. 1500 w. Oest Zeitschr f Berg u Hüttenwesen—Nov. 7, 1908. No. 1148 D.

Timber Drawing.

Timber Drawing at the Julius III Mine, Brüx (Ueber das Stempelrauben mittels Raubwinde im Kammerbruchbau des k.k. Schachtes Julius III zu Brüx). Gustav Ryba. Illustrates and describes a machine for drawing timber from worked-out rooms. Serial. 1st part. 2200 w. Oest Zeitschr f Berg u Hüttenwesen—Nov. 28, 1908. No. 1150 D.

Ventilation.

See Mine Ventilation, under COAL AND COKE.

ORE DRESSING AND CONCENTRATION.

Gold Milling.

See Australia, under GOLD AND SILVER.

Tin.

Notes on Tin Dressing. H. W. Hutchin. An account of a series of tests whose object was to determine the losses in connection with tin dressing. Ills. 4500 w. Inst of Min & Met, Bul. No. 50—Nov. 12, 1908. No. 892 N.

MISCELLANY.

Alloys.

The Alloys of Nickel (Les Alliages de Nickel). A. Portevin. Summary of Prof. Tammann's researches on alloys of nickel with bismuth, cadmium, cobalt, chromium, antimony, silicon, tin, lead, thallium and zinc. Ills. 4000 w. Rev. de Métal—Nov., 1908. No. 1108 E + F.

Canada.

A Visit to the Mineral Districts of Canada. William Frecheville and Hugh F. Marriott. Notes on an excursion organized by the Canadian Mining Institute, describing the districts visited. 1000 w. Inst of Min & Met, Bul. 51—Dec. 10, 1908. No. 1340 N.

Notes on Plant in the Mining Districts of Canada. R. E. Commans. A general idea of the plant at mines visited during the excursion organized by the Canadian Institute. 7000 w. Inst of Min & Met, Bul. 51—Dec. 10, 1908. No. 1341 N.

Great Britain.

Our Mineral Statistics. A review of the Mines and Quarries. General Report and Statistics for 1907, with the exception of the coal and iron trades. 3000 w. Eng'r, Lond—Nov. 20, 1908. No. 741 A.

Jamaica.

Mineral Deposits of Jamaica in West Indies. Francis C. Nicholas. Nearly all the common minerals are found. Ocher and clay give promise of becoming important. 2000 w. Min Wld—Dec. 12, 1908. No. 1034.

Mineral Springs.

The Eruption of the Waimata Mud-Springs. James Henry Adams. Describes the location and discusses the probable origin of the springs. 3 maps. 2800 w. N Z Mines Rec—Oct. 16, 1908. No. 1000 B.

Ore Deposits.

See Nevada, under GOLD AND SILVER.

South Carolina.

The Mines of South Carolina. H. L. Scaife. Information concerning the mineral occurrence and workings, with bibliography. 2000 w. Eng & Min Jour—Dec. 19, 1908. No. 1052.

United States.

See Natural Resources, under INDUSTRIAL ECONOMY.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Automatic Stops.

See Signalling, under CONDUCTING TRANSPORTATION.

Signaling.

Trial of the Rowell-Potter Block Signals and Automatic Stop. Illustrated account of a system of automatic train control under trial on the C. B. & Q. R. R. 1800 w. Ry & Engng Rev—Dec. 26, 1908. No. 1282.

Wire Transmissions Laid in Pipes Filled with Oil for Operating Switches and Signals. L. Dufour. Describes this system of construction as installed at Grypskerk station, Holland. Ills. 1300 w. Bul Int Ry Cong—Nov., 1908. No. 897 G.

Train Dispatching.

The A B C System of Train Dispatching. A. Beamer. Describes this system as used on the Northern Pacific Ry. 2200 w. Ry & Loc Engng—Dec., 1908. No. 796 C.

Trains.

New Royal Train, Great Northern Railway. Illustrated description of fine special saloons for the use of the King of England. 700 w. Engng—Nov. 27, 1908. No. 869 A.

MOTIVE POWER AND EQUIPMENT.

Air-Brakes.

Southern Pacific Air Brake Tests. Abstract of a report, illustrating in detail the present state of air-brakes and their operation. Also editorial. Ills. 8000 w. R R Age Gaz—Dec. 4, 1908. Serial. 1st part. No. 805.

Brakes.

Brake Shoe Friction. G. W. Kiehm. Explains the results of forcing a brake-shoe against a revolving wheel. 2000 w. Ry & Loc Engng—Dec., 1908. No. 794 C.

Electrification.

Electric Traction on Steam Railroads. Edwin B. Katte. From a lecture delivered at Harvard University. Remarks on the advantages of electric operation, the systems commonly used, and the electrification recently installed on the N. Y. C. & H. R. R. R. 3000 w. Sib Jour of Engng —Dec., 1908. No. 1351 C.

The Proposed Change to Electric Traction at the Chicago Terminal of the Illinois Central R. R. From a report by a special committee in connection with smoke abatement. Outlines the present situation, and discusses questions relating to the electrification. 2500 w. Eng News —Dec. 24, 1908. No. 1238.

The Log of the New Haven Electrification. W. S. Murray. Aims to bring the actual operation of the New Haven single-phase electrification as closely as possible to those interested in its merits and faults. Ills. 10000 w. Pro Am Inst of Elec Engrs—Dec., 1908. No. 841 F.

Notes Taken During a Journey of Enquiry in the United States. Em. Uytborck. Principally an illustrated description of the electrification of the N. Y. C. & H. R. and the N. Y., N. H. & H. lines and their equipment, with criticism and comparison. 21500 w. Bul Int Ry Cong—Nov., 1908. No. 896 G.

Freight Cars.

Large Railway Wagons. From the presidential address of Jas. Hewitt, at meeting of the Jun. Gas Engng. Assn. Deals with the construction of large railway wagons and their use at gas-works. 2500 w. Col Guard—Nov. 20, 1908. No. 737 A.

Locomotive Boilers.

The Relation of the Brick Arch to the Efficiency of the Present Day Locomotive Boiler. George Wagstaff. Explains the advantages of the brick arch, considering its disadvantages have been largely overcome. General discussion. 7000 w. Pro Cent Ry Club—Nov. 13, 1908. No. 1298 C.

The Brotan Locomotive Boiler. Illustrated description of a new engine without copper plates and braces. 1500 w. Sci Am Sup—Dec. 19, 1908. No. 1235.

Locomotive Feed Water.

A Large Water Softener. Illustrates and describes a plant designed to deal with 30,000 gals per hour. 1200 w. Engr, Lond—Dec. 11, 1908. No. 1223 A.

Locomotive Flues.

Endurance of Locomotive Flue Material. Alex. Kearney. From the address before the Richmond Ry. Club. A report of investigations of this material and the causes of its deterioration. Ills. 3500 w. Ry & Engng Rev—Nov. 28, 1908. No. 702.

Locomotive Frames.

Frame Failures on Modern Locomotives. F. P. Roesch. Discusses the causes and the remedy. 3000 w. Ry & Loc Engng—Dec., 1908. No. 798 C.

Frame Failures. C. G. Rommel. Discusses points relating to such failures and the repairs. 1500 w. R R Age Gaz—Dec. 4, 1908. No. 807.

Locomotive Performances.

Great Western Six-Coupled Express Locomotive Work. An account of work done by these engines which have proved very satisfactory. 4500 w. Engr, Lond—Dec. 4, 1908. No. 1023 A.

Locomotives.

Articulated Compound Locomotives. C. J. Mellin. An illustrated study of the design and construction of engines of the Mallet articulated type, with related information. 6000 w. Jour Am Soc of Mech Engrs—Dec., 1908. No. 838 F.

Locomotives for the A. T. & S. F. Describes engines comprising a recently completed order, illustrating the Pacific (4-6-2) engine. 1000 w. Ry & Loc Engng —Dec., 1908. No. 797 C.

Engines for the Associated Lines. Information concerning the engines for the Harriman Lines, illustrating and describing the 4-4-2 engine for the Sonora Ry., and the 2-6-0 engine for the Cananea Yaqui River & Pacific. 1500 w. Ry & Loc Engng—Dec., 1908. No. 793 C.

Four-Cylinder Compound Locomotive, Hungarian State Railways. Illustrated detailed description of the Atlantic type balanced compound express engine, adopted as the standard type. 2000 w. Engr, Lond—Nov. 27, 1908. No. 870 A.

Six-Coupled Locomotive for the North Brabant Railway. Illustration with particulars. 200 w. Engng—Nov. 27, 1908. No. 866 A.

Compound Locomotive with Pielock Superheater and Lentz Valves. Illustrated description of an engine for the

Malmö-Ystad Railway, Sweden. 700 w. Engng—Dec. 11, 1908. No. 1217 A.

The Locomotives of the Gotthard Railway (Die Lokomotiven der Gotthardbahn). M. Richter. A historical study. Ills. Serial. 1st part. 5500 w. Zeitschr d Ver Deutscher Ing—Nov. 14, 1908. No. 1190 D.

Locomotive Smoke.

Report of Chicago Smoke Inspection. Dept. on Abatement of Locomotive Smoke. From a bulletin issued by G. E. Ryder, giving facts based upon recent locomotive tests. Ills. 2000 w. Ry & Engng Rev—Nov. 28, 1908. No. 701.

Motor Cars.

Railway Motor Car for Siam. Illustrations of this oil-engine car with brief description. 500 w. Engr, Lond—Dec. 4, 1908. No. 1025 A.

Accumulator Cars of the Prussian State Railways. An illustrated description of the electrical equipment of these cars. 2200 w. Tram & Ry Wld—Dec. 3, 1908. No. 1203 B.

Two-Class Accumulator Cars of the Prussian State Railways (Akkumulator-doppelwagen der preussischen Staatsbahn-Verwaltung). D. Hönsch. Illustrated description of a car to accommodate 100 passengers. 3000 w. Glasers Ann—Nov. 1, 1908. No. 1167 D.

Passenger Cars.

New Types of Broad Gauge Underframes and Bogies. Illustrated descriptions of types for the Indian State Railways. 1000 w. Engr, Lond—Nov. 20, 1908. No. 745 A.

Refrigeration.

A Movable Refrigerating Plant for Pre-Cooling. S. J. Dennis. Read before the Am. Soc. of Refrig. Engrs. An illustrated description of the refrigerating car. 1500 w. Cold Storage & Ice—Dec., 1908. No. 993 C.

Train Lighting.

History of Axle Lighting. W. L. Bliss. Abstract of a paper read before the Assn. of Car Lighting Engrs. 2000 w. Elec Rev, N Y—Dec. 19, 1908. Serial. 1st part. No. 1062.

Wheels.

Flat-Spots on Car Wheels. Prof. Charles H. Benjamin. Illustrates and describes an apparatus for testing such wheels and determining the impact due to flat spots, and the rail deflection. General discussion. 7500 w. Pro W Ry Club—Nov. 17, 1908. No. 1299 C.

PERMANENT WAY AND BUILDINGS.

Earth Slides.

See Washouts, under Permanent Way and Buildings.

Elevated Railways.

Proposed Structural Improvements for the Elevated Terminal Loops at Chicago. Considers details of construction and equipment suggested in a recent report of Charles K. Mohler. 4000 w. Eng News—Dec. 17, 1908. No. 983.

Freight Warehouses.

The Steele-Wedeles Company's Warehouse in Chicago. Illustrates and describes a warehouse serving as a central receiving and distributing station for the freight tunnel system, as well as for an extensive wholesale grocery business. 2500 w. Eng Rec—Dec. 12, 1908. No 957.

Rails.

Effect of Flat Wheels on Rails. H. H. Vaughan. A mathematical analysis. 1000 w. Am Engr & R R Jour—Dec., 1908. No. 847 C.

Rolled Manganese Steel Rail. Gives a report of tests made of rolling rails of different analyses. Ills. 1200 w. R R Age Gaz—Dec. 11, 1908. No. 924.

Stations.

The New Scranton Station of the Delaware, Lackawanna & Western Railroad. Illustrated description of the facilities of this fine station and office building. 2000 w. Eng Rec—Nov. 28, 1908. No. 694.

Glasgow Central Station Extension. Donald A. Matheson. Abstract of a paper read before the Inst. of Civ. Engrs. Describes the reconstruction and equipment to meet modern requirements. 2200 w. Engng—Nov. 20, 1908. No. 740 A.

Terminals.

Railway Terminals. Illustrated description of the extensive terminal improvements in progress in New York City. 4000 w. Sci Am—Dec. 5, 1908. No. 817.

Recent Work on the New York Terminal of the New York Central Railroad. Illustrates and describes details of difficult reconstruction. 2000 w. Eng Rec—Dec. 19, 1908. No. 1060.

A Rail and Water Freight Terminal at Bristol, England; Great Western Ry; Illustrated description of interesting work for the extension of terminal facilities. 1500 w. Eng News—Dec. 10, 1908. No. 936.

Track Construction.

Track Superstructure on German Railways (La Superstructure des Voies des Chemins de Fer Allemande). M. Blum. Illustrates and describes types of ties, rails, rail joints, etc. 6000 w. Rev Gen d Chemins de Fer—Nov., 1908. No. 1111 G.

Washouts.

Railway Slides and Washouts. Abstract of a circular issued by the Roadway Committee of the Am. Ry. Engng. & Main. of Way Assn. Causes and remedies are discussed. 1500 w. Eng News—Dec. 10, 1908. No. 940.

TRAFFIC.

New York.

Freight Distribution by Subway. Briet illustrated description of a system proposed for New York City. 1500 w. Sci Am—Dec. 5, 1908. No. 818.

Review.

Review of Traffic Questions. C. Colson. The results of working the railways during 1906 in France, England, Germany and the United States; the situation in 1907. 2200 w. Bul Int Ry Cong—Nov., 1908. No. 898 G.

MISCELLANY.

Accounting.

Railroad Accounting and the Hepburn Law. Arthur C. Graves. Brief review of the recent railway reports and the information given, with an examination of the provisions of the Hepburn Act. 1500 w. R R Age Gaz—Dec. 11, 1908. Serial. 1st part. No. 925.

England.

Railway Facilities in North-East Anglia. An explanation of the problem arising from the proposed amalgamation of the Great Northern, Great Central, and Great Eastern railways. 2000 w. Engr, Lond—Oct. 30, 1908. No. 198 A.

Presidential Address of James Charles Inglis, before the Institution of Civil Engineers. Discusses the question of transport, especially the work of Isambard Kingdom Brunel. 10000 w. Engng—Nov. 6, 1908. No. 325 A.

The London and North-Western Railway and Crewe Works. A review of the history and detailed description of the principal features. Plates and Ills. 21000 w. (Sup.) Engr, Lond—Dec. 11, 1908. No. 1221 A.

Government Ownership.

The Nationalization of Railways. C. S. Vesey Brown. Discusses the practical workings of state ownership in various countries. 3500 w. Cassier's Mag—Dec., 1908. No. 947 B.

Railway Nationalization. Sir George Gibb. Read at meeting of the Royal Economic Society, London. Discusses the various phases of this subject. 3500 w. R R Age Gaz—Dec. 4, 1908. Serial. 1st part. No. 806.

History.

The Centenary of Railroad Travel. W. B. Paley. Concerning Richard Trevithick's experiments, one-hundred years ago. 1000 w. R R Age Gaz—Nov. 6, 1908. No. 132.

Management.

Organization. A description of the organization of the motive power department of the Lake Shore & Michigan Southern Railway. An important study. 12500 w. Am Engr & R R Jour—Dec., 1908. No. 846 C.

Montenegro.

The First Railway in Montenegro (La Prima Ferrovia nel Montenegro). A. Baldacci. Describes the line and discusses its economic importance. Ills. 5000 w. Riv Marit—Oct., 1908. No. 537 E + F.

United States.

Southern Railroads and Their Needs. John F. Wallace. Extract from an address before the Southern Commercial Congress. 2500 w. Ry & Engng Rev—Dec. 19, 1908. No. 1063.

Review of 1908. Annual Reports. Ray Morris. Review by means of a graphic diagram with explanatory notes. 1500 w. R R Age Gaz—Dec. 25, 1908. No. 1289.

Valuation.

Railway Capital and Values. W. H. Williams. Extracts from a paper before the Traffic Club of New York. A study of methods of valuation and results in the state of Michigan. 1500 w. Ry & Engng Rev—Dec. 26, 1908. No. 1283.

STREET AND ELECTRIC RAILWAYS

Brakes.

Brakes for Electric Tram Cars. Edgar Harry Cockshott. Describes investigations carried out to ascertain the reliability of brakes in use under adverse conditions, and to devise, if possible, a new brake of greater efficiency. 5500 w. (Abridged.) Inst of Civ Engrs—No. 3752. No. 882 N.

Brooklyn.

The Line and Track Department Headquarters of the Brooklyn Rapid Transit System. I. General Features of Arrangement and Construction. The present article illustrates and describes architectural and constructional features. 3500 w. Elec Ry Jour—Dec. 5, 1908. Serial. 1st part. No. 799.

Canal Haulage.

Electric Canal Haulage (Der elektrische Schiffszug). Georg Meyer. An exhaustive discussion of the various systems. Ills. 13000 w. Elek Kraft u Bahnen—Nov. 14, 1908. No. 1178 D.

Cars.

New Standard Car for the Metropolitan Street Railway, New York. An account of investigations made to determine the best type to meet conditions, with illustrated description of the car adopted and its equipment. 2500 w. Elec Ry Jour—Dec. 5, 1908. No. 800.

The Barber Single-Truck Car Used on the Sunbury and Salingsgrove Electric Railway. Illustrated detailed description. 1500 w. Elec Ry Jour—Jan. 2, 1909. No. 1436.

Double Motor Cars on the Blankenese-Ohlsdorf Railway (Automotrices couplées du Chemin de Fer électrique de Blankenese à Ohlsdorf par Hambourg). A. Le Vergnier. Illustrated description of a double car with two motors. Plate. 1500 w. Génie Civil—Nov. 7, 1908. No. 1119 D.

Communication.

The Installation and Protection of Telephones for Electric Railway Service. Frank F. Fowle. Illustrated detailed description, with information in regard to types, cost, etc. 4000 w. Elec Ry Jour—Dec. 5, 1908. No. 801.

Economics.

Action Necessary to Assure a Reasonable Return on the Investment. Charles V. Weston. Discusses the present situation, reviewing the development of transportation in city streets and related matters. 4500 w. Elec Ry Jour—Dec. 26, 1908. Serial. 1st part. No. 1252.

France.

Electric Traction on the Fayet-Chamonix Line and Its Extension to the Swiss Frontier (La Traction electrique sur la Ligne du Fayet à Chamonix et à la Frontière Suisse). M. Auvert. Illustrated description of the power plants, transmission line, substations, rolling stock, etc., of this direct-current road in France. Plates. 5000 w. Rev Gen d Chemins de Fer—Nov., 1908. No. 1112 G.

Interurban.

The Brantford and Hamilton Electric Railway. Illustrated description of a line in Ontario eventually to form part of a system joining Toronto and Detroit. 2000 w. Elec Ry Jour—Jan. 2, 1909. No. 1434.

Locomotives.

Change in Wheel Arrangement of New Haven Electric Locomotives. Drawing and brief description. 300 w. R R Age Gaz—Dec. 4, 1908. No. 804.

Massachusetts.

Financial Condition of Massachusetts Street Railways. James L. Richards. Abstract of an address before the Mass. St. Ry. Assn. 5000 w. Elec Ry Jour—Dec. 19, 1908. No. 1045.

Rack Railways.

A New Mountain Railway in Tyrol. Brief illustrated description of the Rittner line, a portion of which is a rack on the Strub system. 1800 w. Elec Engng—Dec. 10, 1908. No. 1205 A.

Railless.

General Urban and Interurban Transportation and Railless Electric Traction. F. Douglas Fox. Read at Dublin meeting of the British Assn. Aims to show in detail the comparative economics of the tramway and the mechanical omnibus. 4200 w. Engr, Lond—Nov. 20, 1908. No. 746 A.

Single Phase.

Some Notes on the Single-Phase Railway System. Clarence Renshaw. Considers the equipment and operation of single-phase installations. Ills. 6000 w Elec Jour—Dec., 1908. No. 976.

Subways.

Accounts of the London Tube Railways. A detailed analysis for the year ending June 30, 1908. 2500 w. Elect'n, Lond—Dec. 11, 1908. No. 1209 A.

Switzerland.

The Railway of the Bernese Alps (Visite aux Travaux du Chemin de Fer des Alpes Bernoises). A. Maury. Report of a visit by a committee of the Soc. Ing. Civ. de France. Brief description of the line and of the Loetschberg tunnel. 10000 w. Mem Soc Ing Civ de France—Oct., 1908. No. 1307 G.

Track Circuits.

Suburban Electric Railway Return Circuits. E. G. Hindert. Discusses the importance of good contact, types of bonds, testing, etc. 3000 w. Elec Age—Dec., 1908. No. 1229.

Track Construction.

Track Reconstruction in New York. A report of improvements made during 1908, describing construction and methods. 1800 w. Elec Ry Jour—Dec. 26, 1908. No. 1253.

Wires.

Tensile Strength of Trolley Wires. J. E. Fries. Information concerning metals that might be used, and concerning the stringing of such wires. 2000 w. Elec Age—Dec., 1908. No. 1228.

Wire Suspension.

Cost and Construction of Overhead Work. E. Golding. Presents a table of costs to facilitate the estimating for overhead work, with explanatory notes. 1500 w. Elec Rev, Lond—Nov. 20, 1908. No. 732 A.

Experimental Overhead Trolley Construction of the Pennsylvania Tunnel and Terminal Railroad. An illustrated account of this expensive experimental work on the test line on Long Island. Also editorial. 6500 w. Elec Ry Jour—Dec. 12, 1908. No. 918.

See also Wires, under STREET AND ELECTRIC RAILWAYS.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language,* together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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SPECIAL NOTICE.—To avoid the inconvenience of letter-writing and small remittances, especially from foreign countries, and to cheapen the cost of articles to those who order frequently, we sell coupons at the following prices:—20 cts. each or a book of twelve for $2.00; three books for $5.00.

Each coupon will be received by us in payment for any 20-cent article catalogued in the Index. For articles of a higher price, one of these coupons will be received for each 20 cents; thus, a 40-cent article will require two coupons; a 60-cent article, three coupons; and so on. The use of these coupons is strongly commended to our readers. They not only reduce the cost of articles 25 per cent. (from 20c. to 15c.), but they need only a trial to demonstrate their very great convenience—especially to engineers in foreign countries, or away from libraries and technical club facilities.

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CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cents per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated: W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.

CURRENT RECORD OF NEW BOOKS

NOTE—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

Building Construction.

Safe Building Construction. By Louis de Coppet Bergh. Size, 7¾ by 5 in. Ills. Price, $5. New York: The Macmillan Company.

A new edition of a work first published over twenty years ago. It is intended to be a treatise giving in simplest forms possible practical and theoretical rules and formulæ used in construction of buildings. The book takes up the strength of materials, foundations, cellar and retaining walls, arches, floor beams and girders, analysis of transverse strains, reinforced concrete construction, rivets and riveting, plate and box girders, analysis of strains in trusses, trusses of wood and iron, and columns. It has long been a standard book of reference on applied mechanics for architectural draftsmen. The treatment is simple, the book contains many useful and novel practical notes and formulæ, but its constant betrayal of the fact that it was written in the early eighties of the last century will hardly recommend it to the present-day engineer.

Electrical Engineering.

The Arithmetic of Electrical Engineering. Size, 7¼ by 5 in.; pp., 159. Ills. Price, 50 cents. New York: The Macmillan Company; London: Whittaker & Co.

The aim of this little book is to aid the electrical engineering student in acquiring the ability to calculate quickly and accurately. The plan adopted recognizes the difficulty young students encounter in applying their theoretical knowledge to practical problems. The fundamental quantitative relationships and laws related to the special subject under consideration are given briefly at the head of each chapter and then numerous worked-out typical examples illustrating the principles of the subject. These are followed by problems for the student's own working. In all there are 72 examples fully worked and 300 problems for the student. The book should be of assistance not only to students in elementary classes, but also to teachers who have occasion to set problems.

Engineering Calculations.

Practical Calculations for Engineers. By C. E. Larard and H. A. Golding. Size, 7½ by 5¼ in.; pp., 455. Price, $2. Philadelphia: J. B. Lippincott Company; London: Charles Griffin and Company, Limited.

A practical manual dealing with calculations and graphical methods applied to engineering. The general aim of the authors in preparing the work has been to familiarize the student with modern methods of making rapid calculations by the calculating slide rule; some of the more important engineering problems which have to be solved in experimental work, in the workshops, in the drawing office and by the management; graphical methods for the ready interpretation of the results of experimental and commercial work; and the importance of making a study of the business side of his profession. The contents include chapters on technical mensuration; calculation by common logarithms; mechanical calculating devices; pulley problems; principles of moments; work, power and energy; transmission of work through machines; transmission of power; centrifugal force and balancing; acceleration and momentum; steam boiler problems; engine calculations; the commercial side of engineering; the calculation of weights; estimating and cost distribution; remuneration of labor; and the use of section paper in engineering work.

Engineering Reminiscences.

Engineering Reminiscences. By Charles T. Porter. Size, 9 by 6 in.; pp., 335. Ills. Price, $3, 12/6. New York: John Wiley & Sons; London: Chapman & Hall, Limited.

A reprint of series of articles contributed to the columns of *Power* and the *American Machinist.* The venerable author, who is now over 80 years of age, was a pioneer in the design and introduction of the high-speed steam engine in America, and his reminiscences are not only an autobiography but a history of the development of the type of prime mover to the study of which he devoted so many years of his life. The book is written in entertaining style and, quite apart from its value as engineering history, the interest attaching to its frank recital of successes and failures will well repay perusal.

Gas Engineering.

Handbook of American Gas Engineering Practice. By M. Nisbet-Latta. Size, 8½ by 6 in.; pp., 466. Ills. Price, $4.50 New York: D. Van Nostrand Company.

This work is divided into three parts. The first discusses the practical details of water-gas manufacture from the fuels and materials to the gas holder. The second division is devoted to gas distribution, which is treated at length and in a practical manner, and to a brief consideration of the various gas burning appliances. The final part contains a great deal of theoretical, mathematical and technical information on the properties of gases and steam, calorific values, temperature data, testing corrections, tables, etc. The book is a valuable addition to the literature of gas engineering.

Hydro-Electric Plants.

Development and Electrical Distribution of Water Power. By Lamar Lyndon. Size, 9 by 6 in.; pp., 317. Ills., 158. Price, $3, 12/6. New York: John Wiley & Sons; London: Chapman & Hall, Ltd.

The author disclaims any intention of writing a text-book on electricity, hydraulics, concrete work or construction engineering. His aim has been to produce a purely engineering treatise in which all the salient facts concerning the hydraulic development of power, its conversion into electrical energy, and its transmission over long distances, are collated, and their interdependence shown. For the basic principles of hydraulics and electricity the reader is referred to works on these special subjects. The author is concerned only with the relationships between the available power, methods of development, the machinery and apparatus employed, and the final use to which the energy will be put. Part I, on hydraulic development, discusses in separate chapters general conditions, dams, canals and flumes, design of hydro-electric power houses, and water wheels. Part II deals similarly with electrical equipment, devoting chapters to general considerations, alternators, transformers, transmission conductors, pole line and accessories, lightning protection, and switching and control apparatus, and an appendix to the computation of pressures set up in long pipe lines with change in gate opening. The final chapters of the book are devoted to descriptions of nine typical hydro-electric developments in Europe and America.

Power Transmission.

Power and Power Transmission. By E. W. Kerr. Size, 9 by 6 in.; pp., 366. Ills. Price, $2, 8/6. New York: John Wiley & Sons; London, Chapman & Hall.

A book for the beginner in the study of mechanical engineering, largely based on lectures delivered by the author on the elementary principles of engineering. The three parts deal, respectively, with machinery and mechanics, steam power, and pumps, gas engines, water power, compressed air, etc. None of the subjects is treated exhaustively; the aim has been merely to present guiding principles for more thorough investigation. The volume in hand is a second and revised edition. The chapters on steam turbines and valve diagrams have been rewritten and several pages of matter have been added on the subject of heat and the use of steam tables. The value of the book has been further increased by the addition of a large number of good problems and a thorough correction of the errors appearing in the former edition.

Sewage Treatment.

Methods and Devices for the Bacterial Treatment of Sewage. By William Mayo Venable. Size, 9 by 6 in.; pp., 236. Ills., 43. Price, $3, 12/6. New York: John Wiley & Sons; London: Chapman & Hall, Limited.

A discussion of bacterial sewage purification from the standpoint of the civil engineer. The book opens with a briet introductory chapter on the general aspects of sewage purification, followed by a bibliography of books and articles in technical magazines on sewage disposal and related subjects, including the bacterial and chemical analyses of polluted waters. The several methods of sewage treatment are next considered in historical order, separate chapters being devoted to the aerobic treatment of sewage, mechanical removal of sludge, anaerobic treatment of sewage, intermittent contact systems, automatic discharging devices and percolating filters. A summary is then given of the engineering principles involved in the design of purification works, difficulties experienced in some actual installations are described, and the final chapter illustrates the application of the principles enunciated by the author to a few typical examples.

Steel Analysis.

Steel Works Analysis. By John Oliver Arnold and F. Ibbotson. Size. 7½ by 5 in.; pp., xiv, 468. Ills. Price, $3.50, 10/6. New York: The Macmillan Company; London: Whittaker & Co.

A third edition of this well known work, thoroughly revised and considerably enlarged. The general scheme remains unaltered but descriptions of a number of operations now obsolete, included in previous editions, have been omitted, and outlines of new and more rapid methods have been substituted. The most important change, however, is the inclusion of a large amount of new matter on the determination of the elements which have only recently been utilized in the making of steel, the analysis of their ores, of alloy steels, and of ferro-alloys. The section on gas analysis has been thoroughly revised and brought up to date and the latest developments in the calorimetry of fuels are described. Chapters on the analysis of bearing metals and of high-speed steels are other new features. The book will retain its reputation as a clear, thorough and practical guide for the steel-works chemist.

Technical Dictionaries.

Technological Dictionary in French, German and English. Edited by Alexander Tolhausen. Revised by Louis Tolhausen. In three volumes: Volume I, French - German - English; Volume II, English - German - French; Volume III, German - English - French. Size, 6¾ by 4¾ in.; pp., Volume I, 1006; Volume II, 1026; Volume III, 1025. Price, each volume, $2.75. New York: The Macmillan Company.

This well known work, which was published first in 1877, has now reached its fifth edition. It is issued in the form which has been familiar to the engineers of over a generation, but its contents have been considerably improved by a thorough revision of the text and by the addition of a large supplement including all modern terms and expressions in electricity, telegraphy and telephony. The work is wider in scope than most of the smaller technical dictionaries on the market. It is not devoted solely to engineering as that term is now understood, but includes in its plan the definition of terms relating to a large number of the arts, to pure science, and to business. The breadth of its field is at once its greatest defect and its greatest recommendation. As an engineering dictionary it will hardly satisfy the requirements of the modern engineer, but he will find in it a valuable supplement to other works, on account of its inclusion of subjects related to, but not directly connected with, engineering proper.

Illustrated Technical Dictionary in Six Languages: English, German, French, Russian, Italian and Spanish. Edited by K. Deinhardt and A. Schlomann. Volume III, Steam Boilers, Steam Engines, Steam Turbines; Volume IV, Internal-Combustion Engines. Size, 7 by 4 in.; pp., Volume III, 1322; Volume IV, 618. Price, Volume III, $4; Volume IV, $3. New York: McGraw Publishing Co.

We have already had occasion to mention very favorably the two preceding volumes of this dictionary, dealing, respectively, with machine details and tools, and electrical engineering. The two present volumes are fully up to the high standard of those which have already appeared. Thoroughness and painstaking accuracy on the part of the compilers and editors are apparent throughout, and we believe that the successful accomplishment of so much of the immense undertaking gives abundant assurance that the complete work, for which eleven volumes are projected, will stand pre-eminent for completeness and trustworthiness among technical dictionaries in the special fields it is designed to cover.

Water Powers.

Water Power Engineering. By Daniel W. Mead. Size, 9 by 6 in.; pp., 787. Ills., 413. Price, $6. New York: McGraw Publishing Company.

A treatise on the theory, investigation and development of water powers. The author had endeavored to consider all fundamental principles in the investigation, design and execution of water-power development projects and to point out the economic basis on which successful power development depends. The first three chapters are devoted to a general discussion of the history and general principles of hydraulic engineering. Chapters IV to XI deal with the study of water-power projects, rainfall, run-off and stream flow and its measurement. Water wheels and turbines, their selection, testing, governing, arrangement, etc., are treated at length in Chapters XII to XX. The design of plant is then discussed, chapters being devoted to the selection of machinery, the relation of dam and power station, the design of dams, appendages to dams, pondage and storage, etc. The two closing chapters are devoted to the economics of water-power projects.

THE ENGINEERING MAGAZINE

"THE WORLD IS ITS FIELD"

VOL. XXXVI. MARCH, 1909. No. 6.

METHODS OF THE SANTA FE. EFFICIENCY IN THE MANUFACTURE OF TRANSPORTATION.

By Charles Buxton Going.

I. PECULIAR PROBLEMS OF THE ROAD, AND THEIR SOLUTIONS.

The Santa Fe methods, or their results, have attracted wide attention. Railway officials from the very greatest American roads, shop men from manufacturing plants, and technical specialists, have gone to study the system. Certain parts of the practice have been ably presented in the engineering press, notably in Mr. Jacobs' series on "Organization and Economy in the Railway Machine Shop," published in this magazine, Sept. 1906 to Jan. 1907. The purpose of the forthcoming articles is to define all the great features of the Santa Fe problem affecting the manufacture of transportation. They are designed to give a broader view than has yet been afforded of the policy underlying the work, the results secured, and their meaning for the future of transportation in the United States, so far as concerns not only the railways but the shippers and the manufacturers of the country.—THE EDITORS.

THE relation of the railroads of the United States to its industries—the effect of their welfare upon financial, commercial and manufacturing conditions, and especially the correct solution of the problems of economical and profitable transportation—have assumed an importance that makes the study of a leading case not only appropriate to THE ENGINEERING MAGAZINE, but imperative. The Santa Fe, in common with all American roads, has experienced difficulties arising from progressive decrease in rates collected per ton mile and per passenger mile, and from increased expenditures necessitated by rising standards of service performance. Beyond this, it has peculiar individual difficulties caused by its mileage, grades, desert environment, fuel, water and labor conditions. We often find in history that great situations have developed great leaders, and a similar effect is apparent here. Under the chief operating officials, policies and methods have been inaugurated and perpetuated by which the necessary margin between operating costs and operating revenues has been secured and is being widened, with increasing liberality to employees and without increasing charge to patrons. In short, the third way of forcing into parallel the converging lines of cost and compensation in railroad operation (recently referred to in the editorial columns of this Magazine) is successfully applied. In its application there have been developed shop methods, mechanical and manufacturing practice, and relations with employees, which are not only abreast, but in advance, of many of the standards reached even under the keen stimulus of competitive manufacturing conditions.

The chief of these features are:

First, boldness in the adoption and design of engine types suited to the very heavy service of the road, energy in effecting every revision of line and grade which will permit heavier loads to be hauled, and constant effort to load every engine to its full average rating.

Second, the centralization of manufacturing at the most advantageous points, the standardization of tools, operations, and parts, and the stimulus to workmen and foremen provided by a bonus system based on efficiency. These constitute what is generally termed the "betterment work," and combined with special measures for the oversight and handling of the engines on the road and in round-houses and shops, and with a remarkable management of the stores department, they secure high results in the average condition of engines in service, and the repair of power at low cost and with a minimum of detention from the road.

Third, an organization and supervision of the stores system which is unique in its conception and results. This department, far from being a mere clerical bureau, or depository of records, becomes in many respects a leading and a driving force to the mechanical and operating departments.

Fourth, a department of tests serving on one side for routine assistance and instruction to the purchasing and stores departments, and on another side for impartial and thorough experiment and advice on new devices. Collateral and co-ordinate with this, a chemical department serving similarly for chemical inspection or examination of all materials, and originating methods and appliances for new work—as shown conspicuously, for example, in the water-treating plants hereinafter described.

Fifth, a broad-minded and generous provision for the comfort and benefit of employees, caring for their pleasure and satisfaction in and out of working hours while in the service of the road, and extending a voluntarily granted pension on their retirement.

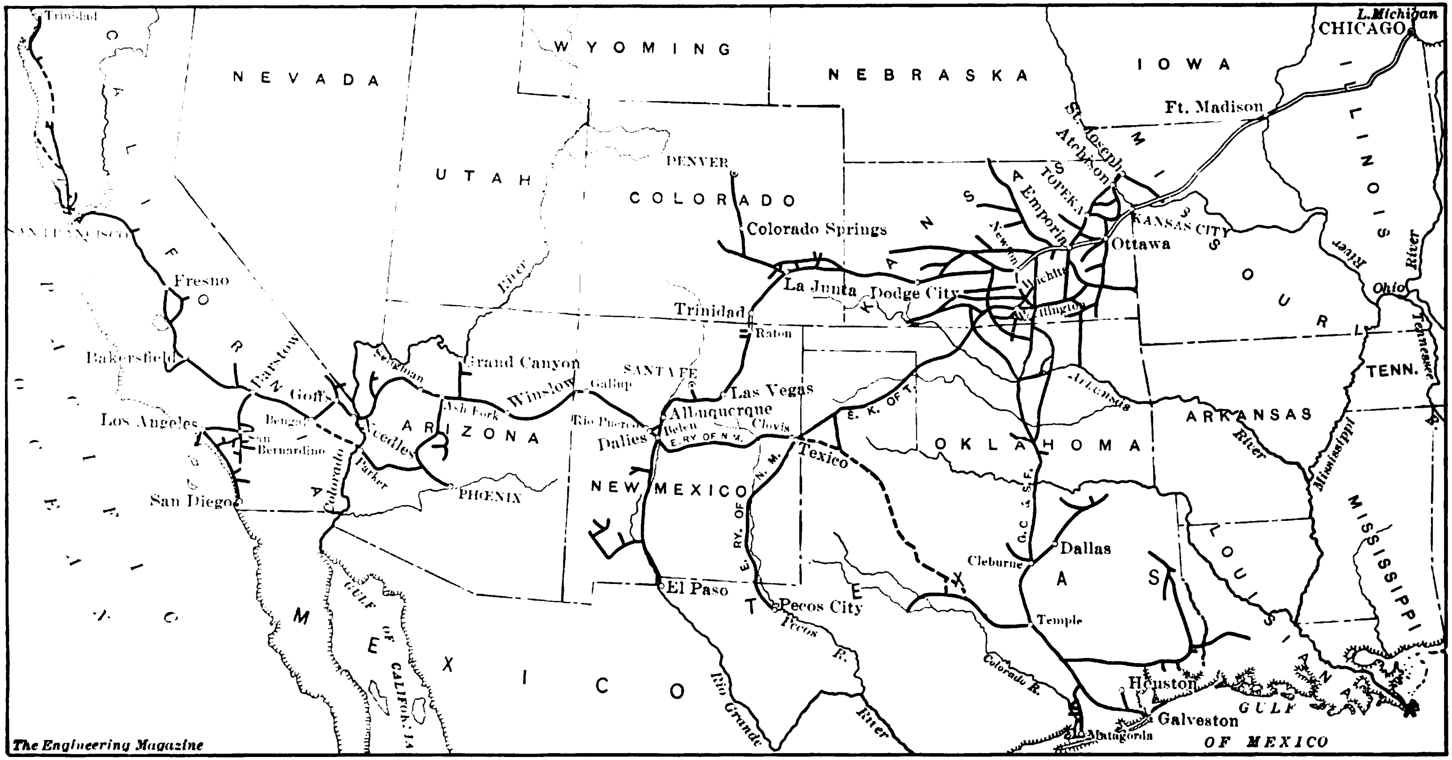
Sixth, a comprehensive and excellently-planned system of apprentice instruction, training up new first-class material for the shops of the road, and solving that often perplexing problem of the "mechanic of the future."

The order in which these features are listed is not intended to express any estimate of their comparative importance. Indeed, the institutions are so intertwined that it would be hard to say which is greater than the others. Each is in some degree dependent on all; each in turn contributes something more to the success of all. It is with these elements of the Santa Fe management, all of them closely sympathetic with, and many of them applicable to, the ordinary mechanical or manufacturing plant, that these articles will especially deal. Before taking them up in fuller detail, however, a short outline of the situation and the controlling conditions on the line of the Santa Fe will help to make clear the circumstances under which these policies have worked to success.

The configuration of the system is roughly that of a nearly equilateral triangle with sides about 800 miles long and angles resting at Kansas City, Albuquerque (New Mexico) and Temple (Texas). From the corners of this triangle, three great stems extend—eastward to Chicago, southward to Galveston, Houston and Matagorda, westward to Los Angeles, San Francisco, and up the Pacific Coast. The northwesterly angle is overlapped by a spreading network of branches covering the rich agricultural sections of Kansas, Oklahoma, and northern Texas, and similar expanding networks cluster about the gulf and Pacific Coast terminals. The southwesterly side of the triangle is still open*; but crossing it and forming substantially a continuation of the Chicago-Kansas City main stem, is the Pecos Valley division, reaching a fertile and rapidly-filling section of southern New Mexico, while other important lines extend from the westerly angle (at Albuquerque) to El Paso, connecting the Mexican railways, and from the middle of the northerly side (at La Junta) to Denver.

The total mileage is about ten thousand—the longest under a single management in the United States. It is nearly twenty-six hundred miles from Chicago to San Francisco, nearly a thousand from Kansas City to Galveston, five hundred from Kansas City to Pecos. The transcontinental line, however, especially attracts interest, and it is to it that the observations embodied in this article particularly apply.

* The line from Texico to Brownwood, Texas, closing this gap, and making a direct through line from San Francisco to the Gulf ports, will probably be completed this year.



OUTLINE MAP OF SANTA FE SYSTEM.

The lines directly operated by the corporations of the Santa Fe System cover 7,900 miles. The Southern Kansas Ry. of Texas, the Eastern Ry. of New Mexico, and the Gulf, Colorado & Santa Fe, which have separate corporate organizations, aggregate 2,177 miles.

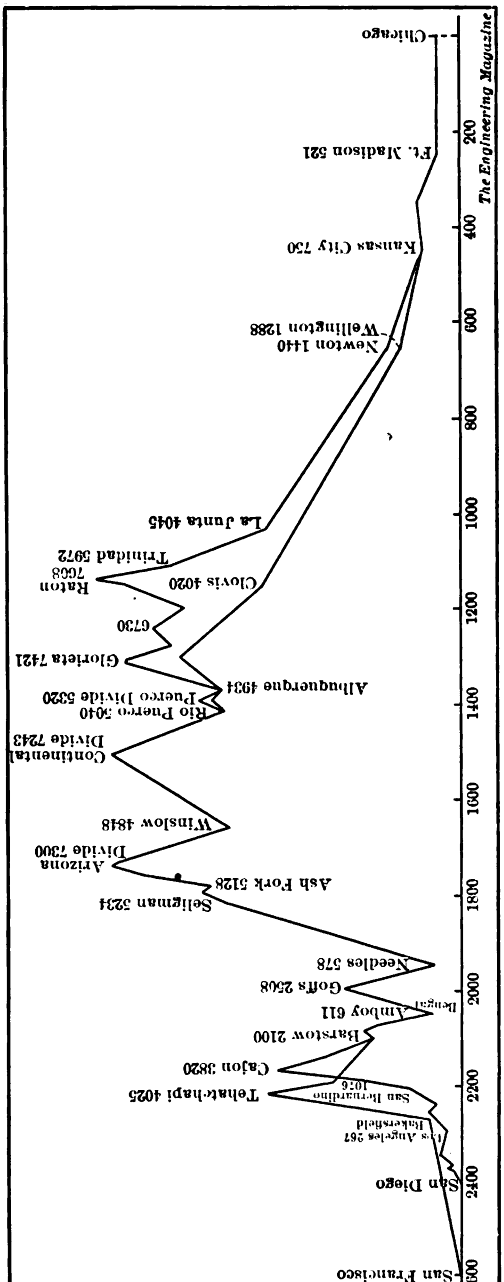


DIAGRAM OF PRINCIPAL SUMMITS AND ELEVATIONS ON SANTA FE TRANSCONTINENTAL LINES.

The new low-grade freight route across the Rockies referred to on page 917 is shown by the lower line from Rio Puerco to Kansas City. Horizontal scale, 1 in. = 400 miles; vertical, 1 in. = 4,000 ft.

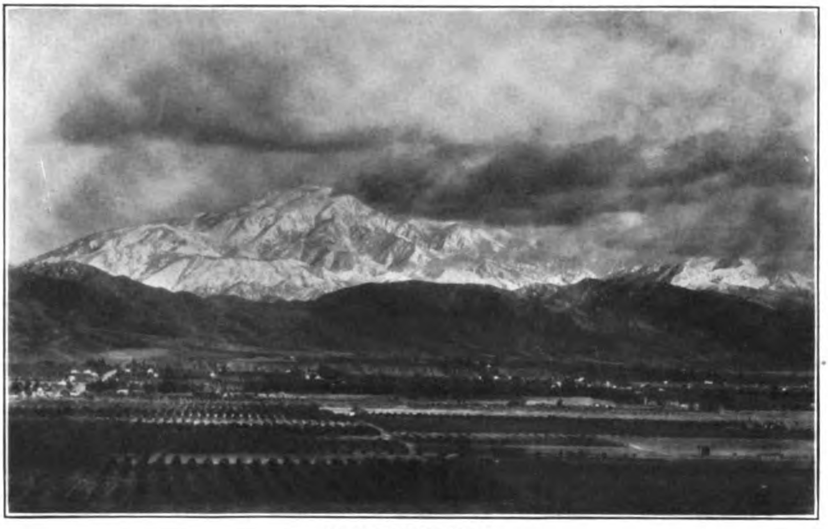
In the nearly three thousand miles between Chicago and the Pacific Coast terminals (including both San Francisco and San Diego) the old main line crosses six great mountain ranges — Raton, (7,608 feet) Glorieta, (7,421 feet) the Continental Divide, (7,243 feet) San Francisco, (7,300 feet) San Bernardino, (3,820 feet) and Tehachapi, (4,025 feet). Even some of the smaller climbs would be marked as important on lesser roads, as, for instance, the 2100-foot rise in 31 miles from Needles, Cal., westward to Goffs; but these appear minor in comparison with the grades of 106 feet and 185 feet to the mile westward up the 16 miles of the Raton pass, and 175 feet

SHOP GROUNDS AT NEEDLES, CALIFORNIA, SHOWING MASTER MECHANIC'S OFFICE AND ROUND HOUSE.

An example of environment improved for the comfort of employees. The grounds are made into a park for them and their families, and concerts are given by a band organized from among their number. The Japanese sign in the upper view says "Keep off the gross."

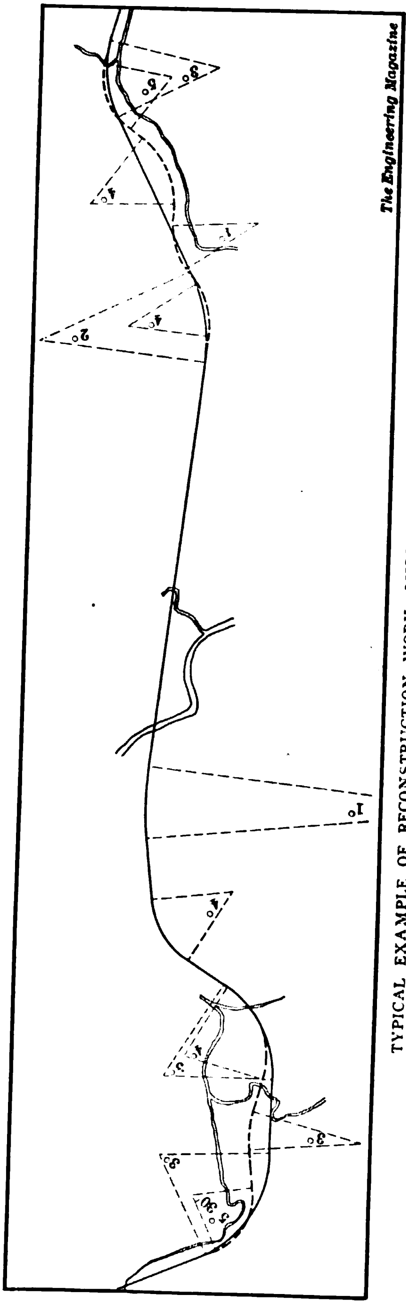
to the mile descending from the summit to Raton station; with 155 and 158-foot grades in the 9 miles from Glorieta to Lamy; with the 25 miles of 116-foot grade between Caliente and the Tehachapi summit, or the 25 miles of 2.2 and 3.0 per cent grade in the Cajon pass east of San Bernardino. For a thousand miles the railways runs through a treeless desert, incapable (at present certainly—much of it incapable ever) of affording local traffic sufficient to pay the section men.

Along a very large part of the whole line the water is bad, along much of it the quantity is scanty, and for considerable distances there is none. For a thousand miles, from Gallup westward, there is no coal. For some hundred miles, including the sites of necessary and important division points, the climate is unfriendly, living is difficult, and labor is hard to get and harder to retain. Of Needles, an experienced inhabitant said feelingly: "In summer there is only a thin crust between this place and hell—and the crust is badly scorched."



SAN BERNARDINO.

The conditions might well seem too hard to permit solution of the problems of constructing and operating the railroad to the coast—indeed, they might seem too hard, even if soluble, to justify the undertaking. But the great commercial reasons demanding the road, the conditions making its construction over all obstacles imperative, and the reward making its operation profitable—these appear when we have emerged from the Cajon pass or crossed the Tehachapi mountain. Along the northern branch lies the great Bakersfield oil region, the rich grape and fruit-growing country about Fresno, the fertile San Joaquin Valley, and San Francisco, with its trans-Pacific commerce and its Oriental freights. At the gateway of the southern branch is San Bernardino, with its rich mile upon mile of orange groves and olives, its commercial activity, and its expanding industries based upon the fruit culture; and from there to Los Angeles and beyond, the whole country is wealth-producing under the assured control of irrigation. Thirty-thousand carloads of citrus fruits were shipped



TYPICAL EXAMPLE OF RECONSTRUCTION WORK, MISSOURI DIVISION OF SANTA FE.

New track is shown solid, old by broken line. Total curvature in 8 miles (between Revere and Medill) reduced from 595 degrees to 485 degrees, and maximum curve from 5 degrees 30 minutes to 4 degrees.

from southern California last year, of which the Santa Fe handled 60 per cent—almost $5,500,000 gross revenue from this item alone. And irrigation is constantly increasing the volume of business to be handled. The Arrowhead Reservoir and Power project, which will gather flood waters from the upper reaches of the Mojave River and deliver them through 19 miles of tunnel across the dividing range into the San Bernardino Valley, alone contemplates a reservoir of 880 acres with a storage capacity of 61,000 acre feet; the two power drops of 1,500 and 1,865 feet respectively will develop 11,000 horse power, before the water is delivered for irrigation and domestic uses with a minimum flow of 2,000 inches continuously. This is but one of many undertakings gauging the expansion of the Coast region and its attendant traffic, and with it the heavy tourist travel is constantly growing heavier.

It is with this stream of passenger travel, with Oriental goods and fruit trains requiring special dispatch, with mining products, or further eastward with the live stock and the heavy crops of the middle west and the central States, and with the heavy freight, merchandise, and machinery tributary to the population and pursuits of the region, that the transcontinental lines of the Santa Fe are occupied. The gulf division deals with timber, agricultural products and stock, and with the army of home-seekers pressing into the southwest.

Any review of railway betterment policies must begin with track, even though these papers are to be devoted particularly to the mechanical department and can include permanent way only in the broadest outline. Three important features are noticeable in the improvements under the Santa Fe engineering department: The construction of new low-grade lines and cut-offs, the rebuilding, double-tracking and revision of troublesome portions of the main line, and the unusual provision for economic maintenance of all track. The first two heads are those which are most closely interconnected with the maintenance of economy in the motive-power and mechanical departments; furthermore, they are so closely associated with each other that they can be more clearly understood if presented together than if considered separately.

The important reconstruction work begins on the Missouri division, which has been largely rebuilt from Fort Madison on the Mississippi to Kansas City, eliminating or reducing curves, lowering grades, and double-tracking the line for the entire distance. The heavy work on this is nearly complete, and much of the second track is in commission. Except for one short stretch of undulating country in Missouri, where a maximum gradient of 0.8 per cent remains, the result of the change will be to give a maximum grade of 0.6 per cent westward, from Chicago to the Missouri River. Beginning again at Newton on the main line, the division running southwestward via Wellington to Texico (which crosses the undulations of the land and formerly had a controlling grade of 1 per cent) has been improved and rebuilt, with a maximum grade now of but 0.6 per cent. From Texico to Albuquerque a wholly new line 270 miles long—the "Belen cut-off," constructed boldly to first-class standards throughout—rejoins the Santa Fe Coast Lines at Dalies and extends the 0.6 per cent grade westward to the Rio Grande River, while contemplated improvements of the main line beyond that will carry the same maximum gradient to Winslow. Thus the Santa Fe is at the point of securing its complete freight line from Chicago across to the Continental Divide substantially with no grade greater than 0.6 per cent. The heavy grades on the Raton, Glorieta and Continental summits alluded to above, and the long stretches of 1¼ per cent grade through Colorado and New Mexico,

STATION AT CLOVIS, N. M., ON THE BELEN CUT-OFF.
Showing the type of fireproof construction and the standards set in developing even a new country. Clovis is a division point on the new Santa Fe 0.6 per-cent-grade line for transcontinental heavy through freight. The saplings on the platform are to be planted in this new town.

are entirely eliminated, and this without increase of mileage. Indeed, the mileage from Newton to Rio Puerco over the Belen cut-off is slightly less than that by the old main line. Reference to the map and profile, on pages 912 and 913, will make the extent and effect of these changes clearer.

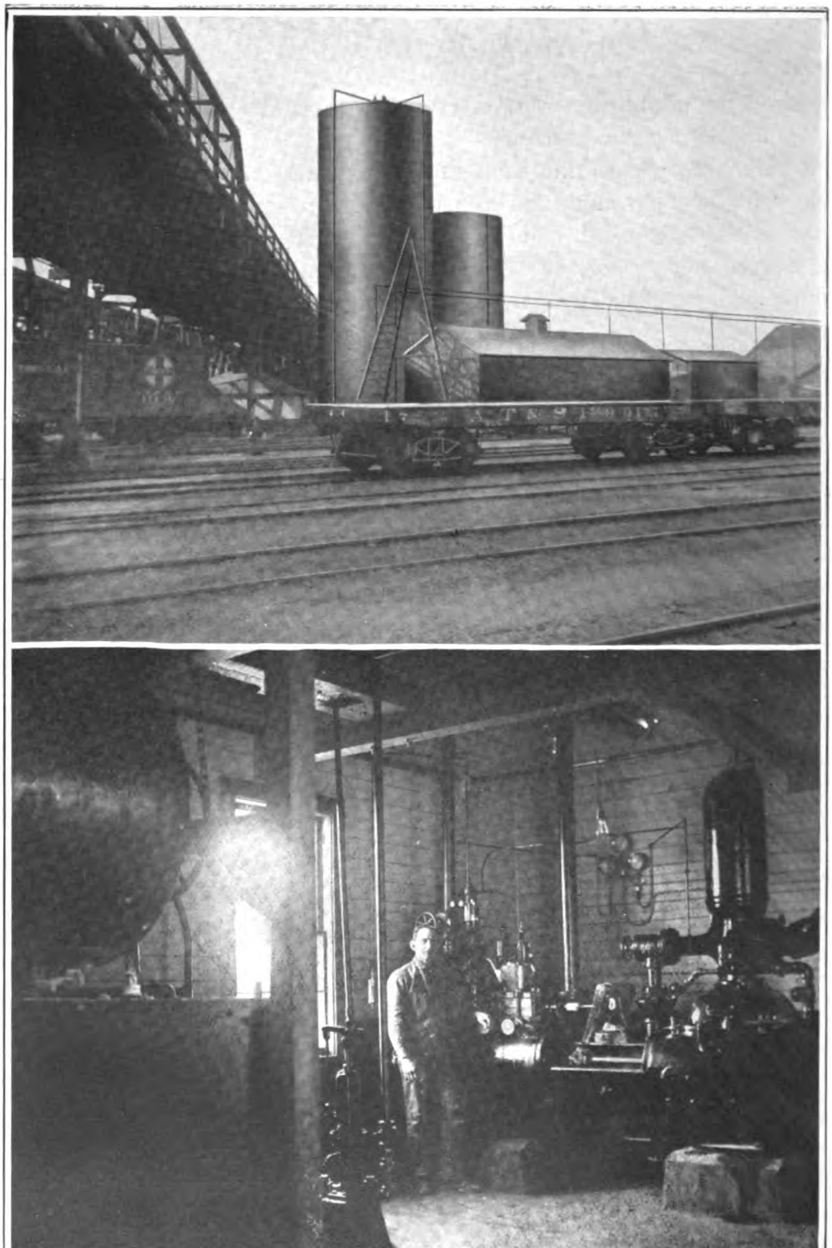
Further west, an extension from Parker (on the Colorado River between Arizona and California) to Bengal will give a low-grade line west of Ash Fork, cutting out the present grades of 1 per cent between Bengal and Goffs, 1½ per cent between Goffs and Needles, and a long 75 to 95-foot grade from Needles to Seligman. With the exception of about one hundred miles across the Arizona divide, and the unimportant stretch on the Missouri division already referred to, the Santa Fe has practically completed a first-class low-grade freight route from Chicago to the Sierra Madre Mountains in California. The line from Texico to Brownswood, referred to previously, will make this low-grade route complete also between California and the Gulf ports. The Arizona divide will still present about fifty miles of 75 to 95-foot grade against the traffic either way, and passenger trains will continue to use the old line; but a project is seriously considered for taking the trains over Raton summit (the hardest hill on the line) by electric power.

Improvement of line, reduction of grades, and even the use of electric power on mountain divisions, are of course in no wise peculiar to the Santa Fe. They are standard modern practice, though displayed here to an impressive extent. Standard also, of course, is the general excellent maintenance of track, though it is noteworthy that the Santa Fe policy has been to keep the line up to good condition through the past eighteen months, while many roads were curtailing expense on this account. In the tie and timber department, however, measures more peculiarly characteristic of the Santa Fe begin to appear. The Gulf lines of the system reach abundant timber, but the Coast Lines country is (or was) for the greater part treeless. The road has planted large stretches with eucalyptus from which, under proper foresting, it can supply an important fraction of its requirements for ties. The researches of the department have circled the globe, seeking woods suited for ties and structural work and for car and coach building. Lastly, and perhaps most important, preservative processes for ties and timber have been highly developed. The principal treating plants are at Somerville, Texas, with a capacity of about 16,000 ties a day, and at Albuquerque with a capacity of 4,000 to 6,000. For ties, crude oil is now largely employed (at least for all woods that will take it), as it has been found fully effective in protecting the fibre against decay for a term equal to the mechanical life of the ties. On woods that will not absorb crude oil sufficiently, and on structural timbers not subject to mechanical destruction, creosote is more generally employed.*

It is the policy of the road to use only treated ties and timber in new work, and in all replacements. Here again the work of the present secures the economy of the future.

The problems of water supply, so far as concerns quality, are solved by treatment with lime and soda, about one hundred treating stations being distributed over the system. The process is generally designed to operate with great simplicity under charge of the local

* The process of treatment is similar in either case, though the details are varied to suit the differing penetrative properties of oil and of creosote. The ties or timbers are loaded upon skeleton cars, and run into horizontal cylinders 120 feet long. The head is bolted on, heat is applied by steam coils, and the air is withdrawn. Crude oil or creosote is then pumped in and the tank is kept under a pressure of about 200 lb. and at a temperature of about 200 degrees F. (both approximately stated) until the gauge record of preservative pumped in shows a sufficient absorption per cubic foot of timber in the cylinder. This usually requires ten or twelve hours. The surplus oil or creosote is expelled by compressed air. The Albuquerque plant has two cylinders and the Somerville plant five. This latter, which uses creosote entirely, last year treated 3,250,000 ties, 9,500,000 feet, board measure, of lumber, and 600,000 lineal feet of piling.



WATER-TREATING AND STORAGE TANKS AND INTERIOR OF WATER-TREATING PLANT, LOS ANGELES, CAL.

The slacking tank and chemical tank are on the left, the small pump handling the lime water in the center, and the main water pumps on the right. A water motor on the discharge of these large pumps drives the other apparatus, the lime water being thus supplied practically automatically in proportion to the volume of raw water passing through the big pump. The whole apparatus and arrangement is of Santa Fe design.

pump man, checked by periodical inspections and frequent examinations by the chemical department. The reagent solution is mixed automatically in determined proportion with the raw water. Precipitation and sedimentation take place in the storage tank, the clear treated water flowing from the upper portion for engine use, and the deposited sediment being flushed at intervals through a valve at the bottom. The Santa Fe storage tanks extend to the ground, instead of being raised (as usual elsewhere) on a structural base with a specially supported tank floor. The lower 15 feet of the tank, at first glance apparently useless, actually serves as a settling basin, and in addition this form of construction effects a saving in expense of both material and erection. The operations and costs of the water-treating system, by divisions and in grand total, are shown in the accompanying table.

SUMMARY OF WATER TREATMENT, YEAR 1908.
Chief Chemist's Office, Topeka, Kansas.

Summary by Divisions.	Grains Incrustants, Av'ge.			Lb. Incrsts. Removed per M Gallons.	Total M Gallons Treated.	Total Cost, $.	Cost per M Gallons.	Total Lb. Incrsts. Removed.
	Before Trtmt.	After Trtmt.	Remvd.					
Illinois	35.7	3.2	32.5	4.64	189376	4996.76	.0263	858402
Missouri	28.6	3.8	24.8	3.54	165613	3967.22	.0239	574380
Kansas City	24.2	3.7	20.5	2.92	152805	4158.87	.0272	446190
Eastern	26.3	4.1	22.2	3.17	300484	6741.55	.0224	831810
Middle	44.7	4.1	40.6	5.80	123749	6093.69	.0491	715724
Oklahoma	35.7	4.5	31.2	4.45	138591	3518.52	.0253	637750
Pan Handle	45.8	4.2	41.6	5.94	75274	3693.24	.0489	397448
Pecos V. Lines	39.3	5.5	33.8	4.97	28566	2011.13	.0704	131467
Western	34.4	3.9	30.5	4.35	163420	5770.13	.0353	681077
Arkansas River	60.2	4.5	55.7	7.95	229257	12850.54	.0560	1950419
Colorado	45.5	3.9	41.6	5.94	123327	3458.70	.0280	483292
New Mexico	41.6	4.7	36.9	5.27	178487	4386.19	.0245	803739
Rio Grande	31.4	3.9	27.6	3.94	61550	2979.19	.0484	231438
Albuquerque	33.9	3.8	30.1	4.30	307534	11614.51	.0377	1013431
Arizona	28.1	3.5	24.6	3.50	192646	7389.35	.0383	694368
Los Angeles	23.2	1.8	21.4	3.05	140859	4455.28	.0316	444414
Valley	33.7	3.3	30.4	4.34	42874	1661.06	.0387	207510
Eastern Grand	28.9	3.8	25.1	3.58	808278	19864.40	.0245	2710782
Central Grand	39.1	4.2	34.9	4.98	501034	19075.58	.0373	2431999
Pecos V. Lines	39.3	5.5	33.8	4.97	28566	2011.13	.0704	131467
Western Grand	44.7	4.3	40.4	5.78	592621	23574.62	.0397	3468888
Coast Lines	30.5	3.2	27.3	3.90	683913	25029.50	.0365	2359723
A. T. & S. F. Prop.	37.2	4.2	33.0	4.71	1930499	64725.73	.0335	8743136
A. T. & S. F. System	35.8	3.9	31.9	4.55	2642978	91566.36	.0346	11102859
System, 1907	32.6	4.3	28.3	4.03	2466965	87414.44	.0355	9579772
System, 1906	35.0	4.1	30.9	4.41	1913398	69081.46	.0361	7906233

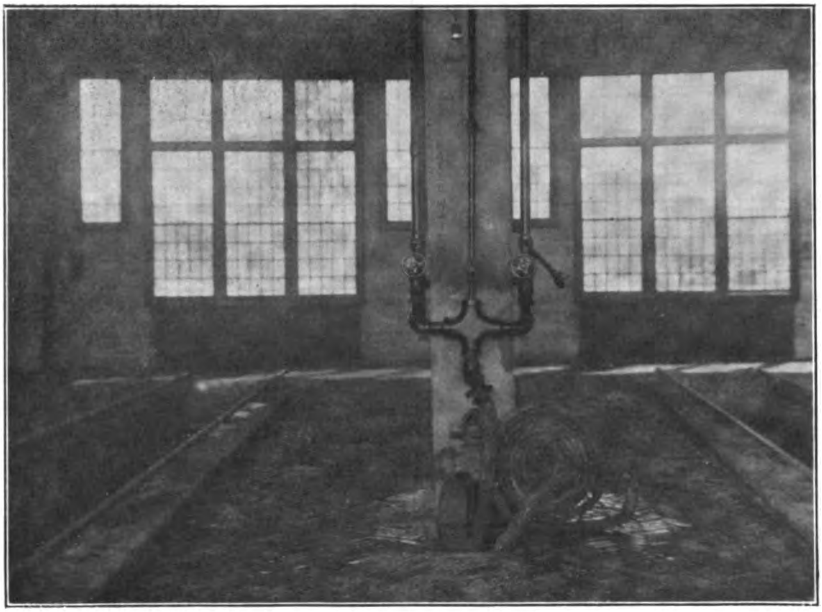
Analyses of Coals Used on the A. T. & S. F. R. R., 1907. | **Results from Storing Coal Seven Months in the Open Air and under Water.**

Mine and Shaft.	Proximate. Water.	Proximate. Volatile.	Proximate. Fixed Carbon.	Ultimate. Ash.	Ultimate. Sulphur.	B.T.U.	Per Cent. Loss in Actual Weight. in Open Air.	Per Cent. Loss in Actual Weight. under Water.	B.T.U. of Ash and Water Free. As Mined.	B.T.U. of Ash and Water Free. Stored in Open Air.	B.T.U. of Ash and Water Free. Stored Under Water.	Per Cent. Loss in B.T.U. Stored in Open Air.	Per Cent. Loss in B.T.U. Stored under Water.	Total Loss Per Cent. Stored in Open Air.	Total Loss Per Cent. Stored under Water.
Big Four Mining, Coal City, Ill.	14.88	35.21	45.00	4.91	2.25	11110	...	5.92	13851	13577	13844	1.98	0.05	1.98	5.97
Acme Mining Co., Streator, Ill..	9.70	38.33	45.86	6.11	2.81	11988	...	2.12	14237	13877	13993	2.58	1.78	2.58	5.00
Toluca Devlin Estate, No. 1....	11.22	36.80	45.90	6.08	2.59	12154	...	1.53	14696	13711	14151	6.73	3.71	6.73	5.24
Toluca Devlin Estate, No. 2....	10.51	36.89	45.46	7.14	3.33	11865	...	2.80	14412	14001	13701	2.85	4.93	2.85	7.78
Roanoke	12.33	36.13	44.58	6.96	3.39	11801	.95	3.18	14621	13885	13960	3.45	4.34	9.40	7.52
Central Coal & Coke Co., Richmond, Mo.	13.89	33.66	42.59	9.86	4.05	10406	...	1.64	13647	13167	13680	3.52	...	3.52	1.64
Marceline, Mo., No. 1..........	12.08	38.77	41.80	7.85	4.44	11433	...	...	14190	13664	13562	3.71	4.38	3.71	4.38
Marceline, Mo., No. 2..........	1199	37.59	41.88	8.54	4.18	11010	...	0.52	13856	13504	13900	2.55	0.04	2.55	.56
Cherokee and Pittsburg No. 5...	5.20	35.34	53.77	5.69	2.48	13212	4.29	4.36	14881	14358	14209	3.16	3.78	7.48	8.14
Cherokee and Pittsburg No. 6...	3.52	35.31	49.44	11.73	5.75	12825	...	...	15131	14543	14372	3.89	3.05	3.89	3.05
Cherokee and Pittsburg No. 8...	4.68	35.12	52.51	7.68	4.01	12849	.60	...	14668	14237	14043	2.94	4.26	3.54	4.26
Cherokee & Pittsburg No. 9...	3.25	37.26	50.74	8.75	4.76	12690	...	...	14420	14261	14130	1.10	2.01	1.10	2.01
Wear Coal Company No. 17....	3.54	36.81	53.47	6.18	3.88	13022	.90	3.85	14422	14204	13170	1.51	8.68	2.41	12.53
Devlin Miller Company........	3.55	37.13	51.65	7.62	4.35	13487	4.40	5.18	15182	14562	14017	4.09	3.72	8.49	8.90
Central Coal & Coke Co. No. 17	2.20	36.18	55.75	5.87	2.34	13361	...	...	.....	.....	.....	...	...	...	....
Central Coal & Coke Co. No. 31	1.73	33.10	49.92	15.25	3.89	12664	...	...	.....	.....	.....	...	...	...	....
Pittsburg & Midway No. 5.....	1.50	34.25	52.78	11.47	4.59	12354	...	...	.....	.....	.....	...	...	...	....
St. L. R. M. & P. Co. Van Houten Mine	1.61	36.84	52.58	8.97	0.79	13098	2.58	1.60	14648	14465	14509	1.32	0.95	3.90	2.55
St. L. R. M. & Co. Brilliant Mine	1.60	37.25	50.83	10.32	0.78	12741	4.73	5.53	14465	14260	14430	1.42	0.25	6.15	5.78
C. F. & I. Co. Starkville........	1.57	31.67	54.22	12.54	0.69	12779	1.41	3.04	14895	14691	14520	1.25	2.60	2.66	5.64
C. F. & I. Co. Katcina at Morley	1.35	32.66	54.73	11.26	0.83	12986	4.18	1.48	14861	14689	14782	1.16	0.54	5.34	1.97
Victor Fuel Co. Delagua C. & S. E. Ry..................	2.07	36.51	52.87	8.55	0.57	12532	...	3.31	14020	14345	14345	...	...	...	3.31
Victor Fuel Co., Hastings......	1.70	35.04	53.20	10.06	0.67	13113	4.78	0.26	14861	14292	14782	3.16	0.53	7.94	.79
Weaver near Gallup...........	12.19	38.29	43.75	5.77	0.76	11214	2.69	0.48	13677	13384	13288	2.15	2.88	4.84	3.36
Heaton near Gallup............	9.71	41.85	42.92	5.52	0.90	11722	4.64	5.16	13818	13508	13320	2.65	3.59	7.29	8.75
Otero near Gallup.............	8.41	40.05	40.78	10.76	0.91	11119	.64	3.88	13755	13107	13350	4.71	2.22	5.35	6.05
Clark 1 & 2 near Gallup........	11.04	40.23	40.93	7.80	0.49	11198	...	2.62	13789	13235	13714	4.02	0.55	4.02	3.17
Weaver mixed Pea 60% and Slack 40%	9.98	39.40	41.52	9.10	0.69	11036	...	...	.....	.....	.....	..	...	...	....
Weaver Slack.................	10.35	36.93	38.52	14.15	1.64	10261	...	...	.....	.....	.....	...	...	...	....
Weaver Pea...................	10.03	37.87	41.35	10.75	.50	10959	...	...	.....	.....	.....	...	...	...	....

TABLE SHOWING ANALYSES OF COALS USED ON THE SANTA FE AND RESULTS OF EXPERIMENTS ON WET AND DRY STORAGE.

These investigations by the Chemical Department of the Santa Fe show but little advantage in storage under water, and but little loss in weight or in heat units from storage through long hot summer months. Both results are unexpected and are very interesting. The value of the information is suggested by the fact that these analyses represent coal costing $3,000,000 a year.

Waterless sections of the road are supplied by tank trains from the nearest supply point, the longest hauls approximating seventy miles. Little towns or hamlets dependent upon local industries in these arid districts are supplied by the railway water trains at figures comparing favorably with ordinary municipal rates. In some cases pipe lines will replace the tank-car hauls, one such line projected from Willard eastward on the Belen cut-off having a proposed length of about one hundred miles.

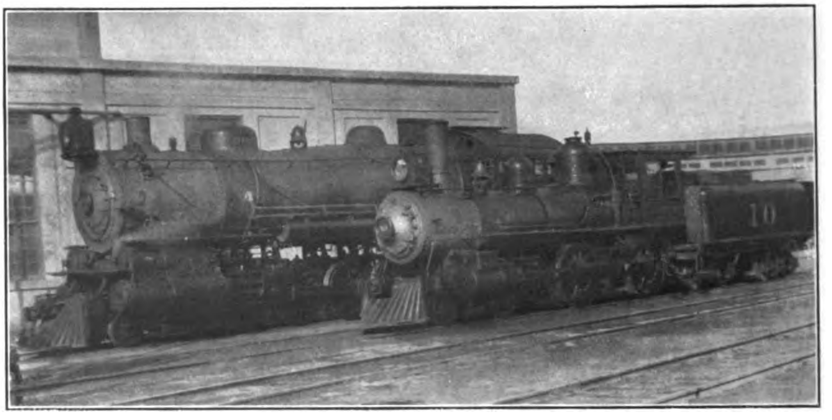


PART OF THE SAN BERNARDINO ROUND HOUSE, SHOWING TYPE OF REINFORCED-CONCRETE CONSTRUCTION, STANDARDS OF ORDER AND CLEANLINESS, AND STANDARD ARRANGEMENT OF PIPING.

Left-hand pipe is treated water, right-hand raw or washing water, center pipe steam. The lower connection on the mixer is for filling and washing purposes; the lower valve, in the box, is the blow-off line.

An interesting feature of Santa Fe practice, closely connected with water supply, is the heat-conserving system which appears in use at Raton, under construction at Needles, in partial service at other points, and is being made standard for the road. This method, in brief, uses the steam blown off from engines in the round house to heat the water supply from which outgoing engines are filled up again. This heat is preferably introduced in the treating tanks where it helps greatly in the precipitating reaction. The water blown off from the locomotive boilers passes into a sump tank, where it settles, and the clear or partly clear hot water above the sediment is pumped back and used over again for washing out, thus not only saving a corresponding amount of fresh water, but avoiding the sudden cooling down which washing with cold water would occasion.

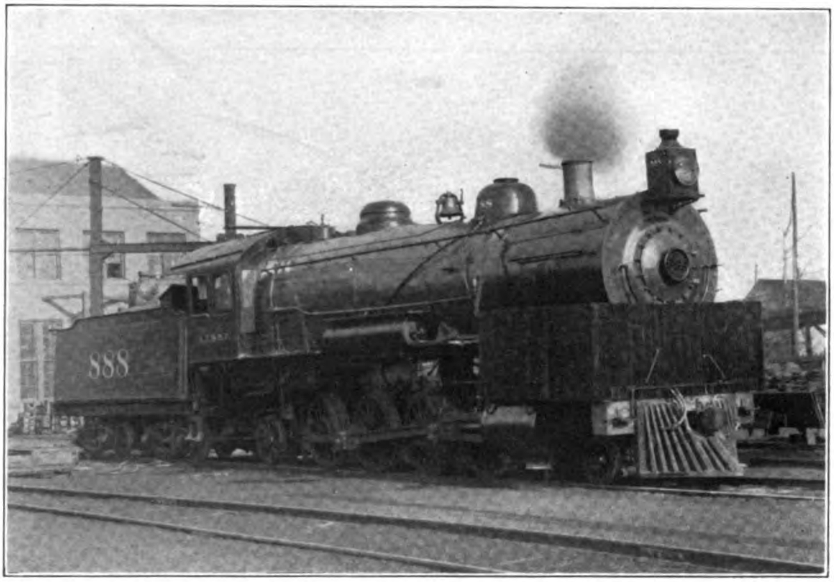
The fuel situation, so far as coals are concerned, is summarized in the accompanying table of analyses, to which is attached also the result of very interesting experiments on wet and dry storage, with determinations of loss in weight and in heating power under both conditions. West of Gallup, as already mentioned, there is no coal; the problem is abundantly solved by the use of oil-burning engines over practically the whole of the Coast Lines. The necessary arrangements of boilers, furnace, and firing have been brought to a high point of satisfaction; indeed, the delicacy and promptness with which one of the heavy oil-fired Santa Fe locomotives responds to her fireman's touch is remarkable. They can be forced to a very high rate of evaporation; indeed, they can be and are worked to a point that keeps two injectors going—but of course the wear of such service is hard, and the flue sheet suffers from the very high temperatures in the fire-box.



THE LARGEST AND THE SMALLEST LOCOMOTIVE ON THE LOS ANGELES DIVISION.

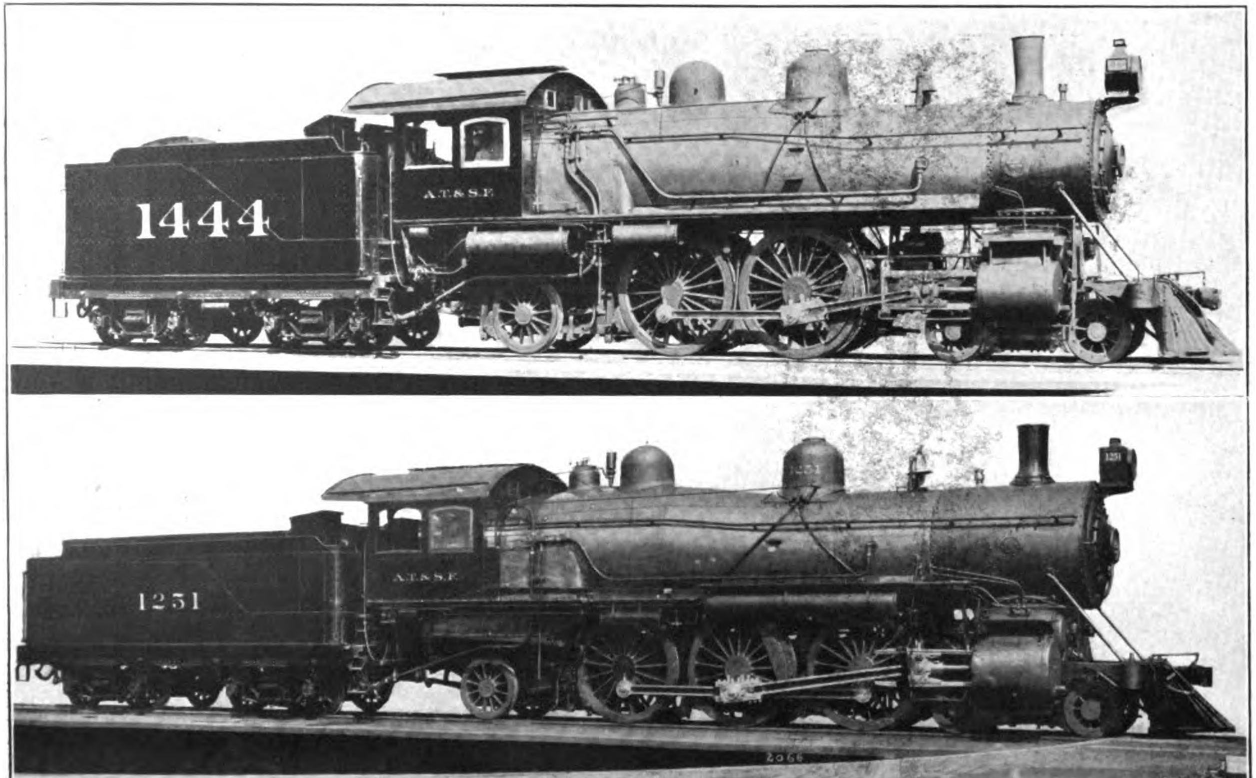
Suggesting the range of traffic conditions to be cared for. The smaller engine, of the "1" class (Manchester 8-wheel) is an 18 by 24 with 1,360 sq. ft. heating surface and weighing 95,400 lb. The larger, of the "900" class (Santa Fe type) is a 19 & 32 by 32 oil-burning compound with 4,796 sq. ft. heating surface and weighing 287,240 lb.; both weights are exclusive of tender.

It is in the selection or development of motive power and equipment specially adapted to economical service under peculiar conditions, however, that the Santa Fe begins to show the strongest individuality and interest. Nowhere else in America has the compound locomotive been given so large place. About 700 out of some 2,000



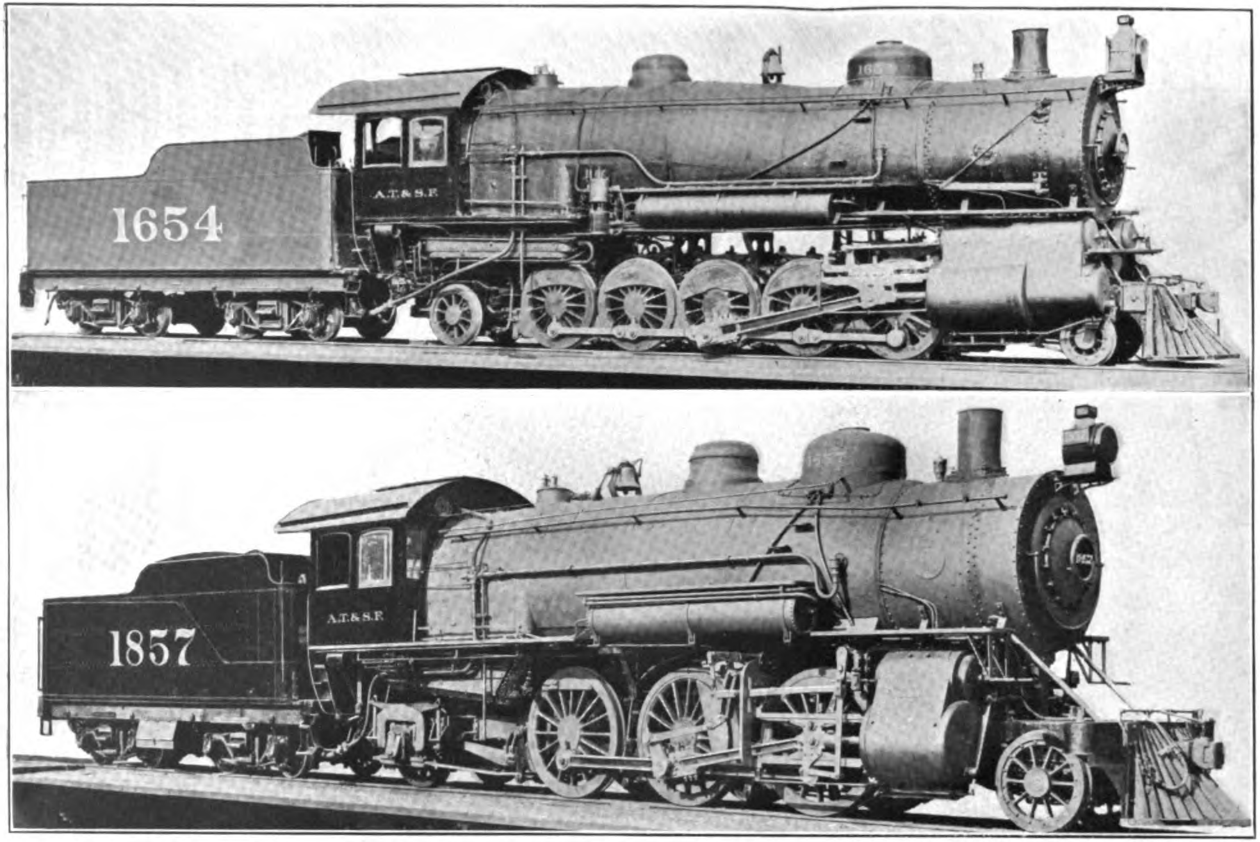
MIKADO TYPE ENGINE USED IN MOUNTAIN SERVICE.
Equipped with new two-section firetube smokebox superheater, Jacobs design, and with testing box on front end. Engine weighs 261,720 lb.; cylinders 18 & 30 by 32 in.; heating surface 5,366 sq. ft.

engines owned by the road are of compound type. The proportion is very much larger than these figures would suggest, if we eliminate engines out of service or engines in yard and switching work and take only locomotives hauling trains on the road. The balanced compounds used in passenger service, based upon the most successful French express-locomotive types, have been developed to a point not reached elsewhere in the United States or in Europe for high speed with the least injury to track. Two freight types combining tractive effort with serviceability and good running speed have been evolved—one for level country and one for heavy grades. Superheating has been introduced to a greater extent than on any road in the country. Some of the heaviest engines in service in America are at work on the big grades of the Rockies, and heavier units still are under negotiation. The operating officials of the road have acted boldly and persistently on the conviction that compounding and superheat reduce the fuel and water difficulties by increasing the economy of fuel and water consumption—that the compound is not only a better machine, but all things considered a more economical machine. One feature which certainly is noticeable is the great starting power which is secured in these engines by simpling them for the first few revolu-



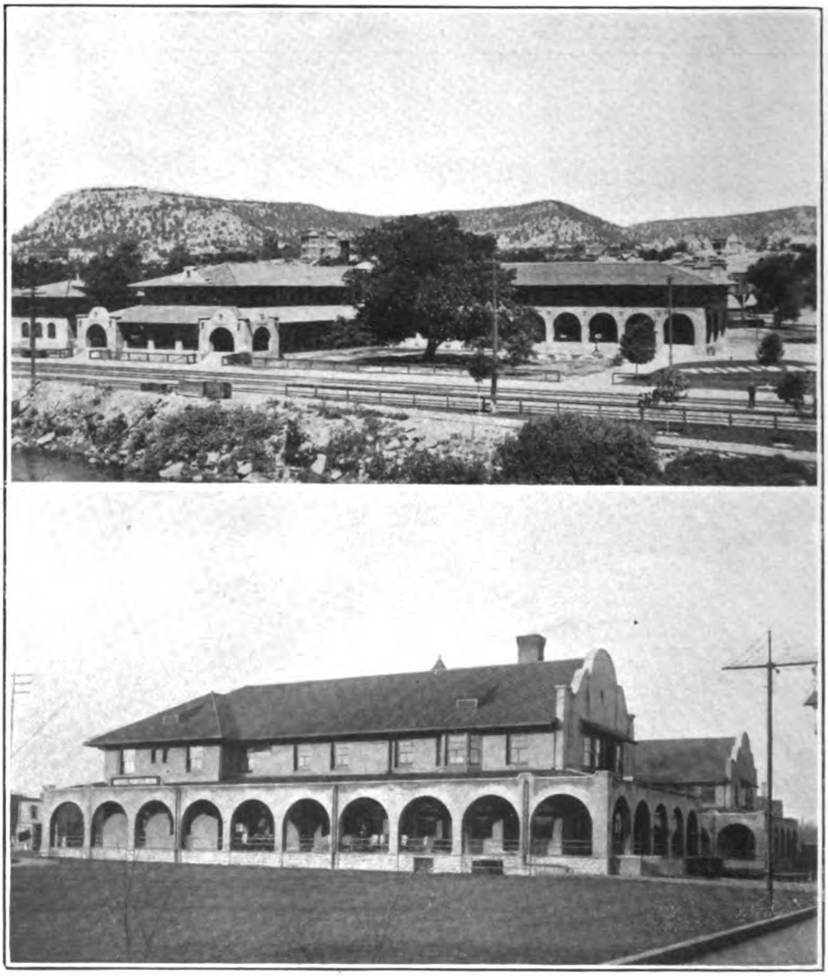
TYPICAL SANTA FE PASSENGER ENGINES. ATLANTIC TYPE ABOVE, PACIFIC TYPE BELOW.

Both are Baldwin balanced compounds. The Atlantic type is 15 & 25 by 26 in., 220-lb. pressure, 3,206 sq. ft. heating surface, and weighs 204,100 lb. with a tractive force of 22,200 lb.; 79-in. wheels. The Pacific type is 17 & 28 by 28 in., 220 lb., with 3,595 sq. ft. heating surface, and weighs 226,700 lb. with 151,900 lb. on drivers and a tractive force of 32,800 lb.; 73-in. wheels.



SANTA FE FREIGHT ENGINE TYPES.

The "Santa Fe" type, above, for heavy mountain work, is a Baldwin tandem compound 19 & 32 by 32 in., 225-lb. pressure, 4,796 sq. ft. heating surface. It weighs 287,240 lb. with 234,580 lb. on drivers and a tractive force of 62,800 lb.; 57-in. wheels. The Baldwin "Prairie" balanced compound, below, is 18 & 30 by 28 in., 225-lb. pressure, 4,020 sq. ft. heating surface. It weighs 248,200 lb. with 174,700 lb. on drivers and a tractive force of 40,800 lb.; 69-in. wheels.



TYPICAL HOTELS OF THE SANTA FE COMMISSARY SYSTEM.
Above, the Cardenas, Trinidad, Colorado; below, the Castañeda, Las Vegas, N. M.

tions; and as a general proposition, a locomotive can haul any train it can start.

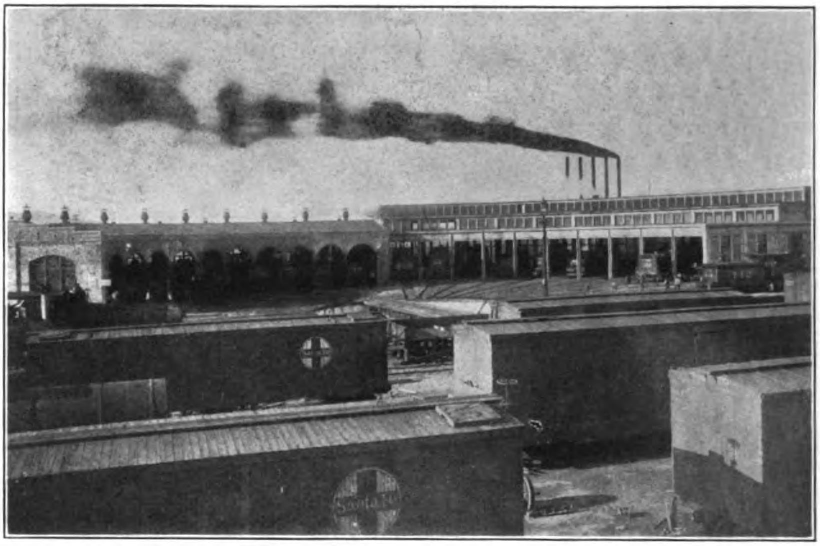
For passenger service a steel-platform, double-bulkhead coach, with heavy bracing in the center to resist shock or telescoping, is the standard. The framing, length, and general exterior design are the same as the standard Pullman sleepers, giving a symmetrical aspect to the train. For freight service the road has not favored extreme capacity cars, being convinced that statistics for the past few years show an inclination away from effective use of these extraordinary

HOTEL ALVARADO, ALBUQUERQUE, ILLUMINATED FOR THE IRRIGATION CONGRESS.

units, and that investment in them is disproportionate to the average service secured. The Santa Fe adheres to a type which in practice gives the maximum proportion of actual load to marked capacity. A considerable portion of the traffic on the transcontinental lines is carried in refrigerator cars, and a large pre-cooling plant is to be erected at San Bernardino for increasing the economy and efficiency of this service in accordance with the latest ideas.

Lastly, a commissary department sufficient to reach across the thousand miles of desert takes the form of a remarkable chain of hotels under management closely affiliated with the road. These establishments impress the chance traveler by their superior and evenly sustained service. Centralized management, and intimate connection with the transportation facilities of the road, bring the advantages of high purchasing ability in the best markets, east or west, to the operation of even the smallest of the stations. Except for the limited trains (which carry diners) the fixed restaurant is relied upon because it serves a wider purpose than the dining car. It caters to the railroad employee, the commercial or transient visitor, and the local resident, as well as to the through passenger; and the standards set sensibly raise the level of the towns in which they are placed. Indirectly and directly through their personnel they are home-makers, and home-making is a really important economic factor in the upbuilding of much of the region through which the road runs.

This summary of the salient features of the Santa Fe road and its



THE ROUND HOUSE, RICHMOND, CALIFORNIA. POWER HOUSE IN THE REAR.
The left-hand portion of the round house is the original structure. The right-hand part, built since the earthquake, shows the modern Santa Fe methods in contrast with the old.

operation, necessarily brief, is intentionally made broader than the scope of the articles which will follow. Each feature touched upon is in its way an expression of a single and definite policy. Each has its proportion of influence in a certain result. This result is the attainment of determined standards and of assured profit in the manufacture of transportation on an immense scale, across unoccupied and unproductive country, and amid forbidding difficulties. Each of the institutions mentioned is the deliberate expression of a conscious purpose of the management of the road, and each must be noted to get any fully rounded image of the whole achievement.

The following articles will take up in closer detail the distinctively manufacturing features of the system in a stricter sense—that is, the stores department, shop methods, and bonus work; and a concluding paper will outline the relations with personnel as exhibited in the apprentice system and the welfare institutions.

THE ENGINEERING QUESTION IN THE UNITED STATES NAVY.

It requires perhaps an enthusiastic—even a boisterous—optimism to expect efficiency in the political administration of Government works. Any corporation one-quarter, or one-tenth, the size of the United States Navy Department that changed its head management as often as the Department has changed Secretaries during the expiring Administration, and that selected executives of the experience and training of most of these Secretaries, would make itself a by-word in the Street and a subject for a receivership. Most of these things we accept, because it is the Government way of doing things—the established order. But now that the politicians have assumed the rôle of efficiency organizers and are trying to adopt the language and guise of business administration, it is appropriate to look deeper and see who or what they are seeking to serve in this borrowed livery. Our contributor's accurate and intimate knowledge of the subject is evident. For obvious reasons, his name must not be given.—THE EDITORS.

FOR ten or twelve years, the status of engineering in the United States Navy has been such as to cause the greatest concern to those who are interested in the maintenance of that high standard which has characterized the design and construction of the machinery of our ships, as well as to those who believe that to maintain such a standard requires the services of men skilled not only in the theory which is the foundation of all sound engineering, but also in the practical application of that theory. When, ten years ago, the engineers of the navy were amalgamated with the line, or military branch of that service, there was some misgiving on the part of engineers, both within and without the navy, that the experiment would prove a success; but the engineering profession was satisfied to accept the judgment of such men as Engineer-in-Chief Melville, that there was no question of the success of the scheme, if (and always there was that *if*) only the law were administered in the manner contemplated by its advocates and by the Naval Committee of Congress.

Unfortunately for the successful carrying out of the plan, the amalgamation was almost coincident with a large increase in the navy, demanding such an unexpected addition to the number of young officers for the performance of purely military duty as to leave few for training in engineering, and thus, from force of circumstances, the purpose of the framers of the law was for a time defeated.

Gradually this condition has been improving, until now the graduates of the Naval Academy are more than enough for the military duty, and are sufficient in number to permit the purpose of the amalgamation scheme to be carried out as its friends expected it would be. So far has it been possible to do this during the past two years that in the battleship fleet which has just completed its cruise around the world, only three or four of the chief engineers are engineering graduates of the Naval Academy, the others being officers with a taste for engineering, who, by study and hard work, have developed into competent engineers, a fact which is attested by the self-supporting character of each ship during this unprecedented cruise.

Just as this happy condition was culminating, the Secretary of the Navy dealt a blow to engineering which is as difficult to explain as the necessity for it is incomprehensible, and which will do more to retard the development of engineering in the United States Navy than any single act since the beginning of the steam navy. By a recent order, he has subordinated the Bureau of Steam Engineering, whose work has always been of the highest order, by appointing the Chief Constructor as the acting chief of that bureau and thus humiliating that small but accomplished body of engineers in the navy who have been conspicuous for their devotion to duty and for the excellence of their work in design and construction, rather than for their attendance at balls and banquets, which seems to be just now a desideratum for official preferment.

Added to this is an order absolutely removing from the control of engineers—civil, electrical or mechanical—all work in navy yards, which they have hitherto supervised; and an announcement of his intention to abolish the bureaus of Yards and Docks, Equipment, and Steam Engineering, as soon as he can get the necessary Congressional authority for so doing. But before proceeding further, it may be well to show briefly the organization of the United States Navy Department and navy yards, and return to a consideration of the questions involved in these orders of a secretary who has been in office less than three months and whose tenure must of necessity end with the Roosevelt administration.

The organization of the Navy Department is indicated below:—

	Bureau of	Chief.
Secretary of the Navy.	Navigation	Line Officer.
	Yards and Docks	Civil Engineer.
	Equipment	Line Officer.
	Ordnance	Line Officer.
	Construction and Repair	Naval Constructor.
	Steam Engineering	Engineer Officer.
	Supplies and Accounts	Pay Officer.
	Medicine and Surgery	Medical Officer.

The Bureau of Navigation is charged with all matters relating to officers and enlisted men and movements of ships; the Bureau of Yards and Docks with public works: that is, with the construction and maintenance of buildings, docks, sewers and streets, and also has direction of central power plants; the Bureau of Supplies and Accounts corresponds with the purchasing department of an industrial establishment, with the additional duty of providing food and clothing for the men, and of disbursing the money appropriated for the pay of officers and men; the Bureau of Medicine and Surgery, as its name implies, has charge of matters pertaining to hygiene and health.

The four remaining bureaus—Equipment, Ordnance, Construction & Repair, and Steam Engineering—are the ones responsible for the construction and equipment of the ships, and for their maintenance in a state of preparedness for war. The Bureau of Equipment has the control of the electrical plant and of the ships' lighting and wireless telegraphy, provides anchors, chains, cordage, navigating instruments, and generally everything of a purely nautical character; the Bureau of Ordance has the armor, the guns and the ammunition; the Bureau of Construction & Repair designs the hulls and designates the spaces to be allotted for various purposes, such as magazines, boilers, and engines, provides small boats, anchor-hoisting and steering engines and winches; the Bureau of Steam Engineering designs the propelling machinery and its numerous auxiliaries, the boilers, and all piping necessary for making the machinery complete, does the heating and refrigerating, and has control of the fresh-water supply.

All questions arising in the naval service and in the Navy Department are referred to the bureau concerned for consideration and report to the Secretary of the Navy, who may or may not accept the judgment of the bureau, and may direct action diametrically opposed to that recommended. There have been instances where a Secretary of the Navy—always a weak one—has taken advantage of his position and of the possession of that dangerous quality, known as "a little knowledge," and has nullified the action of a competent technical officer; but such instances are of rare occurrence, and it may be said that business runs along as harmoniously as could be expected in an establishment of such magnitude and with such diversified interests.

If there is one criticism that might be urged against the system it is that it subjects the navy to periodical changes, such as the one now under consideration, from the fact that there is no permanent head, or as it has often been expressed, that it is a military organization without military control. The force of this objection will be apparent when it is remembered that there have been no less than seven different secretaries during the present administration, and that the result has been much demoralization and some disorganization. Thus it becomes a question whether it would not be better to supplement the present system by the appointment of an officer of high rank who would have a supervisory position over the four bureaus or divisions which have to do with the fighting efficiency of our ships, coordinating their duties in such a manner that they would be immune from the idiosyncrasies of a transient secretary of few ideas and little judgment.

But to return to the organization. At each navy yard there is (or was) an organization based upon the departmental one, with a line officer of high rank as commandant or general manager, having under him technical officers as heads of each of the separate divisions or departments, each supposed to be an expert in the particular division to which he is assigned. The scheme is indicated below, so far as the technical branches are concerned:—

	Department of.	Head.
The COMMANDANT or GENERAL MANAGER (A Line Officer of high rank).	Yards and Docks	A Civil Engineer.
	Equipment	A Line Officer expert in electrical engineering (Equipment Officer).
	Ordnance	A Line Officer expert in ordnance (Ordnance Officer).
	Construction and Repairs	A Naval Constructor (Construction Officer).
	Steam Engineering	A Line Officer borne for engineering duty only (Engineer Officer).

Orders for work emanate from the Navy Department at Washington, which may be likened to the central office of a large establishment, the Secretary of the Navy being the president of the company and the bureau chiefs the board of directors, each with his specialty. Each chief of bureau passes upon all requests for work in his specialty and the estimates of cost, and designates the amount that may be spent in any month. The orders for work are addressed to the commandant (general manager) and he distributes them in accordance with their nature to the head of the department to whom the matter pertains. The latter then directs the work in the shop, or on the ship, as the case may be, and is directly responsible to the commandant for its proper performance within a specified time. He is required to make weekly reports to the commandant, which are forwarded to the Navy Department, and in these reports to state the condition of work on each separate job, the degree of completion, and the additional time necessary for completion. Under this system any question relating to the buildings, the streets, the sewers, or the power plant of a navy yard would be referred to the civil engineer; matters relating to the dynamo engines, the wireless plant, or the anchors or chains of a ship, to the equipment officer; if the battery needs attention, the ordnance officer is the one consulted; if the structure of the ship is affected, the naval constructor; and if the engines or boilers, it is the engineer officer to whom the consideration of such questions is referred. This seems so logical an arrangement that one wonders why a change was thought of. But unfortunately—not for the organization, but for the administration of it—there resulted, as a growth of the system, the establishment in the navy yards of independent shops under each bureau, so that in some of them there would be two or three foundries, machine shops, pattern shops, and smitheries, which naturally were not conducive to economy of operation. To remedy this condition the Secretary of the Navy last year consolidated some of these independent shops, so that in each yard there is now one pattern shop, one foundry, one blacksmith shop, one carpenter shop and one paint shop, where before there were several. The foundry and pattern shops were placed in charge of the engineer officer, which would appear to be their natural place, and the blacksmith, carpenter and paint shops under the naval constructor. The machine shops still remained independent, and strong resistance was made by the naval constructor to putting them under the engineer officer, as was contemplated. The ultimate result of much discussion was the action of Secretary Newberry in placing all shop work, and all "public works" in navy yards, under the naval constructor, so that instead of the organization outlined above, the following is substituted:——

The COMMANDANT OR GENERAL MANAGER (a Line Officer of high rank).	A Naval Constructor supposed to possess the qualifications of a civil engineer, an electrical engineer, an ordnance engineer, a naval architect and a marine engineer.

It may be that the navy possesses officers with such varied accomplishments, but hitherto such a prodigy of mechanical science has been supposed to be non-existent; and it is safe to say that if he did exist, such a genius would not have been permitted to remain so long in obscurity.

The remarkable order which, with a stroke of the pen, produces this transformation, is dated January 25, 1909, and states that the naval constructor will be "responsible for the efficiency of the manufacturing force"—that is, he will have charge of all shops and of the men employed therein—and that the heads of departments who have been displaced, the civil engineer, the equipment officer, the engineer officer and the ordnance officer—experts in their several lines—"may remain on duty" as inspectors, but without any responsibility for the work or authority over the workmen. In other words, the three officers of the sea-going branch shall have no voice in deciding matters for which their education and training qualify them in an especial manner, and such matters must henceforth be decided by a naval constructor who, no matter how skillful he may be as a naval architect, cannot from the very nature of things be capable of rendering correct judgment. Were it not such a serious national question, involving, as it does, the fighting efficiency of our ships, the whole thing would be ludicrous. As it is, it smacks strongly of "Pinafore." Nay, more! It has resulted in actual deception at the New York navy yard, where the principal naval assistant to the engineer officer has been retained in a like capacity under the naval constructor (this by order of the commandant) and has the burden of the engineering work thrown upon his shoulders. Similar practice will undoubtedly be followed at other yards, the purpose apparently being to humiliate the engineer officers of the navy, to make them do the work as heretofore, but to give the credit for it to another class of officers.

At this point it is well to consider the remarks of Rear Admiral Barton, recently Engineer-in-Chief of the United States Navy, who in his last annual report thus comments on the necessity of combining the practical experience gained at sea with the application of that knowledge to the work of designing and constructing machinery. He says:—

It is and always has been the opinion of this bureau that the greatest efficiency results when the officers who design our machinery are also the ones who superintend its construction on shore and later its operation at sea, for thus only can they acquire that familiarity with the needs of the service which suggests at once the things to avoid as well as those to adopt. I think it will be generally admitted by officers of the navy who have given close attention to the subject that the excellence of our ordnance, of our machinery and of our electrical equipment has been due to the fact that the officers who inspected the material and superintended the construction on shore were the same ones who afterwards at sea supervised the operation of these parts of the ships' equipment. And I believe that if this system is not fully carried out, there will be deficiency in that branch in which such a system is lacking.

With the removal of any control by the sea-going officers over the machines which are vital to the ship's efficiency as a fighting machine, we may expect to see American ships fall into such a state of inefficiency as that of the Spanish ships at Santiago or the Russians at Tsushima, for it can hardly be expected that officers will take a keen interest in making a success of appliances in whose construction they are denied a voice, but whose defects they are expected to remedy.

The question that naturally presents itself is "Was it necessary or expedient to make such a change?" That it was not necessary will be apparent to anyone who considers the engineering side of the question, and from that the question of expediency can be readily answered. For the past ten years the engineering situation in the navy has been anything but satisfactory, as has already been stated, and the annual reports of the Chief of the Bureau of Steam Engineering have not failed to draw attention to that fact. From the time that the engineers of the navy were combined with the line officers, the education of all midshipmen at Annapolis has been the same, whereas before this amalgamation there had been a separate course for those who were to pursue engineering. Despite the lack of support for engineering during the past ten years, each year has witnessed the design and construction of ships of all classes whose machinery has challenged the admiration of engineers the world over, and while much credit is naturally due the builders, it is to the designers and officers charged with its operation that full meed of praise must be given.

When, in 1888, Admiral Melville was appointed Engineer-in-Chief in succession to the late Commodore Loring, he surrounded himself with a class of able young officers, graduates of the Naval Academy in engineering, and imbued them with much of that vigor and determination for which he is so noted. These officers soon became recognized in engineering circles as men of rare attainments, and with their increasing experience became more and more valuable to the Government. A few, allured by the offer of higher salaries than they could ever hope to receive in the United States Navy, resigned and are today amongst the foremost engineers in civil life. The majority remained in the navy and continued to do their share of sea duty, only to return after a three-years' cruise to take up again the work of design and construction of machinery, bringing to their work new thoughts and new ideas, born of daily contact with the machines whose design they had previously been so intimately associated with. These are the officers on whose shoulders the bulk of engineering work has fallen during the past ten years; these the officers who have continued the work of designing the machinery of our Fleet and who are now told that their training and experience of thirty or forty years count for naught, and who have been subjected to humiliation without a parallel in the history of the navy.

If the machinery of our ships had been a failure, if weakness had been shown, or machinery had failed to develop the power for which it was designed, some cause might be found for this action of the Navy Department. On the contrary, so well had that machinery been designed, and so careful had the designers been that it should not fail in an emergency, that the trials of our ships disclose the fact that many of our battleships and cruisers would have failed to make the contract speed had the engines not been so well designed that it was possible to force them in some cases as much as 30 per cent beyond their rating in order to get the desired speed. Up to the establishment of the model tank at Washington, our ships had been powered by the engineers, but with the introduction of the tank and the towing of models this was changed, and the constructors specified the horse power necessary for a given speed. On more than one occasion, the engineers protested that the power was too low, and that their judgment was correct will be evident from the following examples:—

The armored cruisers California, South Dakota, Maryland, West Virginia, Colorado and Pennsylvania, of 13,680 tons displacement, were designed for a speed of 22 knots on 23,000 horse power. The average speed of the six was 22.28 knots, but it took 27,928, instead of 23,000, horse power to get it, and fortunately for the contractors the machinery was able to stand the forcing. The British armored cruiser Drake of 14,100-tons displacement, made a speed of 24.11 knots with 31,450 horse power, which power would not have driven our ships more than 23 knots. The three British cruisers of the Black Prince class are of practically the same displacement as our Maryland class, and yet with about 4,200 horse power *less,* they made about .7 knot greater speed.

Again, our three cruisers of the Charleston class, the Charleston, Milwaukee and St. Louis, of 9,700-tons displacement, were designed to make 22 knots on 21,000 horse power. Their average speed was 22.13 knots with 26,210 horse power, while the British cruisers of the County class, of 9,800 tons displacement, made 23.67 knots on 22,580 horse power. Further comment would seem to be superfluous, but as we had already built the Brooklyn, a cruiser of almost the same size and speed, it would appear to have been quite a simple matter to design these ships and come somewhere near the power required for the same speed as the Brooklyn: or, to put it properly, it should have been an easy matter to design as good a model as the Brooklyn's. The results of the design of these two classes of ships as compared with the similar ships of the British Navy are given below:—

	Displacement.	Speed.	I. H. P.
U. S. Maryland class................	13,680 tons	22.28	27,928
British Drake	14,100 "	24.11	31,450
British Black Prince class............	13,550 "	22.94	23,755
U. S. Charleston class.................	9,700 "	22.13	26,210
British County class...................	9,800 "	23.67	22,580

Other examples might be cited, but these are considered sufficient to demonstrate the fact that our naval constructors have a fine field for the exercise of their talent in trying to improve the design of the hulls of our ships, so that they may not suffer by comparison with foreign ships, and that it may not be necessary to force the machinery unduly in order to obtain the speed for which they are designed.

As if the humiliation visited upon the engineers of the Navy were not sufficient, the Secretary of the Navy announced in a memorandum, issued at the time of the order referred to, his purpose to abolish the Bureau of Steam Engineering altogether. Happily, this requires Congressional authorization, and it may reasonably be expected that Congress will think twice before committing such an act.

There is a question so closely related to this subordination of engineers in the navy, and of such vital importance to the Nation, that it must engage the attention of Congress and of the successor of the present secretary, and that is the supply of engineers. Under existing law, engineering is a prerogative of the line of the navy. Such duty is performed by line officers assigned to that special duty by the Navy Department, and it is manifestly necessary that these officers should have an opportunity to become familiar with shop work and with the various branches of the profession of engineering if they ever hope to become competent designers of machinery, as are the present engineer officers. It goes without saying that, when they see the humiliation to which they will be subjected if they take up engineering, they will avoid it as they would the plague, and the result to the efficiency of our ships may be imagined. It is idle to suppose that a young officer of any ability whatever would deliberately put himself in a position where his talents would never be recognized, and where he could never hope for that professional advancement which is the aim of every officer of a military organization, as it is of those engaged in civil pursuits. When young officers are told that if they enter the engineering field they will be forever barred from holding a position of responsibility, it may well be inferred that engineering in the navy will become the most inefficient branch of that service and our ships little better than lame ducks.

To find a cause for this remarkable action on the part of a retiring Cabinet officer would be most difficult. Some have attributed it to certain influences that have surrounded him and smoothed out rough places for him, others to a desire to create such a situation in the navy as would force the in-coming President to retain him in his Cabinet, while still others attribute it to pique that his ambition to continue as Secretary of the Navy had not received the support of line officers of the navy. Be this as it may, the situation is a deplorable one, and it is to be hoped that President Taft, with that rare good judgment which has always characterized his public acts, will give this matter his serious consideration and put engineering in the United States Navy on that high plane which its importance justifies and the efficiency of our Fleet demands.

A SIMPLE COST SYSTEM FOR COMPLEX SITUATIONS.

By John Sturgess.

IF apology is required for describing another special cost system. the excuse must be that the system briefly described here has proven satisfactory after the more recognized systems had failed, and the belief that the reasons why they failed apply with equal force to many factories, even when methods and administration differ widely from those obtaining in the particular institution under consideration.

It should be stated that only one class of factory is kept in view in this article, namely, that manufacturing more or less elaborate standard machinery or apparatus, of a number of types and sizes, where many of the individual parts are common to more than one size or type. It is thought that the above covers a somewhat large class.

The systems which failed (or at least, did not give such satisfaction as the system here described) may be briefly summarized as follows:

Group Costs.—In which a number of machines of given type and size were put through the shop together, on one shop order, time being kept by the men engaged on such shop order by time books or shop-order cards, either entered by hand or punched by recording clock, these cards being turned in daily or weekly, or at the termination of the job according to circumstances, and entered in the cost-ledger account representing that particular shop-order.

Operation Cost.—In which every operation in the construction of all machines manufactured was given a serial number, all such numbers being tabulated and indexed, a job-card bearing the number of the operation to be performed, and the number of pieces to be made, being given to each man, who recorded the time occupied by recording clock or otherwise.

Piece Cost.—In which a card was used to represent each piece of every machine, all operations entering into that piece being marked on the card, and the time occupied being punched or entered in the margin, the time being recorded either for individual operations on the piece, or for all labor regardless of operation.

The above three methods are typical, though variations of each were tried. The book-keeping methods by which all records were brought together so as to give the final cost of any one machine need no comment, except to say they involved a large amount of work, an immense number of cards and entries, and a delay of from a few days to several weeks before any tangible total could be arrived at, which even then was not trustworthy.

Without particularizing, systems based on the above general lines failed for the following reasons:

a. They seriously interfered with the routine and order of manufacture found most economical from shop standpoints, and tended to delay shipments, and especially emergency orders.

b. Their accuracy depended on the veracity of the men, or foremen, recording their own time, which is not reliable, even with recording clocks. If costs advanced (as from bad castings, mistakes, etc.) no satisfactory and reliable explanation could be obtained after the necessary interval had elapsed for collecting totals.

c. Though simple in conception, they became cumbersome in practice, necessitating a vast amount of transferring of entries, and failed to co-ordinate matters properly, so that totals could be instantly grasped and compared, and so that any detail, from the total cost of the machine to the name of the man who drilled a certain hole in a certain piece, could be traced in a few seconds. The importance of this will be appreciated when it is borne in mind that the articles manufactured consisted of several hundred pieces, costing several hundred dollars, the individual items consisting of a great number of small amounts of, sometimes, only a few cents each.

d. They necessitated a vast amount of unnecessary repetition work.

The system described below was found to be free from all above defects and enabled accurate costs to be obtained at moderate expense. In order to appreciate its application, it is desirable to set forth the following data of the business to which the system was applied, and it may be remarked here that the first requisite, when adapting a cost system to a given business, is to have a perfectly clear conception of the essentials of the business, such as is covered by these data.

Classification of Articles Manufactured.—These comprise three classes of machines: (1), water-wheel governors; (2), relief valves; and (3), air compressors, and a variety of special accessories for each.

Each class is made in a number of different types, (A. B. C. etc.) and sizes (1, 2, 3 etc.) but a considerable number of the parts of each class are used on all the types and sizes, these being termed "standard parts." Some of these standard parts, however, have slight modifications, according to the type or size machine they are to be used upon. A standard part may consist of a single piece or a group of pieces. Thus, a centrifugal governor, consisting of 36 pieces, is standard for all types and sizes of Class 1 (water-wheel governors), this being also the case with a lever consisting of one piece.

Pieces which are not included in the above classification of standard parts are standard for one or more types or one or more sizes. Thus, the same cylinder may be used on a *single size* of a *number of types,* while a pedestal may be used on a *number of sizes* of a *single type*. Some pieces are special for a single size of a single type.

For the purpose of facilitating manufacture, minimising stocks on hand and reducing the number of patterns and drawings, the above method of standardization is carried to the utmost extreme consistent with meeting market requirements.

System of Manufacture.—All labor is on the day-work plan, quantities not permitting piece work. All material, including castings, is purchased outside.

Standard parts are made up in quantities according to prospective requirements, usually one or more dozen at a time. Parts which are standard to a limited number of sizes or types are made in less quantities, and parts which are special to a single type or size are usually made only after orders for the machine have been received. In order to reduce costs, parts are made in as large quantities as are consistent with possible changes in market requirements, improvements in design, or methods of manufacture.

A somewhat important factor affecting the accuracy of costs is that it is not always advisable to finish one class of operation completely on a number of pieces at one time. Thus the lathe work on fifty valves may be performed by the whole lot being rough-turned by one man at one time, another man finishing these in smaller quantities at different times as required. The method of dealing with this is described below under "suspense operations."

Orders.—The great majority of orders are contracts covering one or more machines, and frequently include special apparatus for connecting the machines to adjacent machinery at their respective destinations. It often happens that the cost of this special apparatus can be considerably reduced by slight departure from standard dimensions in the terminal parts of the machines, in such cases a considerable advantage resulting when competing against others who may not possess such latitude, and are consequently compelled to submit higher bids. It is comparatively rare for a standard machine to be ordered without reference or consultation as to its fitness in every respect for its proposed destination. Consequently machines are rarely completely assembled and finished until they are assigned to specific contracts.

Cost-records Desired.—The necessity of adopting the classification and method of manufacture described above renders it impossible to keep the individual cost of each machine as a whole, during its progress through the shop. Its total cost must be found by adding the cost of its constituent parts (standard, semi-standard or special) and the cost of assembling.

It is not imperative to record the total cost of each individual machine made, if it is an exact duplicate of others whose cost is known. It is sufficient if the cost of individual parts or operations be recorded so as to note any variation in cost due to changes in the cost, or efficiency of labor or material. For this reason it is desirable that the detailed costs should be so tabulated that any variation in total cost of any part shall be quickly apparent, and simple references provided enabling the reason for the variation to be easily looked up.

THE COST SYSTEM.

Cost Keeper.—The whole of the cost keeping is performed by *one young man* who has had some experience in the drafting room and shop, and is therefore familiar with each part of each machine and knows exactly how and when it is used. *The foreman or men take no part in keeping records.*

Time Recording.—The cost keeper keeps record of the work each man is engaged upon by *personal observation,* making the round of the shop every half-hour for this purpose, using a special tally card to note any change in the occupation of any man since the previous round. As changes are not very frequent a short time only is consumed in making the round, a glance sufficing to show any change. If a change has occurred it is necessary to question the man or the foreman to ascertain the exact time of the change of job. This is the only element of inaccuracy, but under the worst conditions it cannot exceed half an hour and is usually much closer, as no difficulty is found in getting straightforward answers. It is far more accurate than any system when the men put down, or punch on a clock, their own time. It also avoids the charging of time to one job which is really spent on another, or charging to the "shop" time spent in preparing tools etc. for a job which should bear the cost of such preparation. If extra time is consumed on a job on account of bad castings, lack of facilities, or other sources of wastefulness, the circumstances and amount of time are noted on the tally card and recorded on the cost card, but the total time is charged to the job. This makes a subject-of-record a fruitful source of discrepancy between "estimates" and actual results, and reduces the troubles from "excuses" and fictitious "explanations."

At the end of the day the time data collected on the tally card are entered on a "job cost card."

Job Cost Card.—These cards are 10½ by 8 inches (see Figure 1)

Cost Sheet, Sturgess Eng. Co.

DATE JOB (Name of part entered here) NO.______

MARK ___ To correspond with Indexes.

FOR (Name of Machine is entered here)

Lathe		Rate		Drill		Rate ...		Planer		Rate...		Boring Mill		Rate....	
Man's Name	No. of Pcs.	WORK	Total Hours	Man's Name	No. of Pcs.	WORK	Total Hours	Man's Name	No. of Pcs.	WORK	Total	Man's Name	No. of Pcs.	WORK	Total Hours

Shaper		Rate ...		Miller		Rate ...		Boring Lathe		Rate...		Bench		Rate...	
Man's Name	No. of Pcs.	WORK	Total Hours	Man's Name	No. of Pcs.	WORK	Total Hours	Man's Name	No. of Pcs.	WORK	Total Hours	Man's Name	No. of Pcs.	WORK	Total Hours

FIG. I. JOB COST CARD FOR ENTERING THE TIME AS RECORDED ON THE "TALLY CARD." The back is ruled for "Material," and columns for summarising the total cost of material.

and are ruled with a series of triple columns headed "Man's name" "No. of pieces" "Work" and "Total hours." One series of columns is assigned to "Lathe," another to "Drill," and so on for all the operations entering into the construction of the piece. On the back of the cards are rulings for 'Iron" "Steel" "Bronze" and "Stores," with a space for summarising the total cost of material for the part, or parts, represented by the card. *Each card represents one piece of the machine* (or in some cases small groups of pieces), and there are therefore nearly as many cards as there are pieces in the machine. These cards are bound together to form a "book."

As there are some hundreds of pieces in some machines, these books would be inconveniently bulky were it not for the fact that a large number of the pieces compose the standard parts. Each group of standard parts, however, are dealt with as though they were a separate machine and a book made for them accordingly, the total cost of each standard group of parts being carried to the "Summary Book" as a single item. This reduces the number of cards in a book to about 40 for the most elaborate machine and avoids detailed repetition of the standard parts under each machine in the summary book.

Suspense Operations.—Certain operations cannot be carried through continuously for the reasons described under "System of Manufacture." Such operations are kept on a "Suspense Sheet" until a sufficient number have been completed to enable the total cost of such operations on a sufficient number of pieces to be found, before entry is made on a cost card.

Indexing Cost Cards.—As from 300 to 500 cards are in use a ready method of indexing is necessary. Each type, size, and class of machine is known by a denoting letter, while each piece of each machine is known by a number. Each book of cards is marked with the letter representing the machine dealt with, and is kept in an open-top file subdivided alphabetically in thumb-index fashion so that the letters on each are visible. Hanging above the file is an index (see Figure 2) giving the names of each machine and the denoting letters, so that one glance enables any book to be instantly located and withdrawn by one hand.

At the front of each book is another index (see Figure 3) giving the names and numbers of the individual pieces dealt with in the book. The cards are numbered in serial order, the number on the card corresponding to the number of the piece, so that after withdrawing the book a glance at the front (index) card enables the card

Index of Denoting Letters

	File.
No. 1 Self Contained Pump	A
No. 2 Independent	B
No. 1 Air Compressor	C
No. 2 " "	D
No. 3 " "	E
No. 6 " "	F
No. 1 and 2 type "K" Governor	G
No. 1 and 2 type "M" "	H
No. 3 type "M"	I
No. 4 " "	J
No. 5 " "	K
No. 1 and 2 type "L"	L
Centrifugal Governor	M
Dash-Pot Arrangement	N
Pilot Valve Chamber	O
Hand Lever Control	P
12" Auto. Oper. Relief Valve	Q
15" " " " "	R
20" Mech. " " "	S
24" " " " "	T
Poppet Valve Arrangement	U
By-Pass Valve	V
Motor Pump	W
No. 3 Independent Pump	X
Spec. type "C" Governor	Y
Auto. Pressure Regulator	Z

FIG. 2. EXAMPLE OF ALPHABETICAL INDEX OF ALL ARTICLES MANUFACTURED.
This hangs above the alphabetically arranged file holding the cost cards. (See also Fig. 3.)

Index of Part Numbers. File "D." No. 2 Air Compressor.

Card No.	
1	Sub base.
2	Lower half of casing.
3	Top half of casing.
4	Hand hole cover.
5	Bearing caps.
6	Upper half of inner bearing.
7	Lower half of inner bearing.
8	Cylinder.
9	Outer plunger.
10	Inner plunger.
11	Plunger cover.
12	Valve.
13	Filler for outer plunger.
14	Split ring for outer plunger.
15	Crank block.
16	Shaft.
17	Oil ring for shaft.
18	Throw ring on shaft.
19	Oil ring for bearing.
20	Sight feed oil cup.
21	Counter weights.

FIG. 3. EXAMPLE OF FILE D (SEE FIG. 1).

The cost-cards are clipped together in numerical rotation corresponding to the column at left. This form of index is affixed to the first card in each file.

corresponding to any desired piece to be instantly found. By this arrangement any card out of some hundreds or even thousands can be quickly located without memorizing a combination of letters and numbers and without the necessity of even putting down pen or pencil.

The elasticity of the card system is found desirable for the above-mentioned cards, but for summarizing the results in quickly compresensible form a multiple-column, cash ruled book is most convenient.

No. 2. Air Compressor. File "D."

Corresponds with Index. No. of Part.	No. of Pieces.	Name of Piece.	Estimate.	Material.	Labor.
1	1	Sub. Base, Cast Iron.....			
2	1	Lower Casing, Cast Iron..			
3	1	Top Casing, " " ..			
4	2	Hand Covers, " " ..			
5	2	Bearing Caps, " " ..			
6	2	Upper Bearing, Bronze...			
7	2	Lower Bearing " ...			
8	2	Cylinders, Cast Iron......			
9					
10					
11					
12					
13					

FIG. 4. EXAMPLE OF RULING AND ENTRIES IN "SUMMARY BOOK."

One double page right across the ledger is given to each machine manufactured, successive labor records being entered in the multiple columns provided. The facing page is ruled entirely in columns for labor like the extreme right-hand column of this. The index of "Summary Book" is similar to Fig. 1, with the page number extended opposite each item of the index.

Summary Book.—This book contains reference and description columns at the left and a dozen or more cash ruled columns to the right. (See Figure 4.) In the reference columns are placed the denoting numbers of each piece and the number of such pieces used on the machine in question. The name of the piece is entered in the description column, one line right across the double page being devoted to each piece constituting part of a given machine. A double page is devoted to each type, class, or size machine manufactured.

In the first cash column is placed the estimated correct total cost of each part. In the second column is placed the cost of material only, taken from the accurate records on the cost cards. The remaining columns serve to record the labor cost as obtained by the cost cards at different periods, the respective columns being headed with the dates upon which the observations were made. This arrangement not only minimises the work of preparing the summary book for successive records, but shows at a glance any variation that takes place in the cost of any part of any machine, the reason for which can readily be treated by means of the cost cards.

As nothing but the lump-sum cost of each part is given in the summary book, the usefulness of the record is not clouded by unessential figures or extensions. Moreover, as the cost of each individual part of the machine is given, the directions in which economies might be made are readily suggested, while the juxtaposition of the cost-items at different periods shows at a glance whether the costs are increasing or decreasing. These are vital considerations in any good system of cost keeping, for with many systems, after the records are completed at considerable expense the final results are so scattered and fogged by the inclusion of working data, and require so much "turning up;" that a busy manager is more or less deterred from making the analysis out of which the real usefulness of cost records must come.

It is to be observed that the costs dealt with above are only the costs of material and labor, and do not include the indirect expenses or "fixed charges." Many methods for dealing with this item are in vogue, each no doubt having suitable application to different kinds of business; but for the character of business described in the foregoing by all means the most logical method is to ascertain the percentage of the aggregate of all the fixed charges to the wages paid to the productive workmen, and then to add to the direct cost of each machine an amount equal to this percentage of the labor item included in the direct cost. This will then give the total manufacturing cost, to which the desired profit must be added, this profit being real profit available as dividends and not consumed in meeting charges on the business, replacing equipment, refunding of capital, or allied financial adjustments.

CAMELS FEEDING NEAR THE RAILWAY IN TUNISIA.
Photograph taken from the train while in motion.

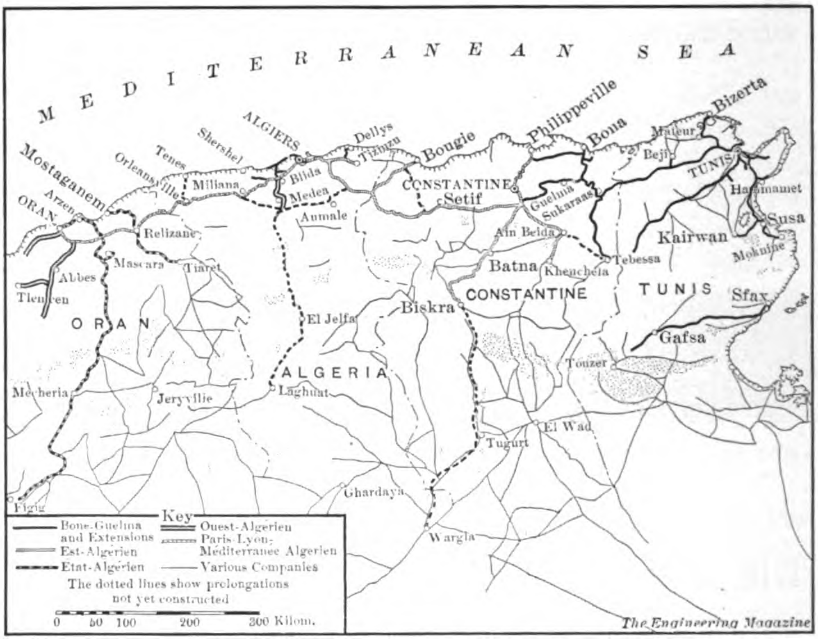
THE RAILWAYS OF FRENCH NORTH AFRICA.

By Edgar Allen Forbes.

This article is the result of personal journeys made in the interests of this Magazine by the author, who traveled from the southeastern terminus of the system at Kairouan, Tunisia, across the Moroccan border and then continued by sea to the southwestern border of French influence, at Mogador, Morocco.—THE EDITORS.

THE French railroad builders have received scant justice at the hands of those who make the periodical literature of the English language. Before coming to Africa, I went carefully over three recent magazine articles on railway progress in the Dark Continent and found only slight references to the lines in French colonies, the probable reason being that publicity is of great financial importance to those railroads whose stock is being offered to wary investors in London. It was something of a surprise to me, therefore, to find about 3,500 miles of good track in Algeria and Tunisia, with more than 200 trains a day on all the branches, counting in both directions.

Omitting from present consideration the only line in Morocco—which is just starting out from Casablanca—there are five companies at work in French territory, with a sixth operating a private line to its phosphate mines. Starting from the Moroccan boundary, the Paris-Lyon-Mediterranée Algérien company runs to Algiers; it also owns the short line from Philippeville to Constantine and has altogether about 500 kilometres of track. The continuation of the trunk



OUTLINE MAP OF THE FRENCH RAILWAYS IN NORTH AFRICA.

line from Algiers to Constantine (464 kilometres) is owned by the Est-Algérien company, which operates also the tourist line from Constantine to the Desert at Biskra and three other branches which bring its mileage up to about 1,000 kilometres. From Constantine to Tunis (about 450 kilometres) and from Tunis to the southern terminus at Kairouan (208 kilometres), the traveler is under the care of the Bone-Guelma company. It has a large number of branches, especially in the vicinity of Tunis, the total mileage reaching 1,500 kilometres. The phosphate company's unconnected line begins at Sfax, on the southeastern coast of Tunisia, and runs through the oasis of Gafsa to the mines at Metlaoui, a mining town of about 600 workers; this line is 243 kilometres long. A connection between Sfax and the trunk line at Sousse, 128 kilometres, is under consideration, but the gap is bridged at present by a public automobile in about six and one-half hours.

The lines of the other two companies run southward, at right angles to the trunk line. The Ouest-Algérien has three branches, the longest being that from Sainte-Barbe (southeast of Oran) to Tlemcen (152 kilometres); the other two have only 160 kilometres combined. The Etat road runs from Oran almost due south to Colomb-

Bechar, a distance of about 950 kilometres. Its only separate line extends from Mostaganem to Tiaret, not quite 200 kilometres.

The three divisons of the trunk line from Oran to Tunis, though owned and operated by different companies, have the British standard gauge of 4 feet 8½ inches, and may therefore be operated as a single line. Most of the branch roads are narrow-gauge and observe no uniformity even among themselves.

Principal Branches.	Kilometres.	Hours' Run.	Through Trains per Day.	No. of Daily Trains Over Parts of the Line.
Paris-Lyon-Mediterranée:				
Algiers to Oran................	421	12	1	10*
Philippevile to Constantine......	87	4½	4	..
Ouest-Algérien:				
Ste. Barbé to Tlemcen..........	152	..	..	7
Blida to Berrouaghia...........	84	6	5	..
Oran to Ain-Temouchent.......	76	2½	3	..
Etat-Algérien:				
Oran to Colomb-Bechar.........	750	26	..	3†
Mostaganem to Tiaret..........	197	9	3	..
Est-Algérien:				
Algiers to Constantine..........	464	14	1	10‡
Constantine to Biskra...........	240	10	1	1
Ouled-Rhamoun to Khenchela...	147	9½	2	..
Bougie to Beni-Mançour........	89	4½	3	..
Menerville to Tizi-Ouzou.......	53	4½	3	..
Bone-Guelma:				
Bone to Tunis..................	355	10½	1	12
Tunis to Sousse................	150	6	2	2
Sousse to Kairouan.............	58	2½	2	..
Bone to Kroubs................	203	7	2	2
Tunis to Kalaa-Djerda..........	235	10½	1	..
Souk-Ahras to Tebessa.........	128	6	3	..
Nine other branches............	400	..	..	39
Cie. des Phosphates de Gafsa:				
Sfax to Metlaoui...............	243	9½	1	..
Casablanca (Morocco) ....About	30	..	..	..

THE RAILROADS OF FRENCH NORTH AFRICA.

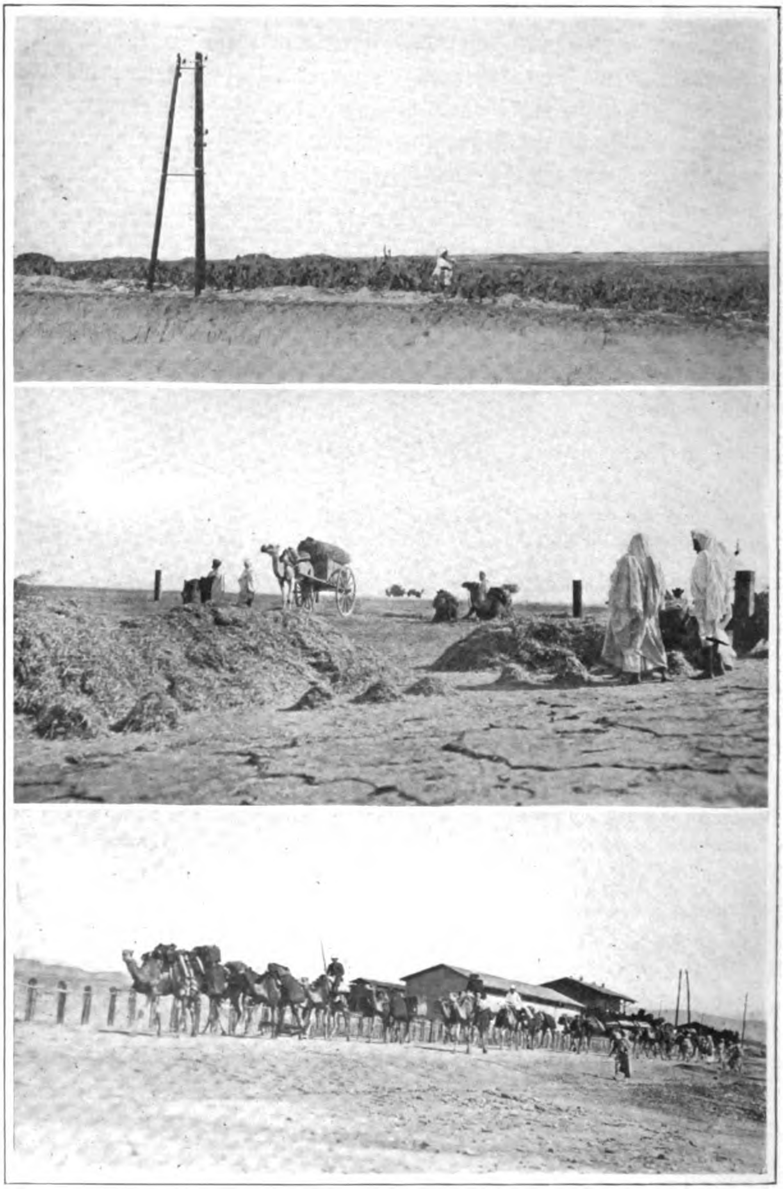
The hours' run is approximate and varies according to the class of train and the connections.

The future extensions of railroad building in this part of Africa will probably be, for the most part, governmental enterprises. A loan of about $3,000,000, negotiated in the early part of 1908, was mainly for the purpose of extending the Algerian lines. The small extensions north and south of the trunk line will be of only local importance, but three of the projects are pointed toward the Sahara Desert. The line from Biskra will doubtless be extended to the rich oasis of

* Also an express three times a week.

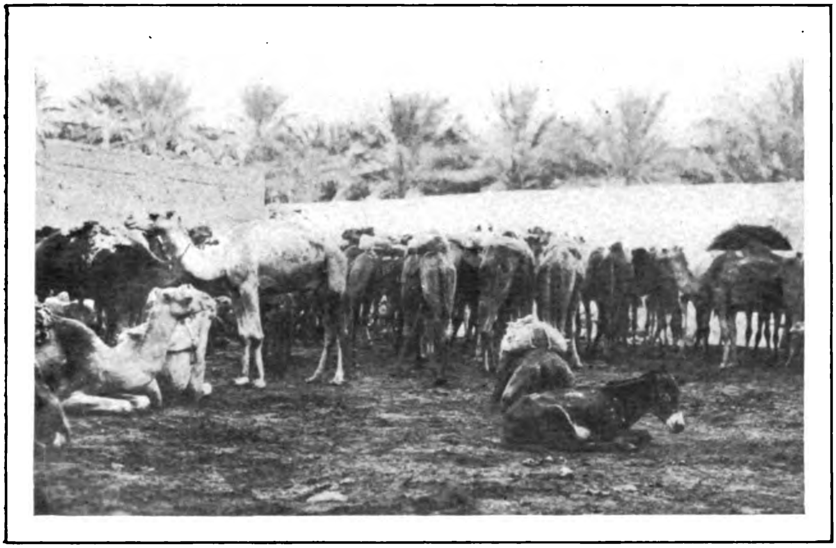
† Through train three times a week.

‡ Express three times a week.



ON THE EDGE OF THE DESERT.

The top view is a cactus farm near Kairouan, Tunisia—cactus being the food of the camel. Next is the "high-water mark" of transportation beyond the railroad. At the bottom is an engineering caravan starting from the station at Biskra into the desert.

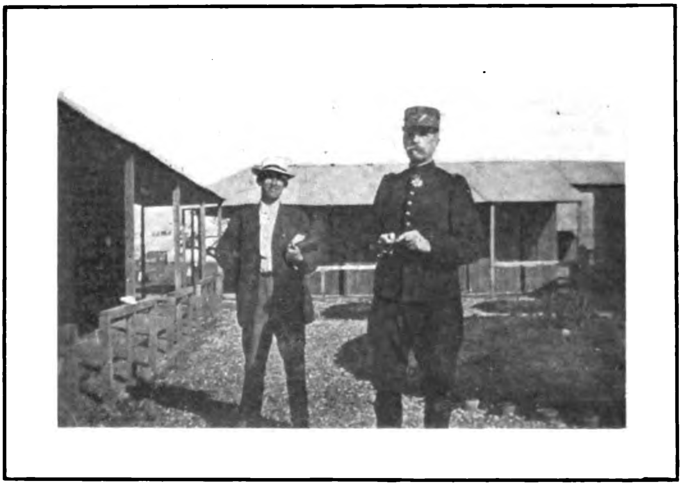


CAMELS AT BISKRA, AFTER A SIX-MONTHS' JOURNEY FROM TIMBUCTOO.

Tougourt and Ouargla; the branch from Algiers to Berrouaghia may be carried as far southward as the oasis of Laghouat; and nobody knows where the state railway already in the Desert at Colomb-Bechar will finally stop. One dream of the French government sees through trains running from Oran all the way across the Sahara to Timbuctoo and Gao, on the Niger—connecting, perhaps, with the

ENGINEERING OUTFIT PREPARING FOR THE DESERT.

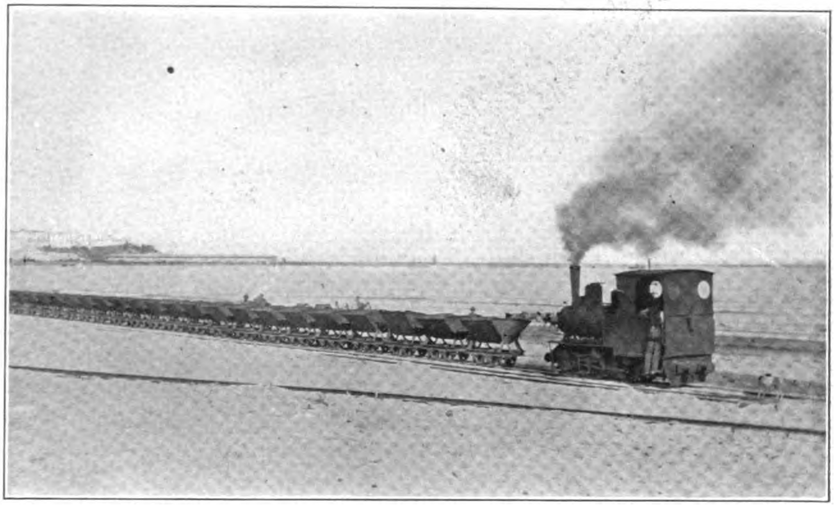
British lines in Nigeria or with the proposed German road in the Cameroons, in the neighborhood of Lake Chad. But the amount of capital required to span the Sahara with steel would make any government pause; even a fast camel requires two or three months to cover the distance. Another dream, equally far short of realization, would connect this state road with a line to be constructed from the west coast of Morocco through the trading center of Tafilet, where the camel caravans from the south would be met by freight cars. But many things must happen in Morocco—and in Europe—before such a Moroccan line is even possible. The French are struggling desperately to retain their foothold on the ten-mile coastal area which the Algeciras conference allotted them, but the Moors want neither



GENERAL D'AMADE, COMMANDER-IN-CHIEF AT CASABLANCA.
Morocco's first railway is being built under his direction.

railroads nor Europeans and gladly avail themselves secretly of any intrigues that other European powers have jealously set in motion. Up to the French occupation of Casablanca, there was not a mile of railroad track in the whole land. The little toy track of Tangier, built for hauling dump carts loaded with sand for harbor construction does not count; the French have one like it at Casablanca, where extensive harbor improvements are well under way. The real railroad is a narrow-gauge line that has gotten about thirty kilometres from Casablanca. One newspaper reported it as being in operation, but I was told in December by General d'Amade, the commander-in-chief, that it had no locomotives and was at present used only for the transportation of military supplies, the cars being pushed by hand or hauled by mules.

Whatever one may say about the French as colonizers, they are thoroughly in earnest in the matter of transportation and communication. In Tunisia they have capacious harbors at Sfax, Sousse, Tunis, and Bizerte; Algeria has Bone, Philippeville, Algiers and Oran; and the only port in Morocco where the French are in full control is trying to make it possible for cargo and passengers to have a safe landing. (My own landing at Casablanca in December was made in a rowboat, against the positive advice of the captain of the small steamer anchored a mile from shore). The French flag is seen with great frequency in every one of these ports; the telegraph wires are everywhere, even beyond the termini of the railroads; and there is a camel postal-service entirely across the Sahara.



THE RAILWAY AT TANGIER.
The only track in Morocco, up to the French occupation. The outfit hauls sand for the harbor works.

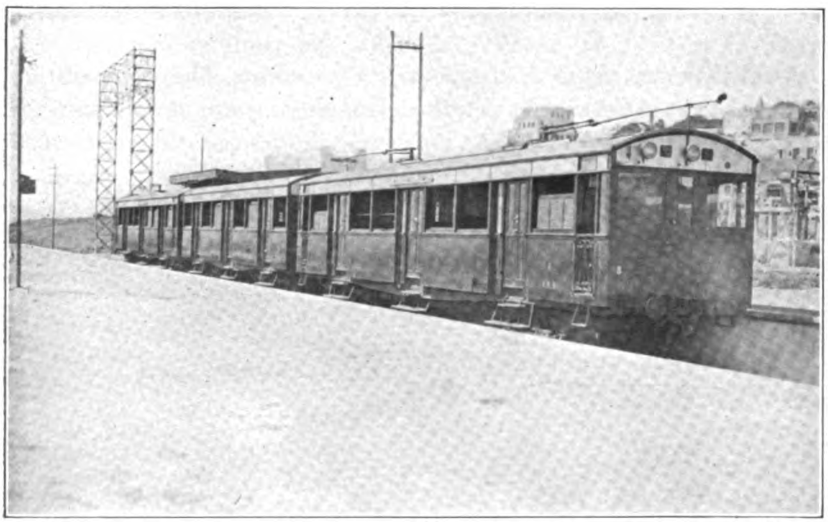
The close connection between France and its north African possessions is shown by the schedule of its mail-steamers. The Cie-Génerale Transatlantique boats leave Marseilles on Wednesday and Saturday evenings. Wednesday's steamer lands a passenger in Oran early on Friday morning, and he may be in Algiers Saturday morning; the other boat makes the same time. Special express trains on the Algerian railroads connect with the Marseilles steamers.

A glance at the map of Africa will show that only three little gaps now prevent a traveler from going all the way from Tangier to Cairo by rail. The first is from Tangier to the Morocco-Algerian frontier, a wild region where no kind of travel is now safe. From that border one may ride across Algeria and Tunisia to Sousse where he meets the short gap that is bridged by automobile. The Sfax road will land him at Gafsa, from which point (or some other) a railroad is needed across Tripoli to the Egyptian frontier. There the Khedive's Mariout Railway will pick him up and take him to Alexandria, whence he may go to Cairo by the Egyptian State Railway.

THE ALGERIAN "DILIGENCE" FOR RAILWAY PASSENGERS AND FREIGHT.

Railroad finance is not a safe subject for a traveler to tamper with, but I should judge that the railroads of North Africa would have a precarious existence if they were not a governmental necessity. There are no forest products of great magnitude; phosphate of lime is the only mineral product that brings to the railroads any considerable revenue at present—and these deposits are not being exploited at many places. Agriculture is the main source from which dividends can possibly come, and to an American most of this vast country looks dubious. The colonist is relatively new to the land and his equipment is inadequate. He is not yet prepared to grapple vigorously with the all-important problem of irrigation. Unless a colonist enters North Africa with a capital of about $1,500, it is practically impossible for him to farm on his own account. Yet there are about 200,000 Europeans in Algeria alone whose living comes from the soil. Cereals, vineyards, olive orchards and cattle are the principal products, with dates from the oases; most of what is not consumed in the country goes across to France. But the railroad catches the colonist "going and coming"; the farmer must import from France most of his necessities beyond what he himself produces.

In Tunisia, the colonist pays $4 or $5 an acre for his land, and the average French "domain" is 1,250 acres; that of other Europeans averages 250 acres. The large average of the Frenchman is probably due to the inclusion of vast estates like that at Enfidaville, which covers 300,000 acres and upon which have been found the ruins of seventeen Roman cities. This estate is owned by a French company which bought it from an ex-minister of the Bey. Some of the railway builders also have large estates. The company which built the phosphate line from Sfax received a concession at Gafsa of 100,000 acres, but it obligated itself to plant three-fourths of it in vines, olives, etc. The importance of some of the larger oases is shown in the case of Tozeur, an oasis situated about 80 kilometres south of Gafsa. It covers 2,500 acres, has a million palm-trees, yields annually about 60,000,000 pounds of dates, and brings in about $80,000 a year to the government in taxes.



A SUBURBAN ELECTRIC TRAIN NEAR TUNIS.

Turning from the subject of freights to the revenue derived from the individual passenger, even a traveler may speak with some confidence. To travel first-class on these lines costs more than in the United States, and you get less for the money. But this is Africa, remember. The trunk-line charges between Oran and Tunis amount to an average of 10 centimes a kilometre, or about 3 1-3 cents per mile; the second-class rate is about 2½ cents per mile, and the third-

THE CITY OF TUNIS.

class tickets are figured at about 1 5-6 cents. The comparative charges of the different lines on their longest runs are as follows:

Road.	Run.	Kilos.	Fare per Kilometre, in Centimes. 1st Class.	2d Class.	3d Class.
P.-L.-M.	Oran to Algiers.........	421	8.3	6.17	4.50
Est-Algérien	Algiers to Constantine..	465	11.2	8.4	6.15
Bone-Guelma	Bone to Tunis..........	355	11.2	8.5	6.00
Ouest-Algérien	Ste. Barbe to Raselma..	152	11.8	8.4	6.15
L'Etat	Oran to Colomb-Bechar.	750	8.36	6.14	....
Phosphate Co......	Sfax to Gafsa..........	205	11.2	8.5	6.00
Average trunk-line..	Oran to Tunis..........	1241	10.2	7.69	5.55
Average per mile in U. S. cents........			3⅓c	2½c	1 5/6c

RAILROAD RATES IN NORTH AFRICA.

The P.-L.-M. rate for points between Oran and Algiers is higher than the through rate.

Stop-overs on one-way tickets are given subject to many conditions, but the holder of a 200-mile ticket may stop for 24 hours at only one point; a 300-mile ticket permits a stop of 48 hours. Round-trip tickets usually cost 30 per cent less than double the single-fare, but they also are subject to numerous restrictions. The limit is worked out mechanically as follows: One to 50 kilometres, 2 days; 51 to 100 kilometres, 3 days; 101 to 200 kilometres, 4 days; 201 to 300 kilometres, 5 days; 301 to 400 kilometres, 6 days; only the passenger with a ticket for 400 kilometres or more may stay a week.

Sundays and holidays are not counted, however. There is also provision whereby the limit may be extended one-half by the payment of 10 per cent additional. Children under the age of three are carried free, provided they are held on the knees; from three to seven years, they are charged half-fare but are allowed only half a seat; children of seven pay full fare.

The whole question of tickets in North Africa is extremely complicated. The man who wearies of the fad of stamp-collecting might find French-African tickets a good substitute, particularly if the specimens were surcharged according to the varying conditions. For example, there are the society and excursion tickets, sold at one fare for the round trip, but which are good only in groups of ten; they have a 10-day limit. Then there are seashore tickets sold only in the summer; they bring only half price. Watering-place tickets are different; they are sold all the year round and families of three get a reduction of 30 per cent; each additional member of the family comes in at 50 per cent. There is also a rate for farm-laborers, but they must travel by tens and in third-class compartments, unless a special car has been arranged; only one ticket is sold to the ten and the price is 4 centimes per kilometre. These laborers, by the way, are the only passengers treated generously in the matter of baggage; they may carry 600 pounds free, whereas the ordinary traveler must pay a high excess rate on everything above 60 pounds. On a small

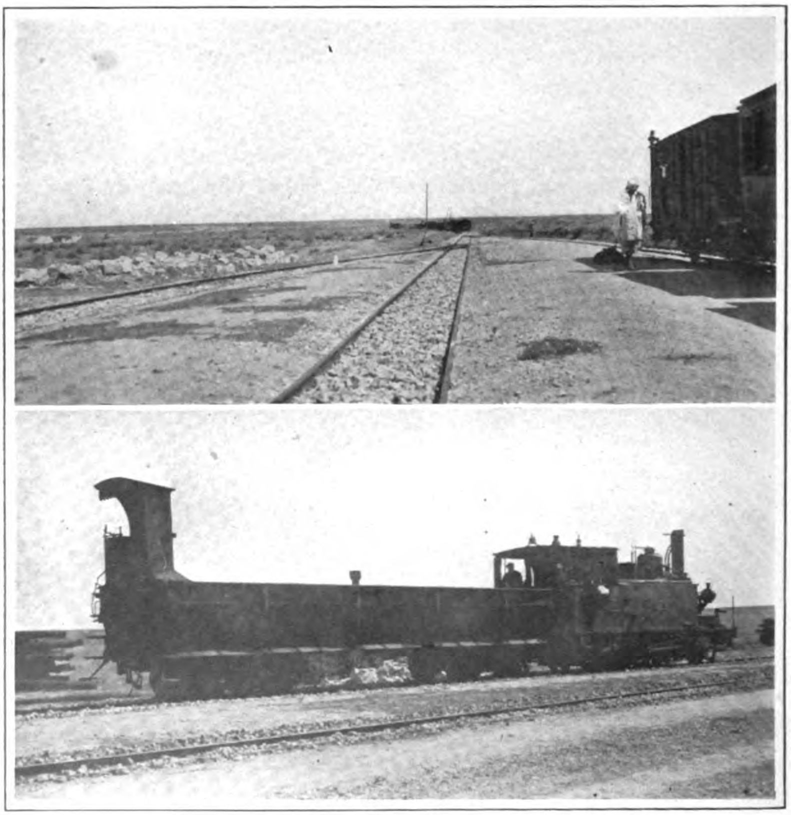
THE WHARVES AT ORAN, ALGERIA.

steamer trunk carried over these lines, I usually paid in excess charges from one-fifth to one-fourth the cost of a second-class ticket.

It struck me as rather strange to find commutation tickets on sale in Africa, for I had always associated them with a more advanced civilization. The photograph of the owner must be affixed, and the cost per kilometre varies in proportion to the distance. A 100-kilometre ticket costs as follows, in francs:

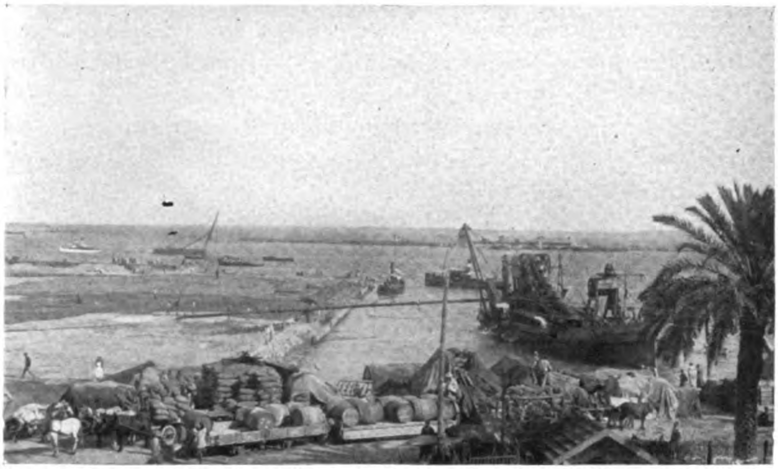
	Three months.	Six months.	Twelve months.
First class	311	467	700
Second class	234	351	525
Third class	171	157	385

There is also a class of college and lyceum tickets which are sold at one-half the commutation rates, but they apply only to qualified



ON THE BONE-GUELMA RAILWAY.

The upper view is a passing point between Sousse and Kairouan, showing the well ballasted roadbed and small rolling stock. Below is a locomotive and flat car, with covered seat for the brakeman.



DREDGING THE HARBOR OF ALGIERS.
The silt is delivered through the long pipe and deposited behind a dyke to form new ground for another pier.

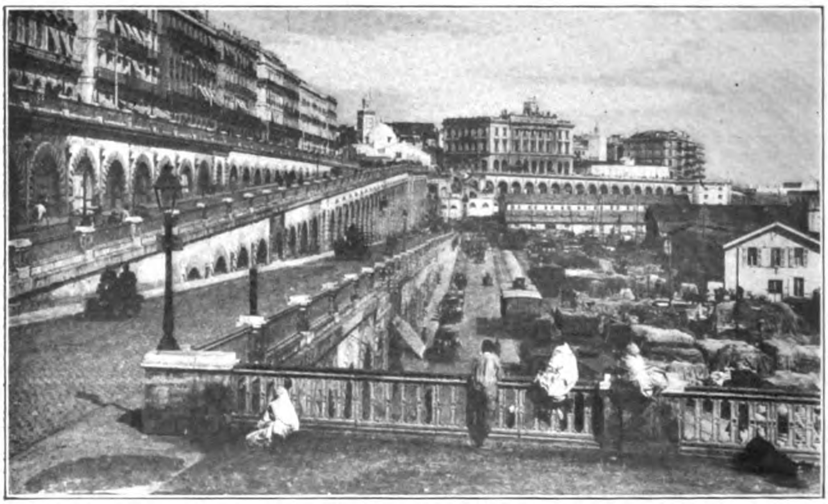
persons between the ages of 21 and 26. These tickets permit no baggage to be carried free.

The nearest thing to interchangeable mileage tickets seems to be the *carte de circulation;* it is good on nearly every road in the system and entitles the holder to buy a ticket for half-fare at any time or anywhere. There are three classes of these *cartes de circulation*: with class A, the purchaser may buy first, second, or third-class tickets, at his pleasure; class B is good for second or third, at the holder's option; class C can be used only for third-class tickets. The cost of the *cartes* that would be such a boon to the American Travelers' Protective Association is as follows, in francs:

	3 months.	6 months.	12 months.
Class A	100	150	200
Class B	80	120	160
Class C	50	75	100

When sportsmen want a special train and can make up the required number of passengers, each must pay 10 per cent. above the first-class fare, and the revenue from baggage and dogs carried must not fall below a minimum of 6.15 francs per kilometre.

Relatively few sleeping-cars are seen along these lines, for most of the runs are short and even the tourist prefers to travel by day, less he miss something. As a rule, a sleeper costs 16 francs, regardless of distance, and a *place de luxe* costs 12 francs. Dining cars are more common, but by no means common enough. They usually have three compartments and one waiter, except those running out of Algiers. The prices are about as follows: Lunch (including wine and "beefsteak") 3.00 francs; dinner, 3.50 francs; collation, 1.50 francs. There are several little tricks about these dining-cars that a stranger does not learn except by experience. For instance, if you chance to be in a crowded second-class compartment, you may go to the dining-car, order a simple lunch or a drink, and remain there in comfort so long as the car is attached. A favorite method of wise Algerians traveling from ten to fifty miles by a morning train is to go direct to the dining-car when the train is made up, order a cup of



NEAR THE HARBOR, ALGIERS.

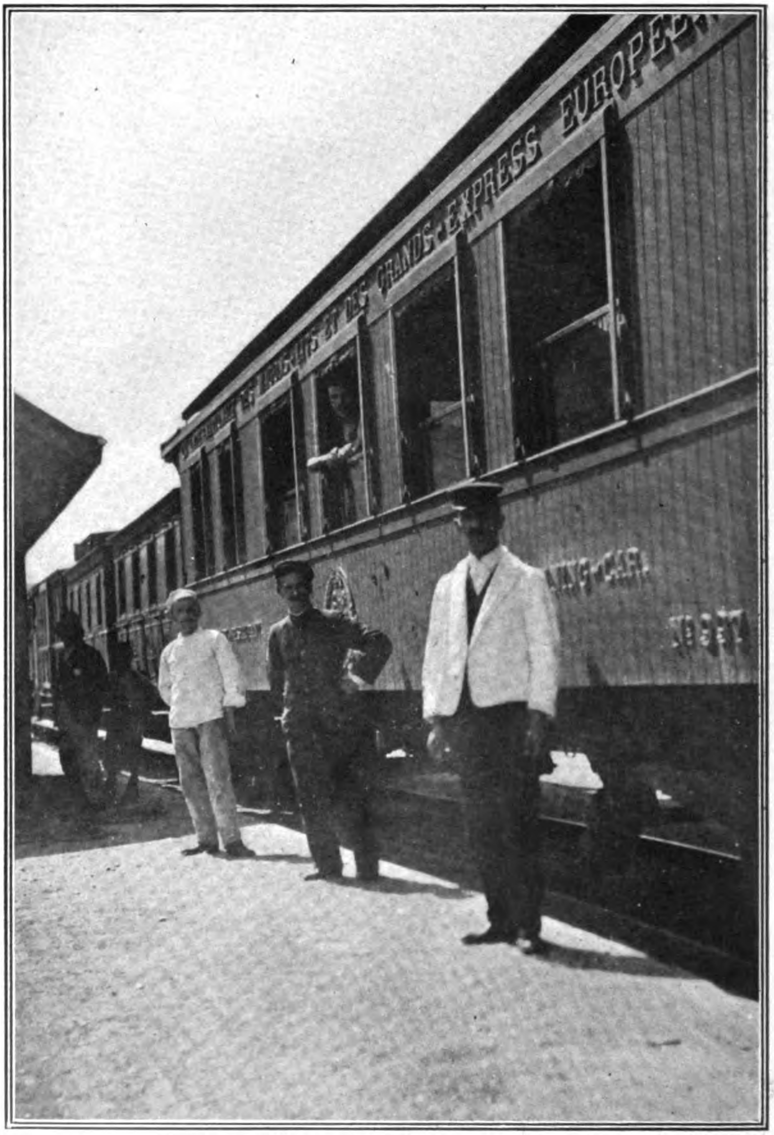
coffee, and hold the seat until their destination is reached. These dining-cars as well as the sleepers are operated by the European Wagon-Lits company. Probably the occasional railroad restaurants are controlled by the railroads. The majority of the passengers on all the trains eat their own lunch in the compartments; the stray traveler is apt to go hungry for no trainman takes the trouble to tell him that this is the place where the train halts for refreshments. Likewise, the passenger who must change trains at a given point must depend upon himself; nobody notifies him.

Except for the turbans and flowing bournouses of the Arabs in the third-class (and occasionally in the second), there is but little about a North African train that differs from what one may see in Southern Europe. The locomotives come from France and bear about the same relation to an American locomotive as a burro does to a draught-

THE TELEGRAPH OFFICE AT SOUSSE.
The government operates posts and telegraph together.

horse. The coaches and cars are also European and have been gathered in from all sorts of bargain-counters. On most of the lines, they are merely rough boxes mounted on high wheels, with cheap seats or benches inside. The compartment system is universal, a

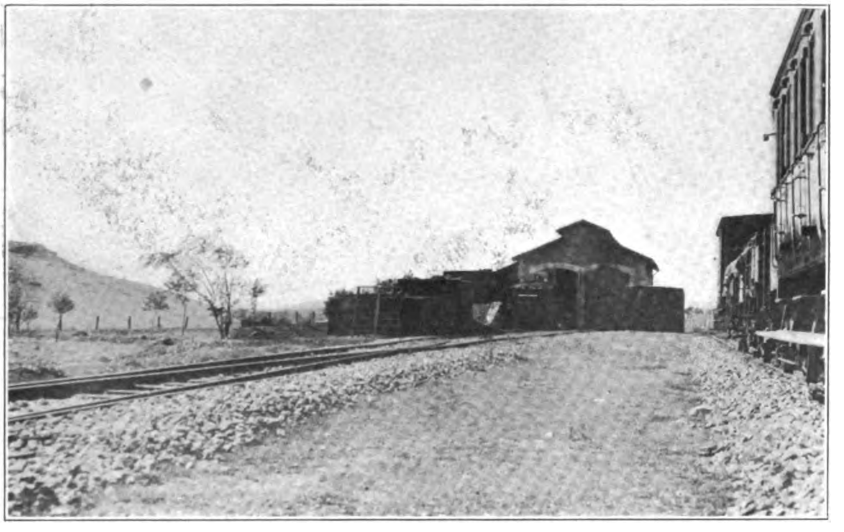
A TYPICAL STATION ON THE BONE-GUELMA.
The man in the foreground, with the little horn, is the station agent. The other Frenchman is the conductor.



WAGONS-LITS DINING CAR ON THE ALGERIAN-TUNISIAN FRONTIER.

The cook, conductor and waiter are standing by the car.

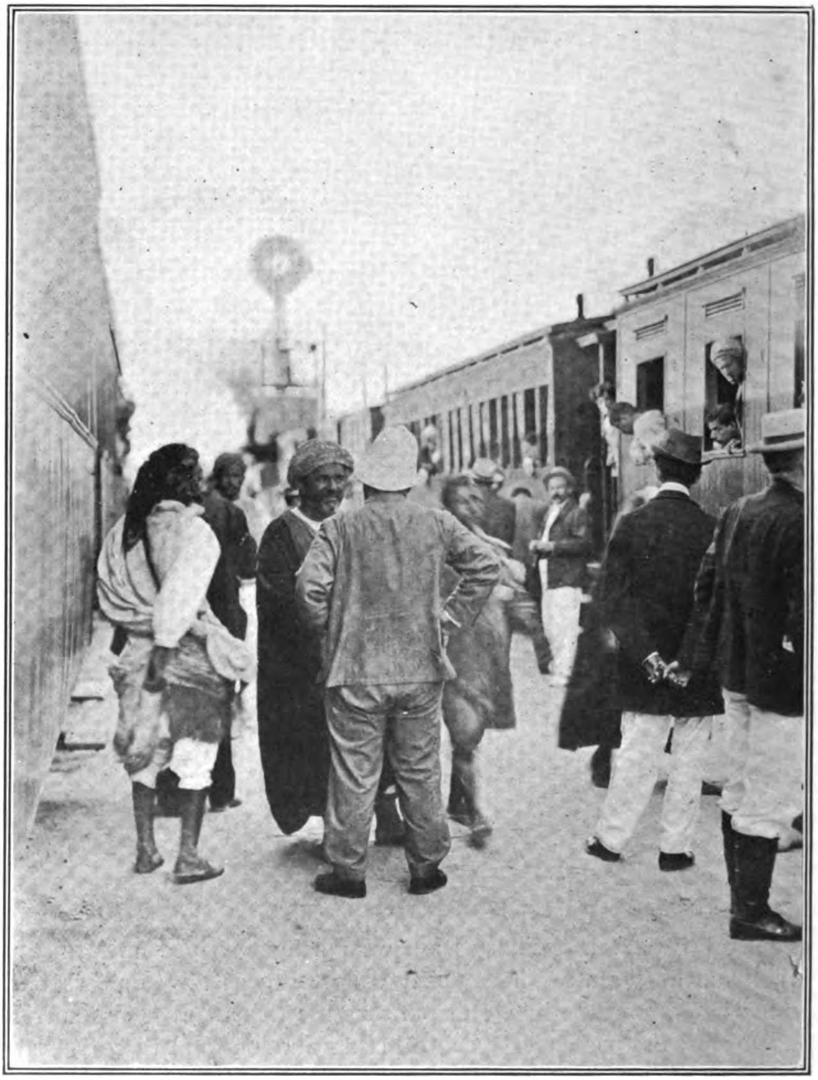
coach generally being divided into four compartments into each of which ten persons may be squeezed. On the train from Tunis to the Algerian border, the coaches have little balconies on the side. Generally speaking there are three second-class compartments to one first; and the number of thirds varies according to circumstances. On the branch lines mixed trains are the rule. There are no newsboys, no wash-rooms, and often no water-closets to be found. The compartments are dimly lighted by an oil-lamp in the roof, but reading is impossible when daylight vanishes. The freight-carriers are of slightly better grade, even on the narrow-gauge lines; and as one approaches Algiers from the east, many fine cars are to be seen. Throughout all of French North Africa, the railroad stations are substantial and attractive, with groves of eucalyptus trees affording the only shade for miles. The Arabs long ago robbed this land of practically all its forests, except in some mountainous regions.



AN EST-ALGÉRIEN ROUND HOUSE, WITH BRIQUETTES PILED OUTSIDE.

The crew of an ordinary train wear a light striped uniform that wholly lacks dignity. The ticket collector generally appears once somewhere along the line, and punches the ticket. It is not surrendered until the passenger reaches his destination, and there it is delivered to the station-agent on passing out the gate of the enclosure. Every station of importance has an Arab assistant to look after the natives, but the French trainmen are supposed to know enough Arabic for emergencies. The section-gang are usually Arabs, with Italian or Maltese foremen.

They have rather an amusing way of starting a train, especially in Tunisia. It is the station-master and not the conductor who gives the signal. He blows a shrill whistle, then the conductor blows a sort of bazoo, the engineer toots the locomotive, and we are off.



A JUNCTION POINT ON THE BONE-GUELMA.

The Chicago windmill in the background pumps water for the railroad tank.

At times the conductor calls out *"en voiture!"* before sounding his bazoo.

From an engineering standpoint, these North African lines do not, as a rule, greatly interest Americans. About two-thirds of the track runs through plains or follows valleys. In the Algerian Mountains, however, there has been done some fine engineering work of many kinds. Two hours east of Algiers, the train runs through one tunnel after another, and there is at least one tunnel on the main line that is a mile in length. Apparently, it was cheaper to make tunnels than to build bridges, for I recall a long detour and four tunnels made in getting around a ravine. From a traveler's point of view, I should say that the road enters many of these tunnels at curves entirely too short; the locomotive is almost in some of them before the entrance can be seen.

AN UNUSUALLY FINE TANK ON THE EST-ALGÉRIEN RAILWAY, AT EL GUERRAH.

But these are the country's first railroads and we must not expect too much. As time passes by and the country reaches a higher stage of development, the lines will doubtless be straightened, the equipment improved, and the service bettered in general. Meanwhile, the railroads serve the country admirably, and the tourist generally finds something to growl at on any road.

SYSTEMATIC FOUNDRY OPERATION AND FOUNDRY COSTS.

C. E. Knoeppel.

VI. FOUNDRY ORGANIZATION AND MANAGEMENT.

Mr. Knoeppel's series began in our issue for October, 1908, and preceding parts have dealt with the elements of the problems of foundry costing, the importance of correct burden apportionment, and the classification and apportionment of costs.—The Editors.

A FOUNDRY enterprise, considered as an organization, is in many respects like a chain, the strength of which is measured by its weakest link; and until the profit-eating elements—the inefficiencies—are discovered and eliminated, it cannot be expected to perform the *impossible* task of producing the results anticipated by its founders, any more than a chain can lift ten tons if one of the links, because of its weakness, is only strong enough to lift seven tons. To strengthen the links of a business—to make them work under a greater load—is the task which confronts every ambitious executive, and it cannot be done by concentrating attention on one link or a few links; *all links* must receive their proper consideration.

The demand of the times is *increased earnings;* this involves a search for latent earning capacity—a search in every nook and corner for opportunities to better results, whether good or bad; and this searching process should not be a haphazard, occasional, half-hearted affair, but a critical, systematized analysis all along the line. "Chemistry of results" is of vital importance, just as important to the success of the foundry as a business as "chemistry of iron" is to the melting operations as a single department of the business, for it considers the important fact that *productivity* is the essential factor in the success of any foundry enterprise applicable to the methods in use, the clerks, the machines, the cupola, the cleaning room, as well as to the moulders and coremakers. Even a trifle of increase at each point will certainly result in greater earnings. It is the little things, which are oftentimes overlooked because they are little, that amount to something substantial in the aggregate.

Analysis, important as it is, is a *post-mortem,* a tearing-to-pieces-looking-for-trouble process, and while it is an important element in pointing out the way to correct existing evils, it is just as necessary to have at work an *ante-mortem* process—a process anticipative in nature—a creative and constructive force—a force which considers that all work, while distinct, must be subservient to a general scheme of things, which admits of something being done with regard to its relation to other things—"organization" in other words, applicable to the business in its entirety, to the various departments, to the clerical work, etc., and definable as follows:

"The result of a resolving of the forces at work into their component parts; their classification so as to enable them to follow well defined channels, that the work may be guided along the most logical lines and responsibility placed where it properly belongs; and finally their combination into one harmonious effort, supervised and directed by a master mind."

A customer ordering castings will specify a certain analysis of the iron. He will want a certain percentage of silicon, sulphur, manganese, etc., and it is up to the foundry superintendent so to plan his work as to produce castings which when chemically analyzed will show how they fulfil the specification. In conducting your business, you specify a certain analysis—profits; perhaps you specify the margin of profit that you require your final analysis to reveal to you, and you must organize your business so that this final analysis will either come up to your desires or show you what was wrong in order for you to introduce the elements necessary to bring about the results you specified. There is no more excuse for a lack of organized effort in the foundry business than there would be for a foundryman to dump his different brands of pig iron, scrap irons, etc., onto one common pile.

An accounting arrangement, no matter how carefully planned and installed, can only *register* results, not *produce* them, but this does not mean that the accounting should be considered as of little or secondary importance; in fact, the forces which register or record the results, as well as those which produce them, must be well organized if maximum efficiency is to be the outcome. Let us therefore take up the matter of organization, first as applied to the accounting and then to the engineering branches, by briefly considering the following questions:

1.—Should the cost accounting be considered a part of the general accounting or be kept separate from it?

2.—Should the accounting be on the basis of monthly, quarterly, or yearly results?

3.—Should the inventory be a perpetual or continuous one or taken at regular periods for closing the books?

4.—Can mechanical aids be employed to advantage?

5.—Is a comprehensive accounting arrangement expensive?

6.—What may be expected from an efficient accounting arrangement?

One of the basic principles about which a system of foundry accounting should be built, is that it should consider the important fact that business as it is now conducted is nothing more or less than a conversion of assets from one form into another. A foundryman starts with cash in the bank, which he converts into labor and material. From this expenditure he secures castings which when sold appear as accounts receivable, then as cash, as payments are made, and so back into labor and material again, from one state into another, in the form of a complete circle. From this point of view, a foundry accounting arrangement, to be efficient, should consider the costing as a part of the general accounting scheme, in order that *all* items effecting the business can be properly recorded and not lost sight of. Cost information carried through the general books so that everything must be in balance, at the end of a period, is going to mean that the accounting will be more comprehensive than if the costing was a sort of spasmodic, hit-and-miss, incomplete and perhaps inaccurate sort of an affair.

It would not seem as if question two was entitled to any consideration whatever. It is difficult to explain why an executive will rest content, as so many do, with anything short of a monthly accounting, making possible a thirty-day statement as to his conditions. Cases are numerous, however, where a monthly trial balance and an annual or perhaps a semi-annual closing of the general books seems to be the custom. Twelve opportunities in a year for locating and correcting faulty conditions, as against one or perhaps two chances, is something worth considering, as it places an executive in much closer touch with the various details of his business than a yearly accounting possibly could—in fact, in the majority of cases, if results are not as they should have been, it is almost impossible to analyze a yearly statement so as to lay a finger on the leaks and the inefficient conditions which were responsible. As no manager in these days, can afford to "fool" himself or to work in the dark regarding what is going on all about him, we are safe in concluding that a thirty-day accounting arrangement is absolutely essential.

Regarding question three, as to the matter of a continuous inventory, a brief consideration should show that such an institution is not only advisable but necessary, if the accounting scheme is arranged to make possible a thirty-day statement. Material is converted money and should be regarded just as carefully as the cash is; but how is this converted asset regarded by the majority of our foundries? Every reader can call to mind case after case where the proper care of the materials purchased is a matter of little concern; where careful attention is given to the matter of buying, but once the material arrives, this same careful attention seems to be conspicuous by its absence in so far as concerns the way this material is used. An item like torches and wicking does not seem to be of any great consequence, but how about the thousand and one items with which the foundry is concerned in the course of a year? Some workmen are careless by nature; others become so, even the most careful sometimes, when they realize that not only are there no safeguards thrown about the materials, but that it seems to be the duty of no one in particular to see to it that the materials are used judiciously. Even if a lax handling of the purchased materials does not result in making them careless, it tends to make them so; and at the same time it robs the executive of the means that might enable him to "cut corners." A concern which had been rather liberal in allowing their workmen to use waste as they saw fit, decided to place the issuing on a more systematic basis with the result that in the first month the consumption was reduced by about 25 pounds—a small item, perhaps, but an item which in a year meant 300 pounds less to pay for. No more material should be purchased and used than is necessary to produce good results, and the less an executive has to pay for, the more he can use in other directions. As the aims of a continuous inventory is to furnish the executive an efficient control of his materials, so that he can know that this expenditure is not out of proportion to the results obtained, it should need little argument to convince a foundryman that purely from the standpoint of good business, of possible financial gain, a positive knowledge of his material is something to be desired. Even if it did not save him a cent, he would at least know that because of this control of things, he has not wasted any money.

As to mechanical aids in accounting, I am of the firm belief that they can be used to decided advantage in any foundry office. What an executive wants is a knowledge of his results as quickly as they can be gotten to him, and if he is forced to depend upon his clerks to add columns of figures, multiply and divide, without the aid of mechanical devices, he must either employ a large force of clerks or wait for his information until it is too late to be of value. A progressive manager should do neither when an installation of machines makes it possible not only to operate with a minimum number of clerks, but to secure his information on time. One of the most prominent manufacturers of adding and listing machines has a machine peculiarly adapted to the needs of the foundry business, in that pounds-hours-dollars can be added at one time, materially reducing the work of summarizing production costs according to the various classifications. There are several makes of multiplying and dividing machines, any one of which will pay for itself within a short time, as they not only make the work easier for the clerks but enable them to do their work with much more rapidity—the most important result being the absolute accuracy with which the machine can be made to operate.

Is a comprehensive accounting arrangement an expensive proposition? To arrive at an answer to this question, let us place the expense of operating a foundry with the simplest kind of an accounting arrangement in contrast with one which is designed to give the desired information. In the first place let us assume that in a foundry running at a capacity of 25 tons daily there are employed, in addition to the executive, an office manager at $100 per month, to look after the purchasing, orders, etc., and a bookkeeper at $75 per month, who with a stenographer at $40 per month can look after the accounting and the balance of the office work. This would amount to $2,580 yearly, or 35 cents per ton. To place the accounting on a proper basis, it would perhaps be necessary to add to the above a foundry clerk at $65 per month, an office clerk at $40 per month, a stores clerk at $50 per month, and an office boy at $30 per month, a total of $2,220 more a year, or 30 cents per ton, which (on the basis of a cost of $50 per ton for the castings produced) would mean an extra clerical cost of less than one per cent as a cost to make possible a proper accounting arrangement.

As to what may be expected from a comprehensive accounting arrangement, it can be said that the principal result would be clear and concise statements reflecting the conditions of the business. Not very high sounding, perhaps, but full of meat just the same. A hospital doctor arranges for information concerning his patients during his absence, and at regular intervals, the nurses and attendents register in a systematic way the important details concerning pulse, temperature, etc., which upon the arrival of the physician will show him the condition of the patients during the time he was away from the hospital. He knows whether they are better or worse, and from this information plus his knowledge of the cases, he is in a position to plan out his future action. A manufacturer is the doctor of his cwn business, his statements and charts being the information as to pulse, temperature, etc., a study of which will enable him to plan for the future. Figures in themselves are dry and uninteresting, but with reason and judgment (analysis) applied to them they assume a far different aspect. To illustrate. A correct accounting scheme would show what the total production was in a certain period and it would also show the number of hours in which this production was made. Placed by itself, this information would mean very little to the executive beyond the fact that his plant worked a certain number of hours and that his production was a certain amount. If however, these figures should show in addition that this production in the time specified meant 500 pounds per man per day, the executive would have something in the way of valuable information, for by comparing this figure with the relative production per man for previous months, he could satisfy himself from his knowledge of the work, as to whether the result was satisfactory or not. Analyzing still further, he could get the relative production of the work for Jones, Smith, and Brown, and would perhaps find that on the work for Brown the production fell below what it should have been. It is fair to assume that by concentrating his attention on the production of Brown he would be able to increase it to some extent, any increase being accompanied by decrease in the cost to produce the work, consequently more profit —this added profit being the result of an arrangement which reflected the condition of only one feature of the business. There are many other possibilities in this reflection process, but the one given is sufficient for purposes of illustration. At any rate, from the above arguments we can decide in favor of an accounting arrangement which will not only be accurate and efficient but designed to show the pertinent details of the business in a simple yet comprehensive manner.

Efficiency is the elimination of inefficiency—once it is found. It therefore becomes the duty of the executive so to arrange his details as to allow this "finding" process to work to advantage, which can best be done through means of a correct and well balanced organization. Human nature is liable to pass over the possibilities for profit when some one else is likely to receive credit for the good that is done, but once put a responsibility squarely up to an employee, letting him understand that while he will be held strictly responsible for failure, he will receive credit for accomplishment, and from that moment better results may be hoped for. In other words, the incentive to do must be furnished, for there is nothing that will do more to create harmony and promote action than mutual trust. Nonconformists must of course be weeded out or swung into line, for there can be no successful business without authority. This can be accomplished through the force of organization and personality much more easily than it can be by the force of fists. Men cannot be made to do a thing, but they can be led. The employee owes a duty to his employer, to be sure, but this does not mean that this duty is all one-sided. Make the organization what it should be—place responsibility where it properly belongs—furnish a man with an incentive to look for the troubles which exist to a greater or less degree in every business, and the inefficiency will be brought to light, for efforts will be made to bring about increased productivity, and increased productivity is synonomous with increased efficiency.

For example. There are no doubt a number of foundries where the rule is for the moulder to take out their work after pouring off, remove clamps and gaggers and temper the sand for use again. Here is an inefficiency which may not have been noticed simply because it was not up to anyone in particular to do more than was required of him. Results may have been satisfactory and consequently good dollars are being thrown away because of this faulty condition. What does it mean in dollars and cents? Suppose in a shop, fifty men take 1½ hours per day to remove their work and clean up before beginning the real work for which they were hired. Assuming that the production is at the rate of 400 pounds per man per day, these fifty men could produce, in the hour and a half that is lost, 900,000 pounds, or 450 tons, in one year worth, we will say, $60 per ton or $27,000. This is not the only result, for not only would the work of taking out the castings at night cost considerably less than the amount paid to the moulders, but the moulders would be producing 460 pounds per man per day instead of 400 pounds—any increase in the amount produced resulting in a lower cost per ton for burden.

Suppose that we take another example showing the possibilities in increasing productivity. In a certain foundry we will say that the daily production per man is 450 pounds, which through careful management is increased to 500 pounds. Chart 3 in my second article* shows that at 450 pounds the cost is $51.50 per ton, while at 500 pounds the cost is $50.00 per ton—an increase in the production per man of 50 pounds, or 11.1 per cent, accompanied by a decrease in the cost of $1.50 per ton or almost 3 per cent. On the basis of fifty producers, the smaller production would mean in a year a total production of 3,375 tons which at $51.50 per ton would be $173,812, while on the basis of 500 pounds per man per day, the yearly production

*The Engineering Magazine, Nov., 1908, page 223.

would be 3,750 tons which at $50.00 per ton would be $187,500 in cost or an increase in the cost of $13,688. The result as far as production is concerned is an increase of 375 tons during the year, which at $60 per ton as a selling price would mean $22,500 in increased sales, and this amount less the cost of this increased tonnage—$13,688—leaves $8,812 on the yearly profit on the additional amount produced. Nor is this all there is to consider. We are still getting $60 per ton for the 3,375 tons which had been costing $51.50 per ton, but because of the increased tonnage are now costing $50.00 per ton, so that on the 3,375 tons we are making an additional profit of $1.50 per ton or $5,062 and this with the $8,812 profit mentioned above means a total yearly profit of $13,874—the result in dollars and cents of an increase in the productivity of the workmen.

Let us for a moment consider another phase of the subject—the losses due to faulty organization. A moulder usually has five things to work with—flasks, patterns, cores, gaggers and clamps, sand, and sometimes a sixth item can be added to these—special rigging like anchors, core barrels, etc. If things are not planned out as far in advance as possible we are likely to see moulders waiting for flasks, and if they are not suited to the work, waiting until the carpenter either cuts a part of a flask bar away or knocks out a bar or two so that new ones can be added. Or we may see a moulder waiting for his pattern, or waiting until the foreman ascertains whether the pattern is the right one or not, or the pattern may have to be sent back to the pattern shop for some repairs, or if the moulder attempts to make the casting from the pattern as it stands he must spend some little time in patching up his work in order to make the casting according to the pattern. Or again, we may see a moulder going after his cores and chatting with his fellow workmen on the way to the core room and back, or waiting because the cores are not quite ready, or perhaps they were neglected by the core-maker and have not been made at all, or perhaps they have been made and made wrong. We may also see a moulder digging into the back end of his floor for gaggers and clamps, and if he does not find all that he wants or what he wants, he may be seen on a "borrowing" expedition, or he may wait until some are brought to him from the supply—if there is one. We may also see him start on a piece of work, stop and go for some sand, or wait until the sand is brought to him by one of the laborers. As for the special rigging, we may either see the moulder going for what he wants or waiting until it is brought to him. We may also see some little time wasted in the morning because the new work coming in has not as yet been handed by the foreman to the moulders most

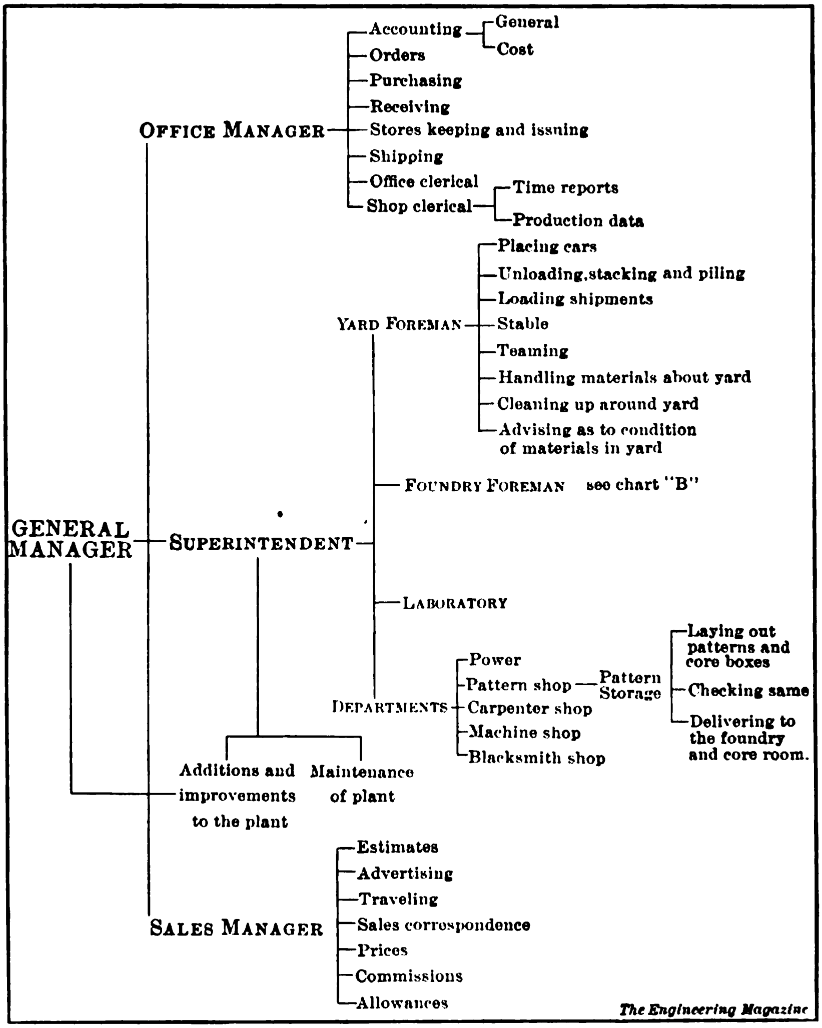


CHART A. GENERAL ORGANIZATION OF THE FOUNDRY.

competent to make it. Time not only costs money but production as well, for if we assume that with fifty moulders, 20 minutes is lost each day because of the waiting, delays, mistakes, annoyances, etc., that are often to be found in our foundries, we are not only losing, on the basis of $3.00 per day, labor amounting to $1,494 in a year but the lost time to the extent of 4,980 hours. If this lost time could be made to yield at the rate of 400 pounds per man per day, the result would be 199,200 pounds as increased production, or 100 tons, which at $60 per ton would mean $6,000 more in sales yearly.

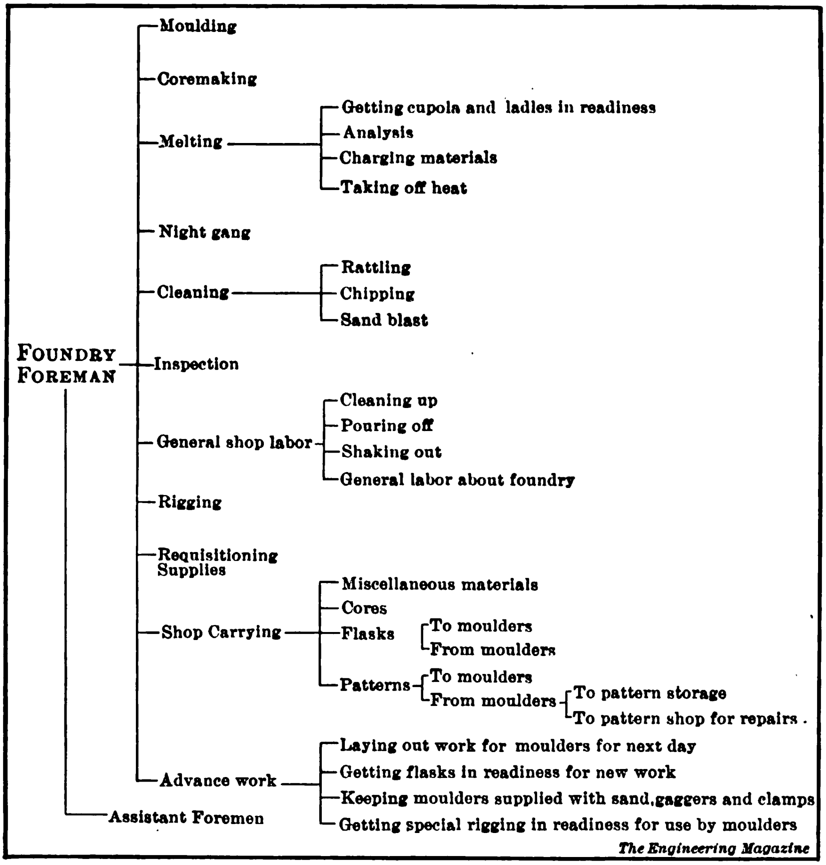


CHART B. ORGANIZATION OF WORK UNDER THE FOUNDRY FOREMAN.

Authority should be carefully defined and then centralized along the lines suggested in the charts, which accompany this paper; criticism and recommendations for betterments should be solicited and acted upon, and once those connected with the organization can feel that their opinion is desired in matters affecting their own work, it will not be long before they will be on the lookout, all along the line, for the loose ends, the leaks, the inefficiencies; and as a man looking for trouble is sure to find it, so will the man looking for places which can be bettered be better able to locate them than he who goes about with his eyes closed.

THE NATURE AND CHARACTERISTICS OF THE NEW STEELS.

By O. M. Becker.

II. THE EFFECT OF ALLOY METALS ON THE PROPERTIES OF STEEL.

In a preceding article Mr. Becker discussed the physical constitution of steel and the nature of the changes caused by tempering. In this concluding paper he takes up in detail the influence of each of the ordinary alloy elements. The discussion as a whole provides one of the most complete reviews of the subject yet presented in English.—The Editors.

IN a preceding article we have examined into the composition and structure of steel as disclosed by chemical and metallographic methods, and we have discussed the phenomena of hardening and the changes in structural condition which it involves. We came in conclusion to the effect which the several substances alloyed with steel exercise on these changes of condition.

Not only do the several hardening metals act more or less differently with respect to the transformation points or temperatures at which steels containing them change from one to another of the three conditions already described, but they produce somewhat different physical properties. Vanadium, for example, even when present in very small proportion, tends to make steel very tough, increasing its tensile strength to an extraordinary extent. A vanadium steel in the form of wire has been reported as having a tensile strength of 400,000 pounds per square inch! This is so astonishing as to raise some doubts concerning the accuracy of the report. A test not open to doubt, however, made by a large steel-making concern, yielded the following results with a two-inch bar:

Elastic limit, pounds per square inch	222,200
Tensile strength, pounds per square inch	227,300
Elongation, per cent	11.5
Reduction of cross section, per cent	42.0

The proportion of vanadium in this steel was almost infinitesimal, being but 0.17 per cent., as shown in the following partial analysis:

	Per cent.
Carbon	0.34
Sulphur	0.025
Phosphorus	0.027
Manganese	0.40
Chromium	1.00
Vanadium	0.17

Another steel recently put upon the market for use in machine parts rather than for tools, is claimed to have a tensile strength in excess of 272,000 pounds, in bars. The makers decline to give out its composition, but it evidently is a chrome-vanadium steel.

As is well-known, carbon also confers greatly increased tensile strength, though in a degree scarcely comparable to that conferred by vanadium; while on the other hand it tends, as the content becomes high, to increase brittleness. Very high carbon steel (and also high manganese steel) has been made so hard that it could be pulverized like glass.

It is rather difficult to arrive at exact conclusions with reference to the influences of the several metal hardening substances, from the circumstance that ordinarily several are present simultaneously in any steel undergoing tests. Some manganese, silicon and carbon, for example, are always found in steel, it having so far been impossible to eliminate them wholly in the process of manufacture. Even if it were possible to determine separately the influence of each element, it may be doubted if results arrived at in this way could be considered conclusive; for apparently in all cases, and certainly in some cases, their mutual influence tends to modify their individual effect—as already instanced of tungsten and manganese—and perhaps even to nullify it wholly or in part. Much experimenting, however, has been done; and while perhaps it is yet too soon to state full and final conclusions concerning the utility and limitations of the alloy elements, the investigations of Dr. Guillet, Mr. J. M. Gledhill, Professor Carpenter, Messrs. Taylor and White, Mr. C. A. Edwards, and others, make it possible to give interesting general conclusions and to indicate in some cases, at any rate, their limitations in high-speed steel. The following statements are believed to summarize the present state of knowledge upon this subject.

The influence of carbon in ordinary steel is so well-known as scarcely to need repeating here. It is sufficient to say that this metalloid increases tensile strength and hardness, and when high makes steel very brittle, as already indicated above. It has been previously shown that at low temperatures the carbon and iron are combined as pearlite, which is soft, with an excess of hard and brittle cementite or soft and tough ferrite according as the carbon content is above or below 0.89 per cent; and that at higher temperatures, up to where the steel becomes "burnt," this structure is replaced by the very hard and strong carbide called martensite or hardenite, while the excess of carbon above 0.89 per cent forms the hard but brittle carbide called cementite, which tends to make the steel brittle.

In high-speed steel its influence is much the same, and in addition it combines with tungsten, molybdenum, chromium, and the like metals, to form carbides; one soft, brittle, and not permissible in a high-speed steel; the other, formed upon the destruction of the first at a very high temperature, hard, and essential to this kind of steel. The best modern high-speed steels are low in carbon, rarely in excess of 0.7 or 0.8 per cent, and frequently much lower—indeed, in some cases there is only as much carbon as it has been impossible to keep out, none being intentionally put into the mix. The strong affinity of carbon for iron and other constituents of high-speed steel makes this slight amount quite sufficient for the formation the high carbides which give these steels their peculiar characteristics.

The maximum limit seems to be near 2.0 per cent. Low carbon renders the steel more forgeable than high, and avoids the brittleness accompanying the latter. The proportion of carbon does not materially affect the cutting speed if between the approximate limits of 0.85 and 2.00 per cent. The degree of hardness in high-speed tools, as in the case of ordinary steel, depends largely upon the proportion of carbon. Hardness, however, is not an essential property of high-speed steel, though for most purposes it is desirable, especially in cutting exceedingly refractory materials. "Red-hardness," on the other hand is, according to Taylor, the one distinguishing property of high-speed steel by virtue of which it is able to resist to so marked a degree the softening effect of heat and therefore to stand up so astonishingly under heavy work. According to the same authority this property does not at all depend upon the carbon content, and is not even noticeably affected by variations in the carbon content up to about 1.3 per cent, and possibly above.

Tungsten, like carbon, imparts hardness, though to a considerably less degree. At the same time it imparts, when in combination with certain other alloys, if not alone, also the quality of red-hardness; and this in proportion to the amount present, up to 16.0 and perhaps 19.0 or 20.0 per cent. Higher tungsten adds nothing to the cutting efficiency, and on the contrary decreases the property of red-hardness and consequently the cutting efficiency when used in cutting tools. With a tungsten content ranging between 18.0 and 27.0 per cent, according to Gledhill, the steel becomes softer and tougher, but does not stand up well. Taylor indicates that its limits of highest efficiency appear to lie between 6.5 and 8.75 per cent approximately, and that it is most effective when combined with approximately 5.0 to 6.0 per cent of chromium. He also leaves it to be inferred that tools low in tungsten are deficient in red-hardness and rapidly deteriorate. Somewhat less than 1.0 per cent of tungsten appears to be necessary to develop this property, even in the presence of moderately high chromium. In the manufacture of high-speed steel tungsten is more largely used than any other of the hardening elements, because of its comparative cheapness, as well as because of the special qualities it imparts in combination with certain other elements. Of itself it does not make steel self-hard, as has been already shown, except it be heated to a very high temperature; and it is not yet certain that it, of itself, imparts red-hardness. Most likely it does not. In order to make a tungsten steel red-hard, and therefore high-speed, the tungsten must be combined with manganese, chromium, nickel, or perhaps other elements; and that in a pretty definite proportion, it would seem.

Mention has been already made of the formation of tungsten-iron carbides at moderate temperatures, and the transformation of these soft and brittle crystals into very hard and strong carbides at very high temperatures. When these carbides are compound, that is, are carbides of not tungsten and iron alone, but of manganese and chromium, and possibly other elements, then the mass of steel permeated by them resists wear and moderate degrees of heat in the manner characteristic of high-speed steel. It is red-hard.

Molybdenum very closely resembles tungsten in its influence upon high-speed steel, but is almost twice as active. From 4.0 to 4.5 per cent of molybdenum therefore is sufficient to make a tool high-speed. The difference in the amount required, however, is fully offset by the present higher cost. It is frequently found in high-speed steels, though not usually to replace tungsten entirely. It does not seem to answer so well as tungsten, for along with desirable properties molybdenum imparts also certain others which are not desirable, and which may even be fatal to good tool service. The tendency of molybdenum tools is to be brittle, to fire-crack, to be weak in the body, or to be irregular. Mr. Taylor thinks the latter defect very likely due to slight variations in heating, the critical limits between which this must be done probably lying close together. This seems to be indicated by the fact that cutting tools made of molybdenum steel run best when heated to a temperature slightly lower than is usual with other high-speed steels; and also that when heated above 1,000 degrees C. (1,840 F.) they are inferior and have short life. When combined with tungsten in small proportion, molybdenum is said by Gledhill to increase slightly the efficiency of tools. Like tungsten it does not affect the transformation points, whether much or little be present, until the steel has been first heated to a very high temperature, almost to the melting point, so that the double carbides, formed at the lower temperatures, are destroyed.

Chromium is now considered one of the most important alloys used in high-speed steel. It adds greatly to the tensile strength of hardened steel when present up to 5.0 per cent, and allows it to be readily forged at a very high heat. It acts like tungsten and molybdenum in the formation of soft and brittle double carbides of iron and chromium, which are broken down at high temperatures, the steel then becoming self-hard in the austenitic or γ (medium hard and tough) state if the chromium be high. It tends to raise the critical points, and in combination with tungsten or molybdenum imparts the property of red-hardness. It confers a hardness somewhat like that conferred by carbon, which however is modified by the toughness also imparted when the chromium is not excessively high, the molecular cohesion of the steel being then much greater than in carbon steels. The steel in consequence is strong and tough, unless the chromium be very high, in which case the tendency is toward brittleness, as in the case of high carbon. Chromium steel, especially when vanadium also is present, is well calculated to resist the stresses and shocks incident to the work of high-speed steel. Since chromium confers hardness, obviously high chromium indicates the need for low carbon. In some respects it behaves like manganese, for a tool high in chromium will be self-hard and high-speed even though the managanese be very low, or even quite absent. Its range of greatest effectiveness appears to lie between near 1.0 and about 6.0 per cent. High chromium tools are very hard and very efficient upon refractory material. They are however easily injured by overheating and require care in hardening. Tools low in chromium are very tough and work well on soft materials.

Chromium-tungsten steels have this important advantage over most other high-speed steels: they are treated with comparative ease, requiring less special knowledge and skill to make efficient tools of them. They melt, nearly all of them, at about 1,375 degrees C. It is unnecessary, however, to heat them to this point, for a temperature of 1,260 degrees C. will confer just as much red-hardness as will the higher heat. There is, therefore, a range of considerably more than 100 degrees C. within which the heating may be done with perfect safety and without variation in the efficiency of the tool. As pointed out elsewhere, it is the very narrow limits within which the heating must be done that makes certain other high-speed steels so liable to produce defective or inefficient tools. Within the range indicated above there is a sufficient variation in the color of the heated steel to make it possible to gauge the temperature with the eye closely enough for most purposes.

The precise effects of vanadium are not yet fully understood. Its power of conferring high tensile strength upon steel, even when present in very small proportion, has been already mentioned. Dr. Guillet points out that vanadium, forming double carbides as in the case of the other alloys already described (which however are not destroyed at high temperatures even), does not lower the transformation points and therefore does not of itself make steel either self-hard or high-speed. Neither does it confer the quality of temper-resistance or red-hardness, though it does seem to retard the formation of carbides. When present to a maximum of 2.0 per cent vanadium allows tools to be readily forged. Such tools also stand up well, but no better than do chromium tools. Vanadium is not now generally used to replace chromium, but to supplement it. Thus used its effective range seems to be approximately from 0.15 to 0.35 per cent. Excess over this proportion adds little, if anything, to the quality of tools. It does not follow, however, that no more than this amount of vanadium is put into steel, during the making; for it is asserted that it is not unusual for as much as 0.3 per cent of it, added to the contents of a crucible before melting, to have entirely disappeared by the time the steel is analyzed. The explanation is that minute quantities of it act to cleanse the steel, removing certain obscure oxides perhaps, combining with them and being carried off in slag. It is certain however, that small amounts placed in the melting crucibles add very materially to the quality of high-speed steel, tending to make it mechanically sound and homogeneous and to give it a tough molecular structure. A peculiar quality it imparts, to a greater degree than any other of the alloy substances, is that of self-lubrication. This obviously is a very desirable quality in high-speed tools especially.

Nickel, much used for armor plate and steel intended to resist wear, frequently in combination with chromium, though found in some high-speed steels is not very much used for cutting tools. It is more often used, usually in combination with chromium, for rock drills, and rock crushing machinery, shoes and dies for stamp mills, and other parts subjected to violent and repeated shocks. Since nickel confers toughness and greatly increases the elastic limit of steel, its combination with chromium produces an excellent steel for the purposes mentioned, though it does not appear to be of any marked advantage in high-speed cutting tools. Nickel has been mentioned along with manganese as a typical steel-hardening substance. It acts, when alone in steel, to lower the transformation points in proportion to the amount of alloy present; and in sufficient quantity, makes steel self-hard in the martensitic state. Still higher nickel, like higher manganese, tends to make steel self-hard in the austenitic state. Such steel however does not seem to be high speed to any considerable degree—which is to say, neither of these elements seems to confer the property of red-hardness, either alone or in combination with the other. Nor does chromium seem to help in this respect, as it does when added to tungsten or molybdenum.

Cobalt, so closely resembling nickel in its general characteristics, does not seem to behave very much like it when alloyed with iron. It apparently has little, if any, effect in lowering the transformation points. Cobalt steel therefore is not self-hard, but usually is of a pearlitic structure (soft). It has, however, a tensile strength rather higher than that of carbon steel, though scarcely comparable with that of nickel steel. The utility of cobalt as an alloy in high-speed steel remains to be shown.

Titanium has been used in small proportion in some high-speed steel, and to a considerably larger extent it has been used in the manufacture of other steels. It is reported to add greatly to the hardness, tensile strength, and elastic limit of steel, closely resembling vanadium in this respect, though Dr. Guillet seems to think its influence unimportant. Information is lacking as to whether or not titanium can be used to replace other hardening elements to any considerable extent. It is so widely distributed and is so cheap compared with the other hardening substances used in high-speed steel, that its exploitation in this direction will be watched with much interest.

Unlike titanium, the ores of uranium occur but rarely. Some experiments have been carried on to determine the utility of uranium as a high-speed steel alloy; but thus far it has not been shown to add any important qualities which are not obtainable by the use of cheaper elements already much used.

Aluminum, often used in the manufacture of ordinary steels as a purifier during the making process, does not appear to add any desirable quality to high-speed steel, and so far as can be learned is not much, if at all used in its manufacture.

Until recently very little was known of what is perhaps the most curious of all the metals, tantalum. For the matter of that, a good deal still remains to be learned concerning it. Like most other hardening elements, it readily combines with carbon; but the carbides thus formed are not soft, as is the case with the others, but very hard. A small amount of carbon is sufficient to carbonize a large amount of tantalum. It is considerably more than twice as heavy as iron, bulk for bulk; is about as hard, when in the annealed state, as soft steel; and has a tensile strength nearly a third higher. When hardened by alternate heating and hammering, metallic tantalum becomes so hard that a diamond drill will scarcely touch it, while at the same time it retains a remarkable degree of toughness. No information is at hand as to its specific influence upon high-speed steel, but it is known that one maker uses tantalum in steel for drills, dies, and tools of like nature. The strong affinity of tantalum (when hot) for oxygen makes it necessary to heat tantalum steel under special conditions that will prevent contact of the heated steel with the air. The electric furnace is mostly used for this purpose. Tantalum ores are rare, and ferro-tantalum (the form in which it is used) is costly.

The importance of manganese in the manufacture of steels of all kinds, and its influence upon high-speed steel in combination with tungsten, have been already mentioned. Like nickel and chromium, manganese seems to hinder the formation of the double carbides of tungsten and molybdenum. Steel containing these elements in combination with a sufficient proportion of manganese (or of nickel or chromium) therefore are self-hardening without the high heat treatment, though they are not necessarily high-speed to any considerable extent, even when they receive that treatment. Very high manganese makes steel cold-short (brittle when cold) and susceptible to fire cracking. Low manganese does not, apparently, affect the property of red-hardness or temper resistance; but it does tend toward strength and toughness in the body of a tool, while at the same time allowing it to be readily forged and annealed. The apparent effective range of manganese content lies between about 0.2 and 1.2 per cent. If above 2.0 per cent in connection with low carbon, the steel is likely to be very hard and brittle, unless the percentage is also above 6.0 per cent. The tendency seems to be to substitute chromium for manganese above 1.2 per cent. The chromium seems to do the work better than manganese beyond this point, and does not cause the undesirable tendencies above mentioned.

Silicon, like manganese, has an important function in the manufacture of steel; but in the proportion usually met with, has no important influence upon the structure or physical properties. An iron-silicon alloy containing from 5.0 to 15.0 per cent of the latter can be readily forged cold, like nickel; but is not forgeable at a red heat. Very high silicon increases the hardness of steel, and at the same time greatly increases, the brittleness. A singular circumstance is that an alloy of about 20.0 per cent silicon becomes harder when slowly cooled than when quenched. In high-speed steel high silicon sensibly lowers the cutting speed, though up to about 3.0 per cent it is said to increase the efficiency, especially upon hard material. Taylor indicates that 0.15 or thereabouts is, generally, most satisfactory.

Sulphur and phosphorus are as difficult to keep out of high-speed steel as out of other steels; and while they probably are slightly less harmful than in carbon steel, nevertheless they should be kept as low as possible. The former in steel tends to make it red-short and the latter cold-short. More than 0.03 per cent of phosphorus is ruinous.

It is seen from the above that while there are several agents more or less adapted to steel hardening, most of them are not well enough known, possess certain negative qualities, or are too rare to be available at the present time. Tungsten, molybdenum, chromium, manganese, and vanadium, besides possibly titanium, are now in general use to give tool steel properties not conferred by carbon, or to enhance the influence of that element. As has been already mentioned, the influence of any of these elements separately is not necessarily the same as when combined with others; and indeed in most cases there seems to be considerable difference, as for example in the case of tungsten and manganese or tungsten and chromium, already referred to. So far, therefore, it has not been possible to work out theoretically a formula for a high-speed steel mix. The method has necessarily been that of cut and try, further development being along the lines indicated by more or less successful mixes.

If Mushet steel was not strictly speaking high-speed, it was at any rate the forerunner of high-speed steel, and the development of the latter grew out of the former. Analyses of self-hardening steels have been previously given. The composition of the original self-hardening steel, R. Mushet Special, has been frequently given:

	Per cent.
Carbon	2.0
Tungsten	5.0
Chromium	0.5
Manganese	2.5
Silicon	1.3

Analyses of several typical self-hardening steels were given in a preceding table.* The average composition of some twenty brands of self-hardening steel, as determined from an analysis of each, is shown in the table on page 987, together with the average composition of about twenty-five brands of good high-speed steels as made within a year or two of the present time.

A first glance at this table does not reveal any striking or apparently essential difference between high-speed and self-hardening steel; and indeed it is stoutly maintained that there is no such essential difference—that Mushet steels are high-speed if treated by the Taylor-White high-heat process. Indeed, when it is remembered that it was with self-hardening or Mushet steels that Taylor and

* THE ENGINEERING MAGAZINE, February, 1908, page 808.

COMPOSITION OF SELF-HARDENING AND HIGH-SPEED STEELS.

	Self-hardening. Average.	Self-hardening. High.	Self-hardening. Low.	High-speed. Average.	High-speed. High.	High-speed. Low.	Steel recommended by Taylor as best all-round cutting steel.	
Carbon	1.8	2.4	1.1	0.75	1.28	0.32	0.682	0.674
Tungsten	7.3	11.6	4.5	18.00	25.45	14.23[1]	17.81	18.19
Molybdenum	4.58[2]	...	....	3.50	7.6	0.00[2]	....	....
Chromium	1.6	3.4	0.07	4.00	7.2	2.23	5.95	5.47
Vanadium	...	...	....	0.30	0.32	0.00[3]	0.32	0.29
Manganese	1.8	3.5	0.08	0.13	0.30	0.03	0.07	0.11
Silicon	0.56	1.04	0.16	0.22	1.34	0.43	0.049	0.043
Phosphorus[4]	0.032	0.080	0.016	0.018	0.029	0.013	....	....
Sulphur[4]	0.015	0.050	0.004	0.010	0.016	0.008	....	....

White were experimenting, and that it was these that yielded high-speed steels when subjected to the high-heat treatment, it becomes evident that though not now identical, there is a very close relationship between them. An inspection of the table above will show that the chief differences in composition are these:

	High-speed.	Per cent.	Self-hardening.	Per cent.
Carbon	Medium or low	0.3 to 1.3	High	1.0 to 2.5
Tungsten	High	14.0 to 25.0	Low	4.5 to 12.0
Chromium	High	2.0 to 7.0	Low	0.1 to 3.5
Manganese	Low	0.03 to 0.3	High	0.08 to 3.5

The differences, it will be observed, are entirely of degree, and not of kind. The total amount of alloy is very largely increased, and in every case the proportions of the ingredients named are inverted. This of course makes a very great difference in the qualities, though not necessarily in the characteristics, of high-speed steel and of the older self-hardening. The quality which particularly characterizes high-speed steel is red-hardness, the property of resisting the drawing of the temper when heated even to a red color. But red-hardness is imparted to the alloy steels (suitable ingredients being present) chiefly by the high-heat treatment—that is, by heating these steels to the point where they become austentitic, or γ whichever one chooses to name this moderately hard and tough condition. It is natural to suppose that all austentitic steels would necessarily be red-hard to a high degree. This however does not seem to be the case, though indeed the two conditions usually are found together in greater or less degree.

[1] Tungsten is used in all but one of the steels analyzed. In combination with molybdenum the percentage of tungsten is lower than that given.

[2] Molybdenum was found in but one of the self-hardening steels, and in six of the high-speed steels, in the latter always (with one exception) combined with tungsten. The minimum percentage so combined was found to be 0.48.

[3] Found in but three of the steels analyzed.

[4] The exceeding difficulty of determining such infinitesimal quantities as are involved in the separation of phosphorus and sulphur makes these figures more or less uncertain. In most cases it is possible only to say that traces of these elements exist.

Thus far, in high-speed-steel practice, the disposition on the part of users as well as makers, has been to use one steel for all purposes, tools for cutting hard as well as soft materials (wood among the rest), forming dies, crushers or hammers, rock drills, and all the rest of the category of tools. Most manufacturers make rather extravagant claims for universal high efficiency on behalf of their particular steels. It is true that some steels on the market come pretty close to fulfilling the various conditions requisite to universal service, not only making good cutting tools for hard and soft metal and wood, but being suitable also for forming dies, crushing tools, hammer tools, and the like. For the most part however the high-speed steels now on the market are adapted to particular rather than general service. Thus a steel highly efficient in cutting hard material often is not so on soft; and one well suited to cutting is not very likely to be well suited to forming dies and the like. Mr. Taylor mentions one steel tried in his experiments as being superior to all others in all kinds of metal cutting, and gives its composition as follows:*

	Per cent.	Per cent.
Vanadium	0.32	0.29
Tungsten	17.81	18.19
Chromium	5.95	5.47
Manganese	0.07	0.11
Carbon	0.682	0.674
Silicon	0.049	0.043
Phosphorus	....	....
Sulphur	....	....
Iron (presumably)	75.119	75.223

Though nothing is said as to its efficiency in tools other than those for metal cutting, the composition of this steel indicates that it is also good for all tools requiring toughness and wearing quality; so that it may fairly be classed as an all-round steel. Other things equal (price, for example) it would be highly desirable to have in a shop or set of shops one all-round steel equally and in a high degree efficient in all sorts of work there commonly turned out. The need for so many varieties of tool steel heretofore has been a source of great inconvenience, frequent mistakes, and untold annoyance—which all would be dissipated could a single steel be economically substituted for all the varieties now in use. But though this is a consummation greatly to be wished, it has been shown that conditions are not equal. Recently steels have been put upon the market, at prices very greatly below those commonly asked for the ordinary grades of high-speed steel, which are especially adapted to some particular class of work,

* The analysis of this steel is included also in the table at page 987, last column. Taken from "The Art of Cutting Metals," Mr. Taylor's presidential address, American Society of Mechanical Engineers, meeting of December, 1906. Practically all references here made to Mr. Taylor's statements and opinions are based on this report.

as wood cutting, for example. No analyses of these steels is at hand, but they are stated to be intermediate between the high-speed steels and ordinary steels, and evidently are developed from the ordinary self-hardening steels by varying the alloy content so as to secure the highest degree of toughness and edge-holding quality, essential to tools not expected to stand up to the kind of work required of high-speed tools; rather than red-hardness, which is not essential to this class of tools. They purport to fill a gap which has been recognized ever since high-speed tools first came into general use, furnishing a tool possibly slightly less lasting in service, but at a considerably lower cost. The precise field for these steels remains to be determined. Doubtless they will come largely into use for wood working and such metal-working tools as require keen edges but work in such a way (perhaps at slow speed) that they do not get hot enough at the cutting edge to need a high degree of red hardness. Some of them are stated to be especially adapted to use in forming and blanking dies, drop dies, and the like tools which require great wear-resistance, but which also generate no great amount of heat while at work. It remains to be seen whether or not any of these steels can fill the place which high-speed steel only lately has come to fill effectively and efficiently—the use for forming and other dies subjected to tremendous pressures. High-speed steel dies of this sort are very likely to split, and there has been a real need for a steel which would just fit into this use.

The minute structure of high-speed steel, as seen in a fracture, does not differ very greatly from that of carbon steel. It is, in general, seen to be of a fine and uniform granular appearance, with the granules smaller and more uniform, generally, than those of carbon steel. In annealed and forged high-speed-steel the smoothness of structure is increased; and when hardened, the crystalline structure stands out clearly though the individual crystals are very minute.

Under the microscope the structure is seen to be essentially that of carbon steel with certain modifications or additions. Pearlite is found, though generally in smaller proportion than in carbon steel, and martensite (or hardenite) forms a considerable proportion in many cases. This is true, as might be expected, especially of those steels which are high or moderately high in carbon, and which therefore are quite hard. Austenite is nearly always present in high-speed steel which has been heated beyond the higher critical point, and of course indicates that the steel is tough in proportion to the amount present. Changes in appearance and in structure due to hardening, tempering, and forging, are as noticeable in high-speed steels as in carbon steels.

PRODUCTION AND PROSPECTS IN THE COPPER-MINING INDUSTRY.

By Arthur Selwyn-Brown.

THE copper-mining industries were successful throughout the world last year, notwithstanding the commercial depression experienced in most countries. The total output of copper in 1908 was about 715,000 long tons. Of this, the greatest output ever recorded, the mines of the United States contributed 59 per cent.

In the early part of 1908 many of the leading American mines were closed down for short periods or were worked on a reduced scale for various reasons. In the latter part of the year, however, they were mostly operated to the fullest extent, and many new mines became producers. Among these the Ely mines, in Nevada, started with a steady output of 3,000,000 pounds of copper monthly. This has resulted in the production of copper overtaking the demand, and it would appear that if these conditions continue throughout the present year, the United States copper production in 1909 will exceed that of last year by more than 60,000 tons. Naturally this overproduction of copper in a period of reduced prices has caused serious apprehension in speculative copper-trade circles regarding the outlook of the copper industries in the near future, notwithstanding the fact that only two years ago the demand for copper was greater than the available supply. In this article it is proposed to review briefly the present position of the copper industries and outline conditions on the principal copper mining fields.

Copper Production and Prices.

The production of copper and the average price of lake copper in New York for each year in the period 1880-1908 is given in Table I. The figures in this table clearly show that there is a steady increase in the annual production of copper and that the United States are becoming of greater importance each year as factors in copper mining. In the past 28 years the United States copper output has increased from 17 per cent of the world's annual output to nearly 60 per cent. This ratio is still increasing. Little or no connection is noticeable between the price and the output. The average price of copper during the past 28 years was a little over 13 cents per pound.

TABLE I. WORLD'S COPPER PRODUCTION, 1880-1908.
(In Long Tons.)

	World.	Foreign.	United States.	Percentage of U. S. Production.	Price per lb. in New York in Cents.
1880	153,959	126,959	27,000	17	21.50
1881	163,000	131,000	32,000	19	18.20
1882	181,622	141,155	40,467	22	19.01
1883	199,406	147,832	51,574	24	16.50
1884	220,249	155,141	64,708	29	13.00
1885	225,592	151,540	74,052	32	10.67
1886	217,086	146,656	70,430	32	11.00
1887	223,798	142,781	81,017	36	13.85
1888	258,026	156,972	101,054	39	16.78
1889	261,205	159,966	101,239	38	13.49
1890	269,455	153,489	115,966	43	15.60
1891	279,391	152,552	126,839	45	12.76
1892	310,472	156,454	154,018	49	11.56
1893	303,530	156,497	147,033	48	10.75
1894	324,505	166,385	158,120	49	9.52
1895	334,565	164,648	169,917	50	10.73
1896	373,363	167,979	205,384	54	10.98
1897	398,955	178,384	220,571	54	11.36
1898	429,156	194,106	235,050	54	12.05
1899	469,310	215,440	253,870	54	11.76
1900	485,854	216,743	269,111	57	16.65
1901	511,019	242,497	268,522	51	16.72
1902	542,167	247,870	294,297	54	12.16
1903	585,081	273,499	311,582	54	13.72
1904	641,694	278,955	362,739	56	13.01
1905	701,252	298,615	402,637	57	15.89
1906	212,000	302,266	409,734	58	19.60
1907	710,000	309,866	400,134	57	20.00
1908	714,464	293,323	421,141	59	13.42

PRODUCTION OF VARIOUS COUNTRIES.

The contributions of the principal copper-producing countries to the world's output during the past nine years are shown in Table II. The growing importance of Japan, Peru, and Canada as copper producers is well shown by the figures given.

UNITED STATES PRODUCTION.

Copper deposits occur in nearly every State in the Union and in the territories. The largest deposits at present worked, however, are in Arizona, Montana, Michigan, Utah and Nevada. The production of the various States during the period 1902-1908 is given in Table III.

An enormous amount of new capital is at present being invested in copper mines and smelters in the United States. Large as the production is today, it promises to increase rapidly in the near future. It is estimated that when the new properties at present undergoing development are in full operation, the mines of the United States will produce at least 75 per cent of the world's copper. Table III shows that the great producing States at present are Arizona, Montana and Michigan. Utah and Nevada last year showed remarkable

TABLE II. OUTPUT OF PRINCIPAL PRODUCING COUNTRIES. (In Metric Tons.)

	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.
Argentina	76	793	244	137	157	157	107	224	200
Australasia	23,368	31,371	29,098	29,464	34,706	34,483	36,830	41,910	39,000
Austria-Hungary	1,377	1,356	1,626	1,407	1,473	1,346	1,458	1,062	1,000
Bolivia	2,134	2,032	2,032	2,032	2,032	2,032	2,540	2,540	2,300
Canada	8,595	18,575	17,765	19,360	19,490	21,588	19,106	21,022	24,316
Cape of Good Hope	6,828	6,503	4,521	5,314	7,900	7,442	6,645	6,838	6,700
Chile	26,016	31,299	29,373	31,424	30,592	29,632	26,157	27,112	26,000
Germany	20,635	22,069	21,951	31,214	30,262	22,492	20,665	20,818	20,000
Italy	2,797	3,048	3,424	3,150	3,388	2,997	2,911	3,353	3,000
Japan	28,285	27,916	30,251	38,610	35,408	36,485	40,528	49,718	51,000
Mexico	22,473	33,943	36,357	46,040	51,760	70,010	62,690	61,127	38,259
Newfoundland	2,929	2,800	2,906	2,753	2,235	2,316	2,332	1,758	1,600
Norway	3,998	3,429	4,638	6,010	5,502	6,406	6,218	7,122	6,500
Peru	8,353	9,673	7,701	7,925	6,863	8,763	8,641	10,744	9,000
Russia	8,128	8,129	8,814	10,485	10,871	8,839	10,658	15,240	15,000
Spain and Portugal	53,718	54,482	50,587	50,536	47,788	45,527	50,109	50,470	51,000
Sweden	457	457	462	462	542	559	508	2,032	2,000
Turkey	2,341	1,665	1,118	1,422	965	711	432	1,270	1,100
Great Britain	777	610	488	544	501	726	762	711	700
United States	274,933	270,998	288,833	316,239	370,892	397,003	416,226	398,736	432,907
Totals	496,819	532,148	542,209	602,832	663,327	699,514	715,523	733,807	727,474

TABLE III. UNITED STATES COPPER PRODUCTION, 1902-8. (In Pounds.)

	1902.	1903.	1904.	1905.	1906.	1907.	1908.
Alaska	——	1,339,590	2,043,586	4,900,866	8,685,646	7,034,763	4,800,000
Arizona	119,944,944	147,648,271	191,602,958	235,908,150	262,566,103	256,778,437	274,800,100
California	25,038,724	17,776,756	28,529,023	16,597,489	28,153,202	33,696,602	27,750,000
Colorado	8,422,030	4,158,368	9,506,944	9,404,830	7,427,253	13,998,496	10,166,370
Idaho	227,500	778,906	2,158,858	7,321,585	8,578,046	9,707,290	10,080,506
Michigan	170,609,228	192,400,577	208,309,130	230,287,992	229,695,730	219,131,503	226,500,000
Montana	288,903,820	272,555,854	298,314,804	314,750,582	294,701,252	224,263,780	244,446,447
Nevada	164,301	150,000	——	413,292	1,090,635	519,694	11,145,381
New Mexico	6,614,961	7,300,832	5,368,666	5,334,192	7,099,842	10,140,140	7,099,940
Utah	23,939,901	38,302,602	47,062,889	58,153,393	50,329,110	66,418,370	73,448,438
Other States	15,807,536	15,782,761	19,640,409	19,148,764	20,569,489	27,797,092	50,122,918
Totals	659,508,644	698,044,517	812,537,267	901,907,843	917,805,682	868,996,491	941,360,000

increases over their productions in former years. Great developments are taking place in these States. Within the next few years they will become much more prominent as copper producers.

ARIZONA.—The comparatively low price of copper last year had little influence on copper mining in Arizona. The price was barely less than the average price during the last twenty years, and, mine owners, knowing that the circumstances causing the depression in prices were but temporary, kept the mines in operation for the greater part of the year. Arizona is now producing more copper than at any previous period. The large smelters at Douglas, Globe, Jerome, Clifton, Morenci and Bisbee are in full operation. The United Verde smelter has been enlarged and mining facilities have been improved in the United Verde mine by the completion of the tunnel run to tap the ore bodies and drain the mine at the 1,000-foot level. The Calumet and Arizona mine is producing 5,000,000 pounds of copper monthly. In January, 1909, the Copper Queen smelter produced 9,500,000 pounds of copper. This is the best month's record made in Arizona. Prospecting operations are being actively pursued throughout Arizona and many new and promising mines are being developed. The present year will witness a remarkable revival in copper mining, also, in old localities which have long been dormant.

MONTANA.—The copper mines in Montana are at present giving employment to 11,000 men. In addition to the ordinary productive work, a large amount of development work is being done in most of the big mines and the smelters are being improved and enlarged. Very extensive development work is being done in the Minnie Healy and Rarus mines by the Butte Coalition Company. The average depth at which copper is being won on the Butte field is a little over 2,000 feet. The deepest shaft on ore is in the High Ore mine, which is 2,800 feet deep. Ore is being mined in the Anaconda mine at nearly the same depth. Last year the Anaconda was the largest dividend payer among the copper mines. Its dividends totalled $2,400,000 as compared with $7,800,000 in 1907. Since the company was organized in 1905, it has distributed over $41,000,000 in dividends. This is equivalent to 137 per cent on its capitalization of $30,000,000. The ore in the lower levels is diminishing in value. In ten years it has fallen from $15.93 to about $10.54 per ton and, although mining and smelting costs have been reduced, the margin of profit has fallen. It is believed, however, that the company will be able to operate profitably for several years on ore already developed, and as the workings are not very deep, future prospecting operations may open up new ground. It appears probable, however, that the

Anaconda will not be able to occupy the proud position of the greatest dividend payer among American copper mines many years longer. At the present time it costs the company a little less than 10 cents per pound to mine, smelt, and market its copper.

MICHIGAN.—The Lake Superior mines produced about 226,500,000 pounds of copper in 1908, as compared with 220,217,890 pounds in 1907, and 224,407,860 pounds in 1906. The various companies disbursed $5,074,136 in dividends, as compared with $13,469,950 in 1907, and $13,911,500 in 1906. The comparatively small sum disbursed last year was due to the low price of copper. Lake copper was quoted early in 1908 at 11¾ cents per pound, and at 14 cents in December. The average price realized by the mines was about 13 cents per pound throughout the year. The Calumet & Hecla mine continues the greatest producer and dividend payer on the field. Last year it produced 83,000,000 pounds of copper, compared with 88,000,000 pounds in 1907. The company's dividends in 1908 amounted to $2,000,000 as against $6,500,000 in 1907. Since 1880 this company's dividends amounted to $107,850,000, or a return of 4,314 per cent on its share capital of $2,500,000. The ore treated averages 2¼ per cent copper, or about 45 pounds of copper per ton of rock milled. This is of lower grade than the ore treated in former years. In order to balance the falling off in grade, the company is improving its mining and metallurgical plants with the view of reducing costs. A large re-grinding mill is being built which is expected to save about 4,000,000 pounds of copper that has hitherto been lost in the tailings. Most of the mining machinery is now driven by electricity. It costs this company a little under 8 cents per pound to produce copper at present. It is believed that this cost can be considerably reduced in the future.

In addition to the Calumet & Hecla there are eighteen mines producing copper ore in Michigan, and at the end of the present year several more will probably be mining ore. Very extensive prospecting operations are being carried on and these, it is believed, will lead to an increased production in the next few years.

ALASKA.—Extensive copper deposits have been developed in Alaska during the past few years. The Copper River deposits are, perhaps, the most promising. These cover a large tract of country around the head waters of the Copper River and extend well into the Yukon country. During the panic last year financial interests connected with the Amalgamated Copper and the recently-formed International Smelting companies secured control of many of the richest copper claims in the Copper River and other copper-bearing localities in Alaska, in addition to the local railroads and large tracts of timber and coal lands. Very extensive mining and smelting works are planned, ample capital has been provided, and a large army of men will be employed next summer in opening up a number of large copper mines. These works are so extensive that it will be several years before the new mines are fully productive. There is little doubt, however, that within the next few years the copper output in Alaska will become more valuable than the gold output.

The copper production in Alaska in 1908 amounted to 4,800,000 pounds, as compared with 7,034,763 pounds in 1907. About one-third of the present production comes from mines near Prince William Sound. The balance is mined on the Kasaan Peninsula and the Copper Mountain district of Prince of Wales Island. The ores now being worked in Alaska average about 3½ per cent copper and carry from $2 to $4 in gold and silver. The ores in the interior districts are much richer.

NEVADA.—Nevada was formerly celebrated for the richness of its silver mines; at present it is attracting attention by reason of the richness of its gold mines in the Tonopah, Goldfield and Bullfrog districts. In the next few years its great copper production will arrest attention. Copper is found in many districts in the State, and deposits of immense size are being developed in the Ely and Yerrington districts. These deposits are similar in nature. They are composed of metamorphic porphyry and garnet rocks impregnated over wide areas with copper minerals averaging between 2 and 3 per cent copper per ton. The ore developed at present in the Nevada Consolidated mine, at Ely, is estimated at over 12,000,000 tons. The Cumberland-Ely and Giroux Consolidated are not so extensively developed, but they also have immense reserves of good ore. These ores are now being successfully smelted at the Steptoe Valley Smelter near Ely.

The Yerrington copper field is situated in Lyon County, 40 miles southeast of Virginia City and the famous Comstock mines. Ores of similar composition to those found at Ely, but richer in copper contents, are being mined over a large area. The Bluestone, Wabuska, Mountain View, Nevada-Douglas, Mason Valley, Nevada-Rockland mines are being developed and promise to be large producers. The Yerrington copper ores average about 3½ per cent copper.

UTAH.—The most promising copper mines in Utah are in the Bingham district. The ore bodies consist of an altered siliceous porphyry containing small grains of copper minerals disseminated throughout the rock. The average assay value of the ore is 2 per cent copper, 0.15 of silver and 0.015 ounces gold per ton. The ore is mined by open cut with steam shovels and steam and electric tramways. There are eight large smelting works in Utah treating local copper ores and new works are in course of construction. The present smelting capacity is 9,000 tons of ore per day. Utah mines produced 73,448,438 pounds of copper in 1908, as compared with 66,418,370 pounds in 1907. The cost of production runs from 7 cents per pound at Bingham to 9 and 10 cents in other districts.

COST OF PRODUCING COPPER.

Until quite recently, copper-mining companies kept the cost of producing copper secret and even today many of the largest companies refuse to publish their production costs. There are many variable factors entering into the costs and no general figure can be given to cover production generally. As, however, the average price of copper during the past twenty-eight years was about 13 cents per pound and copper mining is a lucrative industry, it is evident that the average cost of producing copper is below 13 cents per pound. From the carefully collected figures given in Table IV. the cost will be seen to range from a little over 5 to 11½ cents per pound. Notwithstanding the great improvements that have been made in recent years in mining and metallurgical methods and the consequent reductions in costs, there is still room for further improvements, and it is possible that within a few years 5 and 6 cents per pound will not be considered at all unusual figures as copper costs.

TABLE IV. COST OF COPPER PRODUCTION.

Mine.	Situation.	Method of Mining Ore.	Cost of Copper Production in cts. per lb
Calumet & Hecla	Michigan	Shaft	8
Mohawk	"	"	11
Wolverine	"	"	7½
Tamarack	"	"	8
Baltic	"	"	9
Champion	"	"	9
Anaconda	Montana	"	10
Boston & Montana	"	"	11
Butte & Boston	"	"	10
Butte Coalition	"	"	10
Nevada Consolidated	Nevada	"	7
Cumberland Ely	"	"	7
Utah Consolidated	Utah	Open Cut	7
Boston Consolidated	"	"	7
United Verde	Arizona	Shaft	8
Tennessee	Tennessee	"	10
Rio Tinto	Spain	Open Cut	5½
Mount Lyell	Tasmania	"	7
British Columbia	British Columbia	Shaft	10
Burraga	Australia	"	8½
Great Cobar	"	"	8
Cananea	Mexico	"	8½

SUBSTITUTES FOR COPPER.

At various times when the demand for copper has been greater than the available supply and high prices ruled, attempts have been made to find substitutes for copper, but its only metallic rival today is aluminium. In Europe the price of aluminium is slightly lower than that of copper and it has been shown that for certain electrical purposes aluminium is preferable to copper. In Europe and to a less extent in the United States, aluminium is used for long-distance electric-power transmission cables. It is also employed for the windings of the field magnets of continuous-current machines, and for terminals, switches, switchboards, bus-bars, binding posts, and similar parts of electrical equipment.

The most remarkable features of the statistics of the industry are the large increases in the production of aluminium in the past few years and the reduction in the price of the metal. It is now selling at from 20 to 22 cents per pound in the United States and from 10 to 13 cents per pound in Europe. But, notwithstanding this remarkable increase in the production of aluminium, copper producers have little cause for apprehensiveness in regard to aluminium being substituted for copper. Both metals have distinct fields of usefulness, and when the price of aluminium falls still lower, as it must, the world's production of that metal will be almost totally absorbed in the manufacture of articles into which copper has never entered.

CONCLUSIONS.—The present condition of the copper-mining industries in the leading producing countries has now been rapidly surveyed. Everywhere, they were found to be in a sound and healthy condition, even in the face of the present low price of copper. The producers are nowhere pessimistic. They feel confident that the small demand for copper at present is due to causes that will soon disappear, and that with the revival in business throughout the world in the next year or two the demand for copper will again outrun the supply. They fully appreciate the fact that, after iron, copper is our most useful metal. Experience has shown that it can very profitably be produced at present prices and few producers will deny the accuracy of the statement concerning copper made by Mr. Carnegie:

"Although production is enormous and increasing apace, it fails to keep up with the demand, which more than in any other commodity is limited by price. If the current price could be reduced 35 per cent the demand would be doubled or tripled; if it could be reduced 50 per cent copper would replace iron for roofing, cornices, piping, and other constructional purposes so as to raise the demand tenfold if not more."

EFFICIENCY AS A BASIS FOR OPERATION AND WAGES.

By Harrington Emerson.

IX. WHAT THE EFFICIENCY SYSTEM MAY ACCOMPLISH.

With this article, Mr. Emerson concludes his series which began in THE ENGINEERING MAGAZINE for July, 1908. He has presented in this group of papers the fullest exposition yet made of "efficiency" ideals and practice. In the judgment of excellent authorities, he has developed more than a system; he has formulated a philosophy. Its possibilities reach farther and touch the individual more nearly than any phase of "conservation of resources" now under discussion. The indications of this evolution of efficiency ideals are clearly apparent in these concluding pages.—THE EDITORS.

WHEN we consider the astounding efficiency of Nature's operations in minute matters—in insect and bird flight, in the stored energy of the fish, in the light of the firefly, in the warmth of the mammal, in the pervasive divisibility of a perfume, in the pumping power of the sequoia—when we consider the wasted energy of the winds and waves, the lavish waste of the radiant heat of the sun and the stars—the conviction may well be forced upon us that if we could cover the whole process and cycle we would find these apparent wastes to be regenerative and recuperative processes, and that the universe will be no nearer extinction a hundred million years hence than it was a hundred million years ago. There is one thing of which Nature has an unlimited and exhaustless supply, of which it can afford to be lavishly prodigal; and this one thing is time. Because it counts not time, Nature's cycle may be wholly efficient, even as the slow oxidation of iron may evolve as much heat as the combustion of thermit; but mortals do not have unlimited time, and, in their haste, they have neglected efficiency which may perhaps still be destined to yield the basis for a higher and more universal morality than that afforded by either ancient religions or modern philosophies. Certain it is that the solution of the old problems seems easier when they are approached from this new point of view. Efficiency is not to be judged from preconceived standards of honesty, of morality; but honesty, morality, are perhaps to be reconsidered and revised by the help of the fundamentals of efficiency.

Efficiency is to be attained, not by individual striving, but solely by establishing, from all the accumulated and available wisdom of the world, staff-knowledge-standards for each act—by carrying staff standards into effect through directing line organization, through rewards for individual excellence, persuading the individual to accept staff standards, to accept line direction and control, and under this double guidance to do his own uttermost best.

If we could eliminate all the wastes due to evil, all men would be good; if we could eliminate all the wastes due to ignorance, all men would have the benefit of supreme wisdom; if we could eliminate all the wastes due to laziness and misdirected efforts, all men would be reasonably and healthfully industrious. It is not impossible that through efficiency standards, with efficiency rewards and penalties, we could in the course of a few generations crowd off the sphere the inefficient and develop the efficient, thus producing a nation of men good, wise, and industrious, thus giving to God what is His, to Caesar what is his, and to the individual what is his. The attainable standard becomes very high, the attainment itself becomes very high, and as to all activities in a nation ought to be as high as in the travelling circus, where every performer, human or animal, is a star, whether bespangled in the ring or driving tent stakes, whether hauling wagons in work clothes or in work harness. Let not the reference to the circus be considered a drop from the sublime to the ridiculous, since in efficiency there is no great or small, and those who have been solving the problems of aerial flight have learned much from analysing the flight of obnoxious gnats, of foul vultures.

Nature counts not time, but there is no eternity for the individual who, though breakfast and dinner were plentiful, is hungry again at supper time. There is not an eternity of time for the corporation which may not indefinitely default on bond interest without dissolution; but the State is perennial, and no high national efficiency can ever be attained unless the State recognizes its function in the efficiency problem and takes over perennial, secular efficiency as its share of the work. The State has not hesitated in the past, does not hesitate now, to mortgage the future for the benefit of the present, as when it piles up an enormous debt for present luxuries, forgetting that Martinique, San Francisco, Valparaiso, Messina, are suddenly overwhelmed by earthquakes and other unforeseeable catastrophies which at any moment occur and tax to the utmost the viability even of an unmortgaged community. The State has not hesitated to annihilate the present for the sake of the future, as when it drafts its citizens into army and navy and slaughters them by the hundred thousand as in the Russo-Japanese and other wars.

It may be that even as ruthless foreign invasion and barbarous conquest were the bane of antiquity, destroying the irrigation works of Nineveh, Babylon and India, so mortgage debts, not less ruthlessly although more slowly, may destroy modern communities and modern States. What would not have happened to England, weighted with her enormous Napoleonic debt, if the steam railroad, if the steamboat, had not been developed in the first half of the nineteenth century, if the stores of California and Australian gold had not, in a single decade, doubled England's trade, thus halving the relative burden of the debt?

Because the philosophy of efficiency is new, modern States have failed to recognize the chief modern justification for the existence of national government—namely, furtherance of national efficiency.

The theory of the interrelation of individual, corporate and national duties as to efficiency is as far as possible removed from the unnatural, and unworkable theories of modern socialism which work directly against efficiency, not for it, and it is equally far removed from the modern theories of State control which penalize, thwart, and interfere with efficient corporations, vaguely fearing that they are a menace to the State, as if the day, the month, the year, even the century or æon, can ever be a menace to eternity.

The function of the individual is not to drag down to the level of his own inefficiency the standards of the corporation, yet these are the avowed aims of modern socialism, of modern labor unions; the function of the corporation is not to drag down to its own competitive level the standards of the State, yet great business men have no higher ideal than to apply corporate method to the State.

The function of the corporation is not to lessen and hamper, but to promote the efficiency of the individual worker, by placing at his disposal all the resources attainable through the corporation, by directing his endeavors and by rewarding him individually, without limit, for efficiency.

The function of the State is not to substitute itself for the individual corporation on the monstrous supposition that all men are more efficient than the selected few, but to take over those secular efficiencies which are as much beyond the years of the corporation, even, as the corporation efficiencies are beyond the day needs of the individual. The function of the State is to act as staff guide and regulator to the activities of the corporate line, to use State powers for the reward of the efficient corporation, for the punishment of the inefficient corporation, even as the corporation uses a bonus based on efficiency to reward the efficient individual, uses penalties founded on efficiency records to eliminate the inefficient individual.

A certain marvelously wise corporation in New England, a corporation wiser than any other I know, laid down as its fundamental principles that it could not expect reliable and steady workers unless it guaranteed permanence of employment; that it could not expect workers above the average unless it offered them remuneration above the average; and it therefore determined its preliminary piece rates not on competitive figures, not on the extent to which it could squeeze down the worker, but on the basis of what a desirable worker ought to earn; and, finding these preliminary rates in many instances higher than those of its competitors, it reduced them, not by scaling down wage reward but by scaling up the productive capacity so that unit costs fell as effort and reward rose. Assuming that such a firm, that other great and wisely directed and managed concerns, attain the highest level of corporate efficiency—what are they to do when competitors elsewhere in the United States employ women and children at starvation wages for long hours, when necessary raw materials pay a heavy import tax, when foreign markets are hampered by discriminating tariffs; what are they to do when raw materials fluctuate in a single year perhaps as much as 100 per cent in value; when interest rates fluctuate between 4 per cent and 10 per cent; when demand for the finished product flows and ebbs like the tides in the Bay of Fundy? How would the efficiency of such a corporation not be supplemented and promoted if the national, State, and municipal governments were alive to their obligations to study and standardize conditions—if the municipalities, States, and central governments stayed out of the market when individuals and corporations were bidding it up, whether for materials or labor; if they came into the market with long matured plans for unhurried improvement, to be undertaken when individuals and corporations were in a period of lull? Why should there not be a minimum wage at which employment in national works, reclamation of arid lands, harbor dredging, canals, highways, battleships and fortifications, would be always open, thus doing away forever with the disgrace of bread lines? Why should a great nation like the United States be, at any moment, scarcely three months removed from famine? Why should the national Government not establish great central reservoirs of raw materials even as it establishes water catch basins to accumulate, in periods of glut—to supply, during periods of scarcity? Such a policy covering a dozen great staples of food, of textiles, and of mining products would finance itself and be in addition a source of revenue. Why should the Government not regulate the supply of money and rates of interest, by advancing freely and at a slowly increasing rate on finished articles of manufacture or against great constructive works of corporations, thus equalizing production?

Why should the two great locomotive-building plants of the country be forced to produce in one year 6,000 locomotives, working overtime under uneconomical conditions, employing 50,000 men, and the next year drop to a production of 2,000, throwing 40,000 men out of work?

Why should the Government and the States and the municipalities not establish standards of hours and wages based on the capacity of able-bodied men, thus eliminating the necessity for either woman or child labor in factories?

Why should a Dingley Bill increase the tariff on stockings and socks, under the mistaken idea that the industry will be transferred to the United States—a purely protective, not revenue measure—the actual effect of the increase being to stimulate efficiency in Saxony, to raise wages in Saxony, so that the price in the United States does not rise, the tariff becoming a revenue, not a protective, measure? As against silliness of this kind, why should the national Government not use the tariff and also its own contracts as rewards for American efficiency? Why should it not say to the United States Steel Corporation, to the Standard Oil Company, to other great corporations: "Show that you are paying standard wages per day for standard hours per day in your mines, in your transportation enterprises, in your plants; show that from mines or wells to finished product you are using the most efficient processes known; show that in all respects you are eliminating needless waste—and then the great power of the tariff shall be used, not only to protect, if protection is required, but to open to you and to extend foreign markets."

No Government can ever rival in efficiency and production a modern corporation; it is folly for it to try; but it can stimulate, promote, and reward efficient corporations even as these stimulate, promote, and reward efficient individuals.

Let us beware lest the exhaustion of our national resources, of our forests, of our free lands, of our coal and iron mines, leave us stranded high and dry out of the running with the older nations of the world who, as Japan is already doing, accept and apply the Gospel of Efficiency.

We have not put our trust in Kings; let us not put it in natural resources, but grasp the truth that exhaustless wealth lies in the latent and as yet undeveloped capacities of individuals, of corporations, of States.

Editorial Comment

The Panama Canal.

MR. KITTREDGE and several other distinguished members of the Senate seem greatly agitated over a comparison between estimates of the cost of the Panama Canal made some years ago by the Board of Consulting Engineers and the total sum of expenditures actually incurred to date. The Senator from South Dakota has put all the dramatic fervor at his command into a reminder to certain engineers that they "pledged their professional reputations" upon the statement that a "lock type canal" could be completed for $142,000,000. The Senator seems to forget the very great difference between could and would. An intelligent discussion of actual conditions "could" be presented before a deliberative body, but it is not likely that it "would" be by Senators who have so little grasp of the situation. In the first place we are not building a canal of the plan or dimensions contemplated in the estimate referred to. That, however, absolutely important in the matter of cost, is relatively a minor matter. The major difference is that we are not working, and under Government direction we never shall work, by methods that even approach in economy those certainly contemplated by the engineers who made the preliminary estimate. No engineer familiar with such methods has ever found it possible to apply them in the construction of the Panama Canal, and no engineer capable of carrying on work with the efficiency contemplated in the estimate, and free to choose his own employment, has ever been able to remain where he was compelled to endure the conditions of inefficiency characteristic of Government undertakings.

It has been left, we believe, absolutely with the distinguished Senators who spoke in the debate on February 10, to formulate the proposition that a sea-level canal "could" be completed at less cost than a "lock-type" canal. No one—not even the most earnest advocate of the sea-level plan—has ever before made this claim. The Board of Consulting Engineers (to which Senator Kittredge apparently refers) estimated the sea-level canal at $272,000,000, using the same unit prices in both projects, and every other commission has fixed substantially the same proportionate costs. Under no conceivable conditions could the cost of a sea-level canal be less than twice that of a lock canal. The same increase of cost for administration and inefficiency which will make the lock canal cost $375,000,000 under Government construction, would make the sea-level canal cost $600,000,000. The Senator's discovery to the contrary is unique. It is indeed gravely doubtful if it could be built at all. Competent engineers have expressed the belief that excavation could not be carried to the proposed dimensions, nor the slopes maintained, under the rainfall conditions on the Isthmus. It is in all probability true, as Mr. Taft has said, that agitation for the "sea-level plan" is tantamount to opposition to any canal at all. But if it were constructed on that plan, the tidal lock that would yet be essential would still retain the vulnerability of the "lock plan"; the Gamboa dam, fundamentally necessary to the tide-level project, would be far more dangerous than the Gatun dam involved in the present scheme; the narrow, tortuous channel which would alone be obtainable would involve greater menace to navigation than the lockage; and the risk of total obstruction or destruction by earthquake slips would be actually increased.

Nor has any one with the slightest knowledge of the subject ever assumed Senator Teller's position that the difficulty of controlling the Chagres River was a bugaboo—that "he took no stock in the Chagres." To the decision of statesmen so enlightened the plans for a great national enterprise would indeed be committed with a full heart. Fortunately Congress seems to understand the strong desirability of adhering to the present plans, and public opinion is constantly growing better informed on the question.

"Popular Science."

FROM this serious confusion in concept of a technical question, we may turn with unmixed joy to a new popular description of the oxy-acetylene blow-pipe. The enterprising press agent of an inventor has been feeding the dailies with "news" of a "torch operated by oxygen and acetylene, radiating a heat of 6,500 degrees said to be the most terrific known to science." It "will cut through any known metal." In devising it, the inventor "tried combination after combination, but with indefinite success. Acetylene, the new gas produced from calcium carbide, attracted him. The intensity of the oxygen flame he knew well. He combined the two." Nothing could make this statement more delightful.

The Cut in Steel.

THE declaration of an open market for steel suspends, if it does not end, one of the greatest attempts ever made to maintain an artificial level of prices for a fundamental commodity—a level independent of cost of production, supply and demand, or general economic conditions. We seem to be in some danger now of swinging to the worst fluctuations of wholly unregulated and uncalculating competition.

It is a long while since such a situation has been recognized in the American steel trade, and meanwhile important changes in the position and proportions of the large producing factors have taken place. The outcome of this revival of the old order amid new circumstances perhaps cannot be reduced to mathematical certainty. At best, we learn so little from observation of industrial phenomena, and forget so soon what we have learned, that most of our lessons must be gone over again every few years. The demonstration of effects during the next few months might be of much ultimate and permanent value.

It is to be feared, however, that with abnormal conditions of general business, with approaching changes of the economic balance due to tariff alteration, and, most of all, with manipulations of conditions and of apparent consequences upon a huge scale for political and market effect, the lesson will reveal nothing of substantial import. Superficially, cheap steel would seem likely to stimulate construction, industrial investment and expansion, and hence general business; but the most important inducement to expansion—cheap money—has already failed signally to induce it. It is to be feared that new ventures will be not so much encouraged by the fact that steel is cheap, as deterred by the expectation that in a little while it may be cheaper. The net result, for some time at least, is likely to be increase of the feeling of uneasiness and distrust—of the unsettlement of confidence—which is the present chief cause of continued depression.

Our Foundry Series.

MR. KNOEPPEL'S review of foundry organization and costing reaches in this issue the completion of the general discussion of the subject. The development of the actual processes of accounting and the treatment of standardization will make another group of equal extent and importance. This second phase of the matter will be taken up after a short interval, an intermission of a few months having been decided upon to relieve the present pressure upon the author's time and attention, and to avoid any risk of interference by other essential plans of the Magazine.

GOLD MINING IN THE STRAIT OF MAGELLAN.

A REVIEW OF THE GEOLOGY AND DEVELOPMENT OF THE DEPOSITS AND OF MODERN MINING METHODS AND CONDITIONS.

R. A. F. Penrose—The Journal of Geology.

EXTENSIVE alluvial gold deposits, of which little is generally known but which promise to become of considerable importance, exist on both sides of the Strait of Magellan, in Patagonia and the archipelago of Tierra del Fuego. Both these regions are owned partly by Chile and partly by the Argentine Republic. The dividing line follows the Andes southward in Patagonia to the Strait of Magellan, thence eastward for some distance along the strait, and thence southward again through Tierra del Fuego, giving most of that archipelago to Chile, but an important part on the eastern side to Argentina. During the year 1907 Mr. R. A. F. Penrose twice visited the Strait of Magellan and investigated the gold-mining industry in that region. The results of his observations are contributed to *The Journal of Geology* for November-December, 1908, from which we take the following details of the occurrence of the deposits and the condition under which they are being worked.

Topographically Patagonia consists of two main divisions, the western part comprised in the main range of the Andes, dropping off abruptly on the Pacific side, and the low, rolling pampas of the eastern part which slopes gradually to the Atlantic. The archipelago of Tierra del Fuego exhibits the same geological and topographical features. The western and southern islands are rugged and mountainous, representing the southern extension of the Andes, while the northeastern part of the main island of Tierra del Fuego is similar to the pampas of eastern Patagonia and may be considered an extension of the same geological structure. In fact, the archipelago probably owes its condition as such to a partial submergence of the southern end of South America.

"The rocks of southern Patagonia and Tierra del Fuego have not been much studied, but from the little that is known of them, it may be said that in the mountainous areas they are much like those of other parts of the southern Andes, granites, various igneous rocks, and slates being common; while in the low pampas country in eastern Patagonia and the northeast part of the main island of Tierra del Fuego, more or less soft, sandy and argillaceous strata predominate, probably belonging mostly to the Mesozoic and Cenozoic eras.

"Gold is said to have been discovered in southern Patagonia by the Chileans over forty years ago, and is supposed to have been known to the native Indians at a much earlier date, but it has been produced in quantities sufficient to attract general attention only in the last twenty to twenty-five years. The gold in the gravels of Rio de las Minas, near Punta Arenas, was one of the earliest discoveries, and a number of miners soon began to work there. Another early discovery was the gold in the beach sands near Cape Virgins, at the eastern entrance of the Strait of Magellan, which was first discovered about 1876, but not actively worked until 1884. Then considerable excitement followed and prospecting parties overran a large part of southern Patagonia and Tierra del Fuego. The search continued for several years with more or less activity, sometimes the excitement subsiding, and sometimes breaking forth again when an especially rich discovery was made.

"During this time, gold was found and actively worked in many places on both sides of the Strait of Magellan, but the principal localities were the following: the gravels in the Rio de las Minas near Punta Arenas; the beaches at Cape Virgins and from there southwestward along the shore to Point Dungeness; the gravels on several small streams to the eastward of where Porvenir now stands, across the strait from Punta Arenas; the beach at Paramo northeast of San Sebastian Bay, on the east coast of the main island of Tierra del Fuego; Navarin Island, Lennox Island, New Island, and Sloggett Bay in the extreme southern part of the archipelago near Cape Horn; New Year Island which lies north of Staten Island, at the eastern end of the archipelago; and several localities in the western islands of the archipelago. In fact, gold has been found to be very generally distributed almost all through the Magellan region, though only in certain localities has it been profitably worked. Most of the important localities yet discovered are in the archipelago of Tierra del Fuego, though a few, such as on the beaches at Cape Virgins and Point Dungeness, are in Patagonia on the north shore of the Strait of Magellan; and gold is also found in places along the southern coast of Chile, for some distance north of the Strait of Magellan.

"About the year 1904 the preparations to use steam dredges in handling the gold-bearing gravel started afresh the boom that had for a time been more or less quiescent. The old method of working the mines had been by hand, gathering the gold in pans, sluice-boxes, or other similar appliances. With the introduction of steam dredges, however, it became possible to handle the gravel much more cheaply and in much larger quantities. Since that time, though the excitement has subsided, work on the gold deposits has steadily progressed, and in a much more systematic manner than formerly. There were in 1907 some twelve or thirteen dredges in operation or being constructed, and the gold industry of the region promises soon to become a far more important business than in the days of handwork. The dredges are not used in handling the beach deposits, as the fury of the storms would soon batter them to pieces, and their use has so far been confined to the inland deposits.

"Until recently the largest gold-mining operations were at Paramo and Lennox Island, but since the introduction of the dredges, the most active operations are on the northwest part of the main island of Tierra del Fuego, just across the strait from Punta Arenas. Here the town of Porvenir is the headquarters of the industry. This town has been a small settlement for some years, but it jumped into prominence in the gold boom of 1904, and is now a prosperous mining center of about 800 people. The mines are mostly some miles, and often many miles, from Porvenir, but the town is the supply point and the port at which the boats of the miners land.

In addition to the Porvenir region, mining on a small scale, but of more or less importance, is still going on at some of the other localities already mentioned. The chief center of civilization in the whole region is the Chilean town of Punta Arenas, located on a good harbor on the Patagonian side of the Strait of Magellan. It bears much the same relation to this Antarctic gold region as does Dawson City to the gold fields of the Far North.

"The gold of the Magellan region, including the Strait of Magellan and Tierra del Fuego, is, so far as at present known, most all in alluvial, or placer, deposits. Very few gold-bearing veins have been found, though it may be said that in a region so difficult as this is to prospect, gold-bearing veins might readily be overlooked. The alluvial deposits may be divided into two classes, those in beds of creeks or on hillsides, and those on sea beaches where they are subject to the action of the sea during rising and falling tides and during storms.

"The alluvial deposits in beds of streams or on hillsides vary in gold contents from a few cents to a dollar or more per cubic yard, and sometimes, though less commonly, are considerably richer, but most of the ground that is now worked is said to range from twenty-five cents to fifty cents per yard. Under the conditions existing in the region it is difficult to make very low-grade ground pay, but some of the operators expect eventually, with steam dredges, to make a profit on very considerably lower-grade ground than they are working now. The gold-bearing gravels vary from a few feet to many feet in thickness; ten to thirty feet or more being not uncommon. An 'overburden' or capping of barren ground, of variable thickness often occurs.

"The gold on the beaches is sometimes on the immediate surface and sometimes covered by from a few inches to several feet of barren sand. On some beaches it is well up on the shore, on others it is near the water level, and on still others it is below the water level. The sandy strata carrying the gold are rarely over a few inches in thickness, but often very rich. The gold is associated with large quantities of black sand, which seems to be mostly magnetite, and numerous small garnets.

"The gold, whether from the creeks, hillsides or beaches, is said to be quite pure, though it contains often a little copper and silver. It occurs generally in rather fine particles, but sometimes small nuggets, often flat and about the size of lima beans, occur, and occasionally still larger ones are found, but no very great nuggets have yet been discovered. The rarer minerals which occur in some other gold districts, like diamond, sapphire, topaz, etc., are said not to be found in this region, though a closer study of the deposits might reveal the presence of some of them.

"As regards the origin of the gold deposits of the Magellan region, it may be said that the alluvial deposits in the creeks and on the hillsides have doubtless been derived from the erosion of gold-bearing rocks, and though such rocks have not yet been found to any great extent in the region, they nevertheless probably exist and may sometime be discovered. If the Magellan region represents the partly submerged southern end of the continent, as already mentioned in this paper, many of these deposits may have been originally formed as ordinary alluvial deposits high up in the mountains, and brought down during the sinking era to a much lower level, while some of them may have been completely submerged in the sea. The gold in the beaches probably came largely from the later erosion of the alluvium in the creek beds and on the hillsides, and perhaps partly from old submerged alluvium from which the gold was thrown up by the sea. In either case the gold has been further concentrated by being washed over and over again on the beaches. It is said that the beaches, after having been carefully worked for gold, seem again to become rich in that metal after a storm or an unusually high tide. This phenomena is probably due partly to the action of the waves and currents in concentrating the gold which the imperfect methods of the miners have left behind in the sand, and partly to the washing up of fresh gold-bearing sand from depths that are undisturbed in ordinary weather or by ordinary tides. So well recognized is this enriching of the beaches that the miners, after working all the sand that can be profitably handled, wait for the next storm or very high tide to come, and then wash the same spots over again with a good profit.

"Prospecting in the Strait of Magellan and Tierra del Fuego is a more difficult task than in most places. Most of the traveling is done in boats, as the land is much cut up by deep tidewater channels and bays, and covered with dense underbrush or immense peat bogs; while everywhere, even on the mountain sides, the soil is soft and boggy, so that walking is difficult and often impossible. Hence traveling in boats and stopping from place to place along the shore is the most practical way of prospecting; but here again another difficulty comes in, as the storms are frequent and violent. The climate, however, though stormy, is not extreme in temperature, the thermometer rarely going much below zero or much above 60 degrees. The mean winter temperature is about 33 degrees F. and the mean summer temperature is about 50 degrees F.

"Aside from the difficulties of prospecting, the industrial conditions under which gold is worked in this region are not as expensive as might at first be supposed. General supplies can be obtained at Punta Arenas at reasonable prices, for it is a seaport and supplies are brought there by ocean steamers at fairly cheap rates. The most expensive item is coal, and this is brought mostly from foreign countries. There is a small deposit of lignitic coal worked at what is known as the Loreto mine, a short distance from Punta Arenas, but the production is very limited and does not go far toward supplying the needs. There is also coal near Coronel and Lota on the Chilean coast, south of Valparaiso, but this is mostly used locally and by ocean steamers. In some parts of Tierra del Fuego there is a good deal of timber of the magnolia, beech, and other varieties, which can be used as fuel, but in other localities it is scarce. All over the region there is a great deal of peat, and efforts are now being made to use this as fuel.

"The season during which mining can profitably be carried on is about eight or nine months, from August to May, while during the rest of the year frost and snow hinder operations. The capital at present invested in the industry is mostly Chilean and Argentine, but it seems probable that, as the region becomes better known, other capital may be attracted to the gold deposits of this far-south country. No very definite statistics of the production of gold in the early days in the region are obtainable, but until recently it has been small, and probably not very many hundreds of thousands of dollars had been produced up to the time of the introduction of the steam dredges. With these, however, the production will probably be greatly increased."

THE FUTURE OF THE AMERICAN PORTLAND CEMENT INDUSTRY.

A DISCUSSION OF POSSIBLE REDUCTIONS IN OPERATING COSTS, FUTURE PRICE MOVEMENTS AND METHODS OF PRICE REGULATION.

Edwin C. Eckel—Association of American Portland Cement Manufacturers.

THE history of the American Portland cement industry up to 1907 was one of uninterrupted progress, so far as annual output was concerned. Up to that time cement production was a young and growing industry which had not yet reached the point where annual output is affected by financial conditions. Certain phenomena connected with the course of the industry in 1906, however, though apparently unperceived by the manufacturers, gave indication of an impending change in conditions. In the January, 1907, number of THE ENGINEERING MAGAZINE, Mr. Edwin C. Eckel wrote as follows: "The cement output, as yet, has not suffered markedly from financial depression. Prices have fallen off in poor years, it is true, but the annual output has always increased. The rise in yearly output from 1885 to 1906 has not only been continuous, but has even shown a tendency to increase its rates of growth. Of course such a condition of the industry cannot be expected to continue indefinitely. Within a few years we must expect to see the rate of increase lowered and finally, in some period of business depression, some year will show a lower output than the preceding year. This will mark the end of the youth of the cement industry, and the beginning of its period of maturity. Though the present condition of the industry is as prosperous as might be desired, it is possible that the change in rate of growth may be quite near at hand. New construction in 1906, and plans for 1907, will provide a great increase in mill capacity. If the succeeding years are generally good, this increase will be taken up without difficulty; but a general financial depression in 1908 would probably result in a temporary check to the cement industry. So far as can be estimated now, the plants which will be in operation before the end of 1907 will turn out cement at the rate of 50,000,000 barrels per annum, and it is doubtful whether such an output could be absorbed if the United States were not generally prosperous." Mr. Eckel's prophecy was ridiculed by a number of cement trade papers, but, as he took occasion to remind the members of the Association of American Portland Cement Manufacturers in a recent paper before that body, it has been amply fulfilled by the progress of events during the last two years. Henceforth the American Portland cement industry will stand on an altered economic basis. An outline of the future problems and possibilities of the industry is given in the following abstract of Mr. Eckel's paper, which was published in *The Engineering Record* for January 9, 1909.

"It seems fairly safe to say that the American cement industry reached a distinct turning point in the latter part of 1907. and that from now on the matter of output must be handled differently. Hereafter we may expect that the cement production will be related very closely to general business conditions; that in times of prosperity we may temporarily fall behind in capacity; but that the approach of business depression will be marked either by radical decrease in cement output or by its alternative, which is general demoralization in the trade. The cement industry has no longer room for poorly managed plants or for weakly financed companies, for in times of industrial stress such plants and companies become a menace to the entire industry."

The costs of Portland cement manufacture are, of course, much lower than in the early days of the industry. Part of the decrease is attributable to the gain in efficiency apparent in any well-conducted industry as machines and men gradually become more fitted to their work. But the bulk of the reduction in manufacturing costs can not be accounted for in this way. The great decreases came in three abrupt steps, coincident with three radical changes in the methods of manufacture, the introduction of the rotary kiln, the adoption of powdered coal as the standard fuel in the rotary, and the introduction of the long kiln.

"So long as there are absolutely no revolutionary changes in our present methods of cement manufacture, no marked decreases in operating costs can be expected. Improvements in grinding machinery can offer little in the way of cost reduction so long as the total amount of grinding to be done remains the same. The main elements in the problem are unfortunately fairly well determined by nature. To make 400 pounds of cement we must burn about 200 pounds of coal, and pulverize almost 1,100 pounds of material, raw mix, clinker and kiln coal. As coal can hardly be expected to decrease in price in the future, and as the other elements of cost are practically unchangeable, there is little room left for further economies. It seems safe to say that the manufacturing costs at well-conducted plants reached in 1904, 1905 and 1908 low levels which can hardly be lowered in the near future.

"The Portland cement industry is now characterized by moderate and decreasing returns to the investor. This condition is caused by the fact that, while free competition is slowly but steadily pushing downward the selling prices of the product, manufacturing costs on the other hand are almost stationary." Prices, if left to absolutely unrestricted competition, will tend to fall to a point which yields a fair profit only to the largest and best mills. Some reasonable degree of price regulation, exercising control in both directions similar to that which now protects the steel trade against wild fluctuations of prices, would seem, therefore, to be a necessity. The simplest system of price regulation is, of course, the pool. Pooling agreements, however, have no legal status; and, while a number of pools have been formed in the Portland cement industry, none of them has had any great length of life. In fact, no form of pool in any industry can be considered durable.

"Since all of our financial history has established the ineffectiveness of any possible form of simple pooling to maintain prices of any commodity at reasonably profitable levels, it is clear that some other type of price regulation must be expected to appear in the cement industry. At present it is difficult to say just what form the final regulating process will take, for the Portland cement industry of this country affords a peculiarly interesting example of an important and growing branch of manufacture whose future organization and control are still matters of uncertainty. During the past few years, however, two distinct movements have become noticeable, and one or both of these may aid in the solution of the problem. The first, which is the normal occurrence in any industry containing a large number of independent competitive units, is the gradual growth of community of interest, which by increasing the size of some of the units, or by decreasing their number, aids in giving stability to the market. The second important movement is toward a control of the trade through the ownership of patents. This form of regulation, though not entirely new in American industrial history, is still much rarer than the other type.

"Ten or even five years ago the business of making Portland cement in the United States was confined to a number of comparatively small mills, each of which was practically independent. Today there is a noticeable degree of concentration of interest in the industry, and three processes are to work to increase steadily this concentration. Owing to the peculiar character of the industry, the final result is still a matter of much doubt. It is clearly impossible for any one organization to gain control of the supply of raw materials, so that in this industry the most effective basis for monopoly is not available. The ownership of comprehensive basic patents would afford a peculiarly serviceable type of control, inasmuch as patent monopolies are thoroughly legal in form.

"Setting aside for the moment the possibility of monopoly, it can be said that the three factors which make for concentration of control are: 1. The normal growth of profitable plants. 2. Consolidation by stock control. 3. The growth of the patent-holding company.

"A well-located and well-managed plant always has opportunity for expansion which is denied to plants of less technical or financial soundness. Many plants in this country have had opportunity for growth, and some have seized these opportunities. Plants which are built or extended at the height of a boom period, and companies which pay out all the profits of prosperous years as dividends can hardly expect to share in this growth. For in by far the majority ot instances, lack of growth in a cement plant has been due, not to defective raw materials or to lack of technical skill, but to unwise financial management, either at the inception or during the active life of the company.

"As to the second factor mentioned, several strong groups of plants connected by stock control rather than by direct ownership are now in existence, and a number of smaller examples of 'community of interest' are known.

"The Portland cement industry, in its present form, is a comparatively recent development and owes much of its mechanical perfection to the efforts of American inventors. As a result of its recent origin, cement machinery and cement-making processes have been the subjects of innumerable patents, while older industries are more nearly free from comprehensive claims. While many mechanical details are of course covered by minor patents, those claims which are likely to have any serious effect on the future of the industry may for convenience be grouped as follows:

1. Patents relating to specialized types of grinding machinery. Patents of this type are numerous and many are sound and valuable. Their only effect, however, is slightly to increase the cost of such machinery; and as the best representatives of the various classes of grinders are fairly well matched in efficiency, the net result is small.

2. Patents relating to the burning process. This group includes many and important claims covering kiln details, fuel burning methods, etc. Some of these patents have, as noted below, exercised an important influence on the industry and may become of still greater importance.

3. Patents on special products. Many patents have been issued covering cements differing more or less from the normal Portland type. Typical cases, for example, are the high-iron marine cements, the low-iron white cements, the high-magnesia cements, etc. Though valuable for certain uses, few of these special cements can be expected to exercise any appreciable influence on the general Portland cement industry. Their unimportance in this respect is largely due to the fact that most of them are more expensive to manufacture than an ordinary Portland. If it should develop, however, that some one of these special products could be made more cheaply than a normal Portland, the case would be very different.

4. Patents covering by-products. Claims for the recovery of valuable by-products, notably sulphur and the alkalis, are numerous; but so far none of these processes has proved to be of much practical importance.

"Regardless of what may be effected along the line of price regulation, it is probable that marketing conditions will, in the near future, be improved in some respects. Among the points to which attention may be directed in this field are the elimination of the 'optional contract,' the development of a warrant system, and the establishment of fixed basing points for quotations. The first of these appears to be a necessity, while the other two are at least open to discussion as to their worth in the cement trade.

"Since its commencement in this country the Portland cement industry has suffered, in common with all other lines of manufacture dealing with basic staples under a highly competitive regime, from a lax regard for contract obligations by purchasers. A buyer, placing a future order for cement or iron, felt apparently no obligation to take the product if the market price fell in the meanwhile. A contract was treated precisely as if it had been a free option, to be called only if prices advanced. It is fair assumption that the first result of increasing concentration of control in the cement industry will be to eliminate this abuse, as has been done in other lines.

"Ten years ago, when the American market was capable of absorbing all of the domestic cement output, even during times of general business depression, the export trade received scant attention, and deserved little. To-day, when depression means complete shutdown to many cement mills, the situation is very different, and a marked effort to develop foreign trade may be expected.

"The countries to the south of the United States are, in general, scantily supplied with fuel, and few of the existing Spanish-American coal fields are well located, with regard to transportation routes and markets. For this reason alone, these areas offer a very favorable field for cement exports from the United States, and as their development progresses this field may be expected to expand rather than to contract.

"While a competitive export trade is not of itself as profitable as a home market, it affords a valuable balance-wheel to domestic trade conditions. Under modern conditions there is always surplus capacity in the manufacture of staples. With depression at home, the surplus becomes disastrous, unless there is some way of disposing of it elsewhere."

THE COST OF CONCRETE CONSTRUCTION.

UNIT COSTS OF FORMS, REINFORCEMENT AND CONCRETE WORK IN TYPICAL STRUCTURES.

Leonard C. Wason—National Association of Cement Users.

THE valuable tables of unit costs of concrete construction in typical structures given below are taken from a paper read by Mr. Leonard C. Wason, President of the Aberthaw Construction Company, at the recent convention of the National Association of Cement Users and published in *The Engineering Record* for January 16. In making public data of the sort usually most carefully guarded Mr. Wason does not wish to be considered as acting from purely philanthropic motives. He sees in the ignorance of inexperienced builders who are entering in large numbers the field of concrete construction a danger of serious injury to the industry. The novice as a rule underestimates the cost of doing good work and his bids are unreasonably low. If he is honest and fulfils his contracts even at a loss to himself, the industry suffers through the demoralization of the true value of good workmanship; if he does poor work through the fear of losing money, the injury to the reputation of reinforced concrete as a structural material may have a very far-reaching effect. Mr. Wason's primary object in publishing accurate cost data is to reduce the pres-

COST OF CONCRETE COLUMNS.

	Forms per square foot				Concrete per cubic foot						
Location.	Carpenter labor.	Lumber.	Nails & Wire.	Total.	Concrete labor.	General labor.	Cement.	Aggregate.	Team & miscell.	Plant.	Total.
Office bldg., Portland, Me...	.138	.089	.001	.173	.064	.004	.087	.084	.012	.022	.273
Coal pocket, Lawrence, Mass.	.057	.024	.001	.082	.166	.003	.073	.041	.008	.016	.307
Mill, Southbridge, Mass.....	.097	.082	.002	.181	.078	.056	.107	.085	.027	.030	.328
Mill, Attleboro, Mass.......	.093	.022	.001	.116	.110	.014	.062	.088	.018	.084	.271
Mill, Southbridge, Mass.....	.080	.056	.001	.137	.108	.048	.100	.087	.013	.034	.340
Coal pocket, Hartford, Conn.	.098	.047	.002	.147	.089	.048	.069	.055	.017	.013	.286
Garage, Brookline, Mass.....	.071	.051	.002	.124	.070	.028	.072	.058	.041	.020	.289
Warehouse, Portland, Me...	.118	.016	.001	.135	.087	.027	.087	.070	.089	.025	.335
Textile mill, Lawrence, Mass.	.061	.013	.001	.075	.095	.019	.109	.027	.018	.015	.283
Highest	.133	.082	.002	.181	.166	.056	.109	.084	.041	.084	.340
Lowest	.057	.013	.001	.075	.064	.003	.062	.027	.008	.013	.271
Average of 9..............	.082	.036	.001	.130	.096	.027	.085	.049	.021	.023	.301

COST OF BEAM FLOORS OF REINFORCED CONCRETE.

	Forms per square foot				Concrete per cubic foot						
Location.	Carpenter labor.	Lumber.	Nails & Wire.	Total.	Concrete labor.	General labor.	Cement.	Aggregate.	Team & miscell.	Plant.	Total.
Power house, Greenfield.....	.165	.107	.003	.275	.143	.020	.109	.101	.008	.016	.397
Tar well, Springfield.........	.064	.041	.002	.107	.076	.005	.026	.075	.013	.040	.335
Mills, Greenfield, Mass......	.106	.061	.004	.171	.077	.011	.109	.086	.007	.055	.345
Car barn, Danbury, Conn....	.044	.051	.001	.096	.128	.018	.036	.071	.011	.010	.319
Coal pocket, Lawrence, Mass.	.072	.039	.002	.113	.056	.004	.078	.041	.009	.019	.202
Mill, Southbridge, Mass.....	.067	.062	.002	.131	.137	.029	.191	.051	.038	.014	.460
Mill, Attleboro, Mass.......	.062	.032	.002	.096	.071	.028	.098	.062	.021	.055	.320
Bridge, Plymouth, Mass.....	.047	.050	.001	.098	.078	.019	.100	.040	.027	.010	.274
Garage, Newton, Mass......	.104	.033	.002	.134	.116	.020	.121	.084	.038	.010	.394
Mill, Southbridge, Mass.....	.057	.051	.001	.109	.119	.027	.132	.037	.013	.034	.362
Coal pocket, Hartford, Conn.	.060	.033	.001	.094	.047	.023	.081	.055	.017	.013	.236
Garage, Brookline, Mass.....	.105	.038	.002	.145	.160	.032	.088	.058	.041	.020	.399
Filter, Lawrence, Mass......	.048	.032	.001	.081	.102	.016	.085	.054	.012	.032	.301
Storehouse, Chelsea, Mass...	.064	.043	.002	.109	.153	.035	.115	.068	.052	.020	.443
Warehouse, Portland, Me...	.037	.029	.001	.067	.186	.030	.096	.069	.043	.046	.470
Textile mill, Lawrence, Mass.	.045	.042	.001	.088	.130	.013	.071	.037	.025	.010	.286
Textile mill, Lawrence, Mass.	.053	.033	.001	.087	.116	.033	.194	.049	.035	.015	.442
Chapel, Portland, Me.........	.053	.027	.003	.082	.100	.008	.127	.091	.041	.010	.377
Highest	.165	.107	.004	.275	.186	.035	.194	.101	.052	.055	.470
Lowest	.037	.027	.001	.067	.047	.004	.071	.037	.007	.010	.202
Average of 18............	.070	.045	.002	.116	.111	.020	.106	.063	.025	.024	.354

COST OF FLAT SLAB FLOORS.

	Forms per square foot				Concrete per cubic foot						
Location.	Carpenter labor.	Lumber.	Nails & Wire.	Total.	Concrete labor.	General labor.	Cement.	Aggregate.	Team & miscell.	Plant.	Total.
Office bldg., Portland, Me...	.078	.039	.001	.118	.043	.004	.087	.084	.012	.022	.252
Fire station, Weston, Mass..	.067	.038	.003	.108	.103	.007	.092	.053	.026	.039	.320
Church, Boston, Mass.......	.067	.037	.002	.106	.146	.017	.109	.072	.020	.010	.374
Highest	.078	.039	.003	.118	.146	.017	.109	.084	.026	.039	.374
Lowest	.067	.037	.001	.106	.043	.004	.087	.053	.012	.010	.252
Average	.071	.038	.002	.111	.097	.009	.096	.070	.019	.024	.315

Cost of Concrete Slabs between Steel Beams.

Location.	Forms per square foot: Carpenter labor.	Lumber.	Nails & Wire.	Total.	Concrete per cubic foot: Concrete labor.	General labor.	Cement.	Aggregate.	Team & miscell.	Plant.	Total.
Bleachery, East Hampton....	.054	.027	.002	.083	.092	.007	.137	.073	.012	.046	.367
Machine shop, Milton, Mass.	.087	.027	.003	.117	.090	.033	.114	.075	.016	.034	.362
Foundry, No. Britain, Conn.	.078	.046	.002	.126	.095	.021	.076	.078	.004	.022	.296
Stable, Boston, Mass.........	.064	.012	.001	.077	.101	.019	.129	.070	.020	.015	.354
Residence, Milton, Mass......	.110	.071	.003	.184	.105	.048	.132	.080	.053	.010	.428
Power house, Pittsfield, Mass.	.029	.030	.001	.060	.131	.008	.123	.068	.013	.010	.353
Laundry, Boston, Mass.......	.058	.024	.001	.083	.092	.021	.098	.089	.022	.010	.332
Prison, Portsmouth, N. H....	.068	.017	.001	.086	.073	.005	.208	.075	.006	.010	.377
Paper mill, Mittineague......	.097	.071	.002	.170	.144	.033	.143	.062	.027	.010	.419
Power house, Quincy, Mass.	.047	.025	.001	.073	.073	.021	.159	.085	.064	.020	.422
School, Waltham, Mass.......	.029	.028	.001	.058	.133	.009	.102	.078	.018	.015	.360
Foundry, Providence, R. I....	.028	.020	.001	.049	.084	.012	.114	.026	.026	.010	.272
Foundry, Providence, R. I....	.043	.021	.001	.065	.111	.010	.128	.029	.029	.010	.317
Highest	.110	.071	.003	.184	.144	.048	.208	.080	.064	.046	.428
Lowest	.028	.012	.001	.049	.073	.005	.076	.026	.004	.010	.272
Average	.061	.032	.002	.095	.102	.019	.128	.068	.024	.017	.359

Cost of Building Walls above Grade.

Location.	Forms per square foot: Carpenter labor.	Lumber.	Nails & Wire.	Total.	Concrete per cubic foot: Concrete labor.	General labor.	Cement.	Aggregate.	Team & miscell.	Plant.	Total.
Fire station, Weston, Mass..	.116	.038	.004	.158	.100	.007	.069	.053	.026	.039	.294
Mill, Greenfield, Mass.......	.062	.038	.002	.102	.060	.011	.084	.086	.007	.055	.303
Water works, Waltham, Mass.	.137	.024	.001	.162	.146	.007	.058	.057	.014	.047	.329
Coal pocket, Lawrence, Mass.	.118	.056	.002	.176	.042	.004	.073	.043	.009	.019	.190
Mill, Attleboro, Mass........	.103	.024	.001	.128	.129	.018	.074	.048	.017	.043	.329
Coal pocket, Hartford, Conn.	.096	.047	.002	.145	.118	.052	.097	.055	.017	.013	.350
Filter, Lawrence, Mass......	.046	.032	.001	.079	.046	.017	.083	.054	.012	.032	.244
Ital'n garden, Weston, Mass.	.101	.073	.002	.176	.102	.008	.105	.081	.019	.010	.325
Stable, Beverly, Mass........	.099	.030	.002	.131	.078	.019	.071	.062	.018	.010	.258
Residence, N. Andover, Mass.	.078	.016	.001	.095	.096	.014	.046	.050	.008	.010	.174
Observatory, Milton, Mass...	.056	.038	.002	.096	.095	.012	.060	.187	.058	.005	.417
Office, Boston, Mass.........	.105	.030	.002	.137	.096	.033	.066	.114	.066	.005	.380
Tunnel, Boston, Mass........	.112	.045	.005	.162	.126	.016	.066	.106	.077	.005	.380
Hospital, Waltham, Mass,....	.058	.028	.001	.087	.089	.017	.034	.063	.023	.010	.236
Residence, Boston, Mass....	.108	.036	.001	.145	.110	.015	.077	.069	.026	.005	.446
Coal pocket, Providence, R. I.	.087	.020	.001	.108	.052	.005	.102	.090	.015	.010	.274
Italian garden, Brookline....	.064	.027	.001	.092	.048	.011	.080	.071	.019	.010	.239
Highest	.136	.073	.005	.176	.146	.052	.105	.187	.077	.055	.446
Lowest	.046	.016	.001	.079	.042	.004	.034	.043	.007	.005	.174
Average of 17............	.085	.036	.002	.128	.090	.016	.073	.076	.025	.019	.301

Cost of Foundation Walls.

Location.	Forms per square foot: Carpenter labor.	Lumber.	Nails & Wire.	Total.	Concrete per cubic foot: Concrete labor.	General labor.	Cement.	Aggregate.	Team & miscell.	Plant.	Total.
Filter, Warren, R. I.........	.103	.048	.004	.155	.062	.037	.086	.068	.012	.031	.296
Tar well, Springfield.........	.071	.031	.002	.104	.040	.015	.094	.075	.013	.040	.277
Tunnel, New Bedford.......	.048	.045	.001	.094	.213	.019	.203	.092	.057	.015	.599
Filter, Exeter, N. H.........	.124	.067	.002	.193	.064	.021	.071	.116	.034	.019	.325
Filter, Lawrence, Mass......	.058	.042	.001	.101	.046	.017	.083	.054	.012	.032	.244
Theater, Portland, Me.......	.081	.024	.003	.108	.112	.013	.078	.078	.003	.020	.303
Warehouse, Portland, Me...	.053	.009	.001	.063	.040	.019	.060	.070	.029	.017	.235
Residence, No. Andover.....	.047	.019	.001	.067	.108	.006	.082	.045	.015	.010	.266
Filter, Lawrence, Mass.......	.048	.035	.002	.085	.055	.006	.039	.027	.011	.010	.148
Residence, No. Andover......	.065	.019	.001	.085	.087	.012	.072	.045	.013	.010	.239
R't'g wall, Naugatuck, Conn.	.134	.047	.001	.182	.097	.013	.056	.032	.022	.010	.235
Hospital, Waltham, Mass....	.048	.028	.001	.077	.043	.019	.038	.063	.026	.010	.199
Greenhouse, Brookline, Mass.	.032	.035	.001	.068	.051	.007	.078	.043	.013	.010	.202
Hotel, Brookline, Mass......	.037	.018	.001	.056	.043	.002	.080	.054	.010	.010	.199
Highest	.134	.048	.004	.193	.213	.037	.203	.116	.057	.040	.599
Lowest	.032	.009	.001	.056	.040	.002	.038	.027	.003	.010	.148
Average	.068	.035	.002	.103	.076	.015	.080	.062	.019	.017	.269

Cost of Footing and Mass Foundations.

Location.	Forms per square foot: Carpenter labor.	Lumber.	Nails & Wire.	Total.	Concrete per cubic foot: Concrete labor.	General labor.	Cement.	Aggregate.	Team & miscell.	Plant.	Total.
Power house, Greenfield......	.119	.077	.002	.198	.065	.020	.098	.092	.008	.016	.299
Eng. foundation, Taunton....	.054	.025	.001	.080	.045	.002	.065	.048	.004	.017	.181
Head gates, Shawmut, Me...	.071	.043	.003	.117	.033	.001	.074	.099	.003	.014	.224
Canal, Lowell, Mass.........	.039	.025	.001	.065	.025	.011	.080	.078	.004	.042	.240
Foundation, Provincetown ..	.069	.043	.002	.114	.039	.004	.073	.099	.011	.049	.275
Dam, Merrimack, N. H......	.066	.037	.003	.106	.081	.008	.090	.055	.008	.031	.273
Foundation, Boston, Mass....	.011	.006	.001	.018	.035	.004	.061	.072	.006	.010	.188
Eng. foundation, Boston.....	.095	.039	.003	.137	.037	.013	.061	.084	.013	.015	.223
Gas holder, Springfield......	.034	.031	.002	.067	.043	.001	.061	.068	.005	.010	.188
Foundation, Providence, R. I.	.016	.011	.001	.028	.051	.002	.047	.076	.010	.010	.196
Highest	.119	.077	.003	.198	.081	.020	.098	.099	.013	.049	.275
Lowest	.010	.006	.001	.018	.025	.001	.047	.043	.003	.010	.181
Average of 10............	.057	.034	.002	.093	.045	.007	.071	.077	.007	.021	.229

COST OF FABRICATING AND PLACING REINFORCING STEEL.

Location.	Weight.	Cost of handling.	Cost per ton.
Office building Portland, Me	324½ tons	$5,115.32	$15.76
Fire station, Weston, Mass	8½ "	40.26	4.74
Mill, Chelsea, Mass	65¼ "	548.81	8.41
Coal bins, Dalton, Mass	8½ "	61.75	7.26
Dam, Auburn, Me	55 "	506.76	9.18
Filter, Warren, R. I	19 "	102.59	5.40
Tank, Lincoln, Me	8½ "	69.38	8.16
Tar well, Springfield	15½ "	59.21	3.82
Monument, Provincetown	24½ "	136.84	5.58
Mill, Greenfield	92¾ "	1,232.01	10.20
Machine shop, Milton, Mass	20¼ "	177.16	8.75
Coal pocket, Lawrence, Mass	28 "	461.16	16.47
Mill, Southbridge	53½ "	142.76	2.67
Mill, South Windham, Me	293 "	3,079.60	10.51
Mill, Attleboro, Mass	49½ "	286.02	5.78
Garage, Newton, Mass	20 "	86.55	4.33
Mill, Southbridge, Mass	30 "	100.08	3.34
Coal pocket, Hartford, Conn	195 "	2,316.60	11.88
Filter, Lawrence, Mass	44½ "	112.84	2.54
Warehouse, Portland, Me	62 "	462.99	7.47
Standpipe, Attleboro, Mass	199½ "	1,547.00	7.75
Highest			$16.47
Lowest			2.54
Average of 21			8.52

ent wild bidding and to do away with unintelligent competition. He admits that he does it the less reluctantly since the older firms in the field have little to fear from the beginner.

In addition to the tables which we reproduce and the discussion incidental to them, Mr. Wason's paper contains a great deal of valuable data on the methods adopted by his company for cost keeping on concrete construction work. He explains in detail the classification adopted in time keeping on various parts of the work, the methods of making reports of various kinds and the means by which actual costs are compared, during the progress of the work, with estimated costs.

A RAILWAY TO INDIA.

A PLAN FOR A RAILWAY FROM EGYPT TO INDIA TRAVERSING ARABIA AND PERSIA.

C. E. D. Black—The Nineteenth Century.

A PLAN for a railway to connect Egypt and India, traversing Northern Arabia and Southern Persia, is proposed by Mr. C. E. D. Black in *The Nineteenth Century* for January. Mr. Black believes that such a line is a necessity from a political point of view, but he points out that it will not necessarily be a commercial failure. His long experience in the Geographical Department of the India Office has given him exceptional opportunities to study the possibilities of such a railway and some of his comments are interesting.

The western section of the line would start from Port Said or Ismailia, connecting at one of these points with the Egyptian railway system. Thence it would traverse Arabia Petræa in a southeasterly direction to the head of the Gulf of Akabah, and then ascend the Wady el Ithm, one of the lateral gorges leading up to the plateau of northern Arabia. Across the neck of the Arabian peninsula the line would run due east for 800 miles to Barsa, whence a short branch would diverge to Koweit, near the head of the Persian Gulf. At Barsa the railway would cross the Shat-el-Arab and the Karun River farther on. Circling round the head of the Persian Gulf the line would be extended to the Indian frontier by either of two routes, through Shiraz, or more southerly, through Baluchistan as far as Karachi, where it would connect with the Indian railways. The total length of the projected line would be 2200 miles. It could easily be traversed in 66 hours, a saving of 7 days over the sea route from Port Said to Bombay.

The route would traverse a quasi-tropical and, here and there, unproductive country, but it would tap several large and very important oases in northern Arabia from which it would draw considerable traffic. It would also serve as an outlet for the produce of Mesopotamia where irrigation is to be employed on a grand scale. The need of better traffic facilities in Persia has been proclaimed for many years. The trade between the coast and the interior is carried on under almost impossible conditions and the opening of an Indo-Egyptian railway would give an immense impetus to both Persian and Indian commerce in the British sphere of influence.

The passenger traffic would be of much importance. A never-failing stream of officials, military men and merchants continually travels between Great Britain and India and the Far East. To these a saving of a week in time would appeal very strongly. The tourist traffic is attaining considerable dimensions, and a large amount of revenue would be obtained from the pilgrimages of the 60,000,000 Mahometans in India to the holy places of Arabia.

A careful estimate of the cost of the line puts the average cost per mile at £6,000. The experience gained on the Hejaz Railway between Damascus and Medina shows that this estimate is not too low. The total cost would be £13,200,000, or with £3,000,000 added for rolling stock, £16,000,000, an amount considerably less than the cost of the Suez Canal.

In Mr. Black's opinion steps should be taken to obtain a concession without delay. The present relations between Great Britain and the ruling party in Turkey encourage the hope that her good-will would be freely forthcoming and the present circumstances are, he thinks, extraordinarily favorable for the detailed examination of the project as a national undertaking.

THE WEIGHT AND COST OF ELECTRIC GENERATORS.

COMPARATIVE DATA ON THE INFLUENCE OF RATED SPEED AND RATED OUTPUT ON THE WEIGHT AND COST OF ALTERNATING- AND CONTINUOUS-CURRENT DYNAMOS.

A. G. Ellis—Electrical Engineering.

A SERIES of investigations has been made by Mr. A. G. Ellis to obtain more precise information as to the relative weights and costs of alternating- and continuous-current generators, and also as to the influence on these quantities of two of the most important factors in dynamo design, namely, the rated speed and the rated output. A large number of designs have been worked out especially to obtain these data and the results of the investigations, which are contributed by Mr. Ellis to *Electrical Engineering* for December 31, 1908, give probably the most accurate information yet published on the points in question. We reproduce Mr. Ellis' graphical representation of the results and a part of his comment upon them.

The curves are, in the main, self-explanatory. It may be noted that the expression "Total Works Cost" designates the total manufacturing cost of the machine as delivered to the stores, including material and labor costs and establishment charges; the expression "Total Weight" designates the total net weight of the machine as completed, including the shaft and outboard bearing.

Figures 1 to 4 give the data on which the deductions are based. The same range of rated speeds has been taken for both A. C. and C. C. machines. In the case of A. C. generators the rated outputs range from 375 to 6,000 kilowatts, while C. C. dynamos are considered only up to capacities of 1,000 kilowatts. Above this rating, Mr. Ellis says, C. C. dynamos are relatively very unsatisfactory except at pressures of over 1,000 volts. Above 1,500 kilowatts they are impracticable at high speeds. Polyphase alternators, on the other hand, are quite satisfactory and practicable at high speeds in units of 6,000 kilowatts and even much higher.

In these investigations variations in neither the rated voltage in both types of generators nor the frequency in A. C. machines have been taken into account. Both of these factors, as Mr. Ellis shows, usually influence the design problems and the weight and cost to a considerable extent. In the interests of simplicity, however, the comparisons have been limited to the two principal factors of rated output and speed, representative voltage and frequency being employed for each class of machines. The curves may therefore be taken as fairly representative for machines of normal voltages and periodicities, but in using them it must be borne in mind that although quantitative values of weight and cost are given they cannot have any wide application. Mr. Ellis has attempted to make them as representative as possible but the primary purpose of his investigations was to contrast relative values.

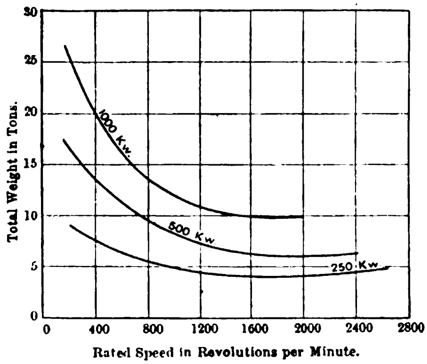


Fig. 1.

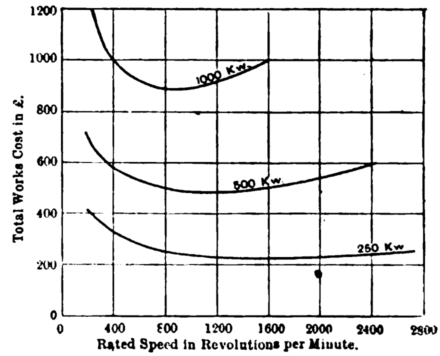


Fig. 2.

FIGS. 1 AND 2. CURVES FOR TOTAL WEIGHT AND TOTAL WORKS COST OF CONTINUOUS-CURRENT GENERATORS.

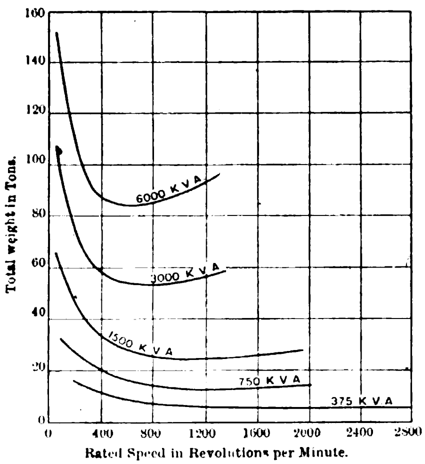


Fig. 3.

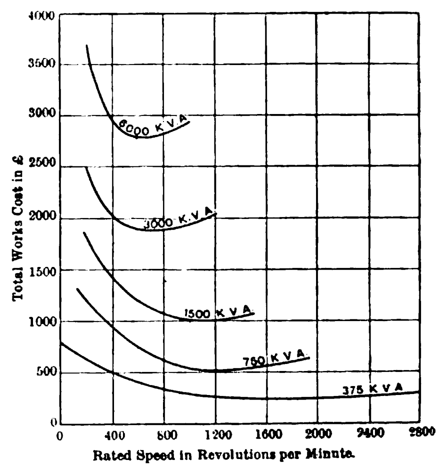


Fig. 4.

FIGS. 3 AND 4. CURVES FOR TOTAL WEIGHT AND TOTAL WORKS COST OF ALTERNATING-CURRENT POLYPHASE GENERATORS.

The simplicity of the basis of comparison has enabled Mr. Ellis to arrive at several broad conclusions which would have remained obscure had it been attempted to take into account too many variables. These he summarizes as follows: "It will be seen from the curves in Figures 1 to 4 that there is a comparatively large range of speed for each rated output, for which the total works cost has practically a uniform value for A. C. as also for C. C. generators. There is, in fact, a certain rated speed for each rated output, for which the cost has a minimum value. Not only for lower, but also for higher speeds, the cost increases. At low and medium speeds, the weight and cost show a continued decrease with increasing speeds. This is, however, less marked the higher the speed, and is by no means in proportion to the speed.

speeds are, as will appear later, higher for A. C. generators than for C. C. generators of the same rated output. High speeds are distinctly more suitable for A. C. generators than for C. C. generators, from the standpoint of manufacturing cost, and this is also most decidedly the case from the operating standpoint.

"These points of minimum weight and cost will be observed for each rated output in the sets of curves in Figures 1 and

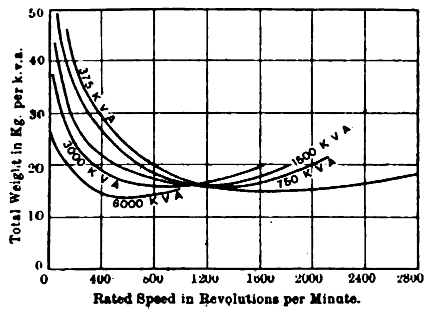


Fig. 5.—Alternating-current Generators.

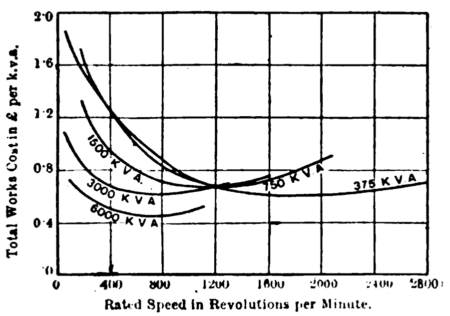


Fig. 6.—Alternating-current Generators.

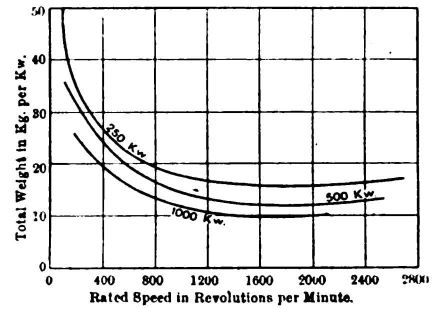


Fig. 7.—Continuous-current Generators.

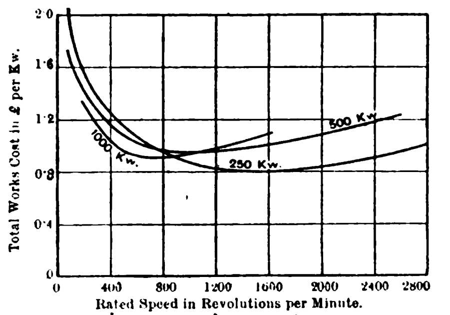


Fig. 8.—Continuous-current Generators.

FIGS. 5 TO 8. CURVES FOR WEIGHT PER KILOWATT AND COST PER KILOWATT FOR ALTERNATING-CURRENT AND CONTINUOUS-CURRENT GENERATORS.

"The speeds shown by the curves in Figures 1 and 2 to be the most economical as far as relates to manufacturing cost, are not the most favourable with regard to performance, their inferiority relating chiefly to commutation. Lower speeds than these, are distinctly to be preferred for continuous-current machines. A similar condition of affairs for A. C. generators is revealed by the curves in Figures 3 and 4. There is, for each rated output, a certain speed at which the weight and cost reach minimum values. These most economical

2, as also in those of Figures 3 and 4. It will also be noted that the most economical speed is greater the smaller the rated output. Here again, as in C. C. machines, there is a considerable range of speeds over which the weight and cost do not vary to any considerable extent. Even at the lowest speeds, where the effect of the speed is most marked, the variation of weight and cost is by no means in proportion to the change in speed. Thus, for example, a 1,500 kilovolt-amperes A. C. generator at a rated speed of 200 revolutions per minute weighs some 45 tons; at 400 revolutions per minute, which is double this speed, the weight is only reduced to some 33 tons; and a further increase of 100 per cent., viz., to 800 revolutions per minute, only reduces the weight to some 26 tons. The total weight reaches a minimum of 24 tons at 1,000 revolutions per minute, and increases again with increasing speed until at 1,600 revolutions per minute, the weight is again 26 tons, which is actually the same as at half this speed, viz., 800 revolutions per minute. Similar observations may be made for the other rated outputs, and also in regard to the Total Works Cost. For a given rated output in kilovolt-amperes the Total Weight and the Total Works Cost per kilovolt-ampere both decrease as the speed increases until the most economical speed is reached, above which both these quantities increase again. This is shown by the curves in Figures 5 and 6, where are plotted the weight and cost per kilovolt-ampere for A. C. generators. These curves are derived from the curves in Figures 3 and 4. For low and medium speeds the weight and cost per kilovolt-ampere rated output are lower the higher the rated output. It will be seen that the 6,000 kilovolt-ampere curve is the lowest of the group, and that the 375 kilovolt-ampere curve is the highest for speeds up to about 1,000 revolutions per minute. At high speeds, say above 1,000 revolutions per minute, the weight and cost per kilovolt-ampere are higher the greater the rated output. Hence higher speeds are more suitable for machines of small, than for machines of large, rated output. In other words, the larger the rated output the lower is the most economical speed.

"It will be noted further that the weight and cost per kilovolt-ampere at the most economical speed for a machine of 6,000 kilovolt-amperes rated output, are smaller than for a machine of 3,000 kilovolt-amperes rated output. For rated outputs below 3,000 kilovolt-amperes the weight and cost per kilovolt-ampere at the appropriate most economical rated speeds, are of about the same value. Thus the minimum weight per kilovolt-ampere is about 13 kilogrammes, and the cost per kilovolt-ampere some £0.45 (9s.) for a machine of 6,000 kilovolt-amperes rated output as against some 15 kilogrammes and £0.6 (12s.) per kilovolt-ampere for a machine of 3,000 kilovolt-amperes rated output and for ratings below 3,000 kilovolt-amperes. In Figures 7 and 8 are given similar curves for continuous-current machines. The weight and cost per kilowatt are in this case derived from the curves in Figures 1 and 2. These curves are of the same nature as those given in Figures 5 and 6 for alternating-current generators. The weight and cost are, at *low* speeds, influenced to a fairly large extent by the rated speed, but when the region of high speeds is reached the weight and cost are almost independent of the speed. In fact, the cost per kilowatt commences to increase again after a certain speed has been reached, as in the curves for A. C. generators. A point of considerable interest is that while the cost per kilowatt reaches a minimum, and commences to increase considerably again in this manner, the weight per kilowatt does not appreciably increase, but remains at a practically constant value."

A NEW PRODUCT OF THE ELECTRIC FURNACE

A DESCRIPTION OF THE MANUFACTURE, PROPERTIES AND USES OF SILUNDUM.

F. Bölling—Electrochemical and Metallurgical Industry.

EXTENSIVE researches on the use of silicon carbide for electrical resistances to stand high temperatures have resulted in the discovery by Herr F. Bölling, a German engineer, of a process for converting any piece of carbon wholly or partially into silicon carbide. In Herr Bölling's early experiments he attempted to produce resistances by mixing silicon carbide powder with bonds of various compositions to bind the individual crystals together, but he found that resistances made in this way, though non-conductors at low temperatures became conducting at about 700 to 800 dgrees C. Later, however, it was discovered that if carbon and silicon be heated together out of contact with air to a temperature exceeding 1600 degrees C., the point at which silicon vaporizes, the silicon will penetrate into the carbon, which keeps its shape, and form with it a layer of silicon carbide of any desired thickness. In this way it is possible to produce resistances without binding materials which will stand temperatures as high as 1650 to 1700 degrees C. The silicified carbon obtained by this process, to which the name "silundum" has been given, is now produced commercially in Europe at a plant in Switzerland especially erected for this purpose. Some details of the manufacture, properties and applications of the material are given by Herr Bölling in an article in the *Electrochemical and Metallurgical Industry* for January, 1909, from which we take the following extracts.

"For the production of this material electric furnaces are used, of the same kind as for the manufacture of carborundum. The pieces of carbon of the various shapes are introduced into a mixture of sand and carbon, that is acted upon by a granular core of coke as conductor for the electric current. Instead of sand and carbon, amorphous carborundum can be used, enriched with sand, to provide for the necessary silicon for the carbon pieces to be converted into silundum.

"The silicification of the carbon depends on the time and the temperature employed. It is possible entirely to silicify the carbon pieces or to cover them only with a layer of silundum. This layer may be of any thickness desired. The shape of the carbon article acted upon remains entirely unchanged. It leaves the furnace in the same shape as it was introduced, and manufacturing marks that are pressed on the carbon remain distinctly visible. Tubes of carbon can be silicified inside and outside. Silundum tubes of any thickness of wall and of any diameters, as obtainable from carbon manufactures, are made in silicifying a solid carbon rod, leaving a core of carbon inside, which is burned away in a furnace, which communicates with the air, leaving thus a tube of silundum. It is possible to make round, square or flat tubes.

"If it is desired that one part of the carbon piece remains carbon on one spot, this place is shielded by another piece of carbon, thus preventing the silicon from penetrating into that particular spot. Lamp filaments can be easily converted into silundum or only covered with a layer of silicon carbide. Charcoal is very easily converted into silundum; so is coke, because both these materials are very porous.

"The silicification takes place easier with porous carbon pieces than with pieces that are pressed very hard and tight and baked. Graphite is easily silicified. Carbon powder compressed at very high pressure can be silicified without being baked first. In order to accelerate the process of silicification, the pieces can be made of carbon and amorphous crystalline carborundum, bound together with tar or any other bond that contains carbon. This modification of the regular process of manufacture may be used in cases where very large pieces, bricks or the like, are to be converted into silundum.

"Silundum is another form of silicon carbide and it has generally the same properties. It is very hard; it resists temperatures up to about 1600 degrees C. when heated in air and does not oxidize. It resists the attack of acids when cold and is a conductor of electricity, its resistance being several times that of carbon.

"The hardness of silundum is variable and depends on the zone around the core of the furnace in which it is produced. Material from the amorphous zone is less hard than that obtained in the crystalline zone. It may be assumed that the hardness depends on the temperature in which the material is produced. The hardness may also depend on the amount of silicon taken up by the carbon. It seems that some pieces contain more or less silicon than others, but no analysis was made to ascertain this.

In regard to the fireproof qualities of silundum, it may be mentioned that at about 1700 degrees C. the silicon leaves the carbon and combines with the oxygen of the air. Small transparent globules are formed (for instance, on a rod that is put in a circuit and heated to about 1700 degrees by the electric current) on the surface, of clear or brownish color. These globules are silicon dioxide. Parts of the silicon escapes in form of a white vapor.

"Silundum cannot be melted, and it behaves in this respect like carbon. The electric resistance of silundum is variable and depends on the kind of carbon and its hardness. Silundum made from porous carbon has a higher resistance than when made of hard carbon. The resistance depends also on the modification of the material. If produced in the amorphous zone the resistance is generally higher than in the crystalline zone.

The first use for which the material found application was for electric cooking and heating purposes. For this use the experiments that led to the invention were made. The electric heating industry for domestic as well as for industrial purposes demands, for a large number of appliances, a higher temperature than can be obtained by ordinary resistance wires. Platinum, of course, can be used, but this material is very expensive, especially so when thick wires or ribbons are used, as should be done, of sufficient mechanical strength. Silundum replaces platinum for this purpose and is much cheaper.

"Electric cooking and heating industries have developed in the last five years enormously and will continue to do so. Any reduction in the price of electric energy will result in a greater demand for electric ranges, which may be used for cooking just like gas ranges. The electric range demands, however, a concentration of electric energy to be converted into heat that can hardly be obtained at present with any system without overheating the resistors or without increasing the weight of the heating plate, with the result that the preparation of a meal requires too much time, in comparison with heating by gas or coal. Silundum stands very high heat, does not oxidize and can be used with the necessary high temperature needed for the purpose. Ranges are produced that have the glowing heat of a coal fire and they are used exactly as those heated by coal.

"For industrial purposes there is a large field for heating apparatus for melting metals, brass, aluminum, lead, tin, etc., and for electric laboratory ovens for high temperatures, and it is especially for this purpose that the material fills a long-felt want. Platinum and platinum-iridium has been used to a great extent for laboratory ovens, but such apparatus are very expensive and they can be repaired only at great expense. Silundum can be used with just as high temperatures as platinum and its price is low. The first cost of the apparatus as well as the expense for repairs are considerably lower than with platinum. For heating purposes the silundum rods can be used single in lengths up to 800 mm, depending, of course, on the diameter, as solid, round, flat or square rods or tubes or made into grids, mounted in a frame and provided with contact wires.

"Silundum stands just as well as silicon carbide the attack of acids, and experiments are now being made to use it as electrodes for electric bleaching purposes instead of platinum-iridium, carbon or graphite. In order to prevent the oxidation of carbon electrodes used for the manufacture of ferrosilicon, it has been proposed to cover these electrodes with a layer of silundum.

"Silundum can be nickel plated or covered with a layer of platinum. It is a very refractory material and does not melt. It is, however, attacked at high temperatures by molten metals, but this should not prevent its use as fireproof material, for it is easily possible to cover the outside of a carbon or graphite crucible or the like with silundum and leave the inside carbon. It is not necessary to silicify pieces to be used for fireproof purposes entirely, but only to a certain depth and according to the use for which they are to be employed. Carbon bricks or any shaped pieces can be covered with a layer of silundum at small cost. It is thus possible to obtain a material that for many purposes will be far superior to any fireproof material known so far.

"Silicified coke can be used instead of ferrosilicon or carborundum in the steel industries, and, as it can be produced at very low cost, it will doubtless find extended application."

THE PREVENTION OF BOILER SCALE BY ELECTRICITY.

A METHOD OF PRECIPITATING SCALE-FORMING MATERIALS BY THE ACTION OF A LOW-VOLTAGE ELECTRIC CURRENT.

F. A Lart—The Engineering Review.

THE results of some simple experiments recently carried out by Mr. F. A. Lart seem to indicate the possibility of preventing the formation of scale by the passage of a low-voltage electric current through the water in a working boiler. The investigations have not been carried far enough to permit the accumulation of any exact quantitative or qualitative data, but, to Mr. Lart at least, the results have been sufficiently practical and conclusive to prove his theories and the deductions immediately involved. A paper outlining his conclusions, originally published in *The Engineering Review*, is abstracted in *The Railway and Engineering Review* for January 23, from which we take the following paragraphs:

"It is not generally known to engineers that the process of converting water into steam in a boiler sets up or is accompanied by distinct electric currents in the water and in the structure of the boiler, or that by passing such a current of electricity through the water in a boiler during the conversion of it into steam, or through any static volume of cold or only warm or moderately heated water such as may be contained in a tank or other receptacle, the deposition of solid matter in mechanical suspension or, in certain cases, in chemical solution in the water, can thereby be effected.

"The electric current induced in the former case is probably of galvanic or voltaic origin, due to the water forming an electro-chemical couple between the different materials or metals of which the boiler is constructed—that is, the steel or iron shell and the copper or copper-alloy fire-box or tubes; or, it may be, through the purely voltaic coupling of the metallic elements comprising the boiler structure, where they are dissimilar or where the boiler is constructed wholly of steel or iron plates and tubes, as is frequently the case, which are possessed of unequal electrical potentialities.

"It is, however, very unusual for any boiler nominally constructed wholly of steel or iron not to carry in some part of it one or more small detail parts made of copper or some alloy of copper, which parts are in direct and regular contact with the water and the steel or iron shell simultaneously. The presence of these materials and metals in close conjunction with the steel or iron of the main structure of the boiler, and both in contact with the water and therefore additionally and most effectively coupled to one another, is sufficient to form, especially if, as is usually the case, the water is possessed of any acidity, an electro-chemical or galvanic couple equivalent to a primary battery, from which proceeds in due order and inevitably an electric current which permeates and affects the entire structure of the boiler and the entire volume of the water contained in it. This electrochemical action exists under these circumstances with static, cold water as well as in the hot and constantly fluent water of a working boiler. In the latter case the action takes place much more markedly, of course, since such action is always assisted in a great degree by heat.

"It is suggested, therefore, that the prevention or the mitigation of the action of scale-formation in boilers through rendering the usually more or less acid water alkaline or neutral by some special process, such as the adding to it of lime, is as much due to the resulting impossibility of electro-chemical action between the water and the metallic elements with which it is in intimate contact as to the total prohibition under these circumstances of the purely chemical dissolution of the scale-forming elements contained in the water."

Mr. Lart believes that this electro-chemical or purely electrical theory is the true explanation of the whole question of scale formation and its prevention. Minute electric currents, he says, can always be detected by a galvanometer connected between the water in a working boiler and the metallic shell, or between two distant but connected parts of the boiler.

"But it has been found, through some experiments recently conducted—that by passing an electric current of very moderate potential, as from any ordinary dry or wet electro-chemical primary battery, through the structure of a working boiler via the water contained in it and in process of conversion into steam, the formation of scale on the heating and general internal water-covered surfaces of the boiler may be entirely prevented, the deposition of the solid matters contained in the water in mechanical suspension and the precipitation of these in chemical solution being accelerated, the resulting deposit or precipitate being simply loose particles or mud of the lime or magnesia or other impurities contained in the natural water.

"So also, though with more difficulty so far as the experiments were conducted, in the case of static, cold water or water only moderately heated or heated up to boiling point and not subject to the violent disturbance or evolution of the carbonic acid gas contained in it, or raised to the intense heat and consequent internal molecular strain and disruption which accompany the formation of steam at any considerable pressure under the ordinary conditions of boiler working. Mr. Lart has not experimented with any electric current of high intensity or quantity, as from a dynamo or power storage cell, and cannot, therefore, state anything as to the effect of such currents in the directions indicated. The experiments were made with a dry cell of 1.5 volts. Possibly it may be found that the most suitable current for these purposes of water purification and scale prevention would be one of low potential and high quantity as in the ordinary commercial process of electro-plating."

The beneficial effect of zinc in preventing scale-formation is due, according to Mr. Lart, to some sort of electro-chemical action. He finds additional confirmation of his theory in the facts that scale does not form in vessels formed solely of non-ferrous metals or in iron vessels lined with non-conducting enamels, and that analyses of boiler scale always show appreciable quantities of ferric oxide. From the latter fact he infers that the iron or steel of the boiler shell forms the positive pole of the battery from which the electric currents in the boiler proceed.

Carbonates of lime and magnesia are readily precipitated by moderate heating; the sulphates, however, cannot be so easily eliminated. "But both in the case of the carbonates and of the sulphates of lime and magnesia, as well as of lime and chalk in purely mechanical suspension or 'solution' in the water, the writer's experiments clearly demonstrated that whether with cold, or hot, or boiling water the deposition and precipitation referred to are much facilitated by passing an electric current of very moderate e. m. f. through the water.

"In each case the deposit occurs as a finely divided and slightly curded or flocculent powder or mud, and not as a coagulated mass or concreted scale. In this fact lies the primary importance of this method of electro-purification of boiler water and scale prevention, because, though, of course, not at all desirable, the presence of a muddy, loose deposit at the bottom of a boiler barrel or fire-box water-space is not at all harmful to the boiler or obstructive to its evaporation and steam-raising duties, provided it is not allowed to accumulate to excess, of course; and is in any case infinitely preferable to the formation of congealed deposit or concreted and fast-adhering scale upon every inch of interior surface covered by the water.

"In applying this electrical method of water purification and scale prevention to steam boilers, the writer would suggest connecting the top and bottom, the sides, and the ends, respectively, each and all, or such as the construction of the boiler may provide, well below the normal water-level, with one or more primary batteries or other convenient electric current supply, so that there would be a continuous electric current passing through the whole body of the water in the boiler longitudinally, transversely, and vertically, as far as possible, and thoroughly permeating it throughout. This would be very easily and simply effected by attaching the wires from the batteries or other current source to brass plugs tapped into the boiler shell, and in every case projecting well into the water and always covered by it."

BEARING METALS.

A SUMMARY OF THE QUALITIES REQUIRED IN BEARING METALS AND THE PROPERTIES OF THE PRINCIPAL CLASSES OF ANTI-FRICTION ALLOYS.

A. H. Hiorns—Birmingham Association of Mechanical Engineers.

AN unusually interesting treatment of the subject of anti-friction alloys for bearing metals is given in a paper read by Mr. A. H. Hiorns at a recent meeting of the Birmingham Association of Mechanical Engineers. A review is given of the qualities required in bearing metals and an attempt is made to give a methodical classification and description of the properties of the main classes of anti-friction alloys now in use, based upon the latest and most authentic information. We abstract Mr. Hiorns' paper from a reprint in *The Mechanical Engineer* for December 25, 1908.

Charpy states that in a well adjusted journal the friction is practically the same regardless of the metal in contact, and depends exclusively on the lubricant; a layer of oil remains constantly between the journal and the bearing and the only friction is between a solid and a liquid. Accurate adjustment and perfect lubrication of bearings are, however, ideal conditions usually impossible of attainment in practice and the nature of the bearing metal is a determining factor in the modification or prevention of such troubles as hot boxes and cuttings.

As long ago as 1820, Rennie studied the friction between two bodies kept in contact by gradually increasing pressure. He found that in the case of small loads the coefficient of friction at the start is practically constant, that the friction increases nearly proportional to the pressure, and that above a certain load the coefficient of friction increases rapidly, the surfaces in contact rub against each other, become heated, and finally cut, which corresponds to an abrupt and very great increase in the coefficient of friction. The load at which rubbing begins is generally greater the harder the metals in contact; on the other hand the coefficient of friction is generally smaller the harder the metals. Hence in order both to reduce friction and to avoid cutting, hard substances should be used for bearing surfaces.

The use of hard substances, however, corrects only the effects of defective lubrication; it is no remedy for imperfect adjustment. In practice the load on a bearing is not uniformly distributed but is concentrated at certain points. If the metal is hard and unyielding, the pressure on these points becomes considerable and leads to heating and cutting. Hence the bearing must have a certain plasticity so as to mould itself round the shaft and increase the surface of contact, and, as the bearing gradually wears away, constantly to restore its contact with the shaft.

These two seemingly contradictory characteristics of hardness and plasticity are secured by employing for bearing metals certain alloys composed of hard grains imbedded in a plastic matrix. This is the main principle aimed at in anti-friction alloys. Plasticity, as well as brittleness, is determined by a compression test. The composition of the alloy is of prime importance since on it the structure depends. The structure may be altered by heat treatment. Under the conditions in which a bearing is used, this alteration is negligible, but serious defects in the bearing may be produced by improper heating before casting.

These defects may be summarized as segregation, coarse crystalline structure, oxidation products and enclosed gases. Segregation is often due to improper proportioning of the constituents of the alloy and the application of excessive heat. It may be more or less prevented by quick cooling but the metal then loses ductility. Coarse crystalline structure is the result of pouring at too high temperature but it may also be due to the use of an excess of deoxidizing agents or to the presence of impurities. The other faults are the result of carelessness in casting.

Friction in a bearing depends on the structure and composition of the alloy. Hard metals have a lower coefficient of friction than soft metals but they are more liable to heating on account of their lack of plasticity. An unyielding metal causes concentration of the load on a few projecting parts, resulting in abnormal pressure on these points which leads to abrasion and heating. The use of copper-tin alloys for heavy loads and high speeds used to be common, on account of their hardness and low coefficient of friction, but they have been superseded by the lead-lined bearing which is now widely used.

The composition of the bearing has a decided effect on the life of the journal. It is generally considered that a soft bearing causes a marked decrease in the journal's life, though the reason is not altogether clear. One authority says that driving axles have a tendency to wear tapering and hollow on account of the uneven distribution of dirt in the packing. But uneven wear is caused by the use of babbitt strips above the bearing surface, and the tendency to wear hollow has been traced to this cause.

A test of the compressive strength of bearing alloys is of importance, for the alloy must be hard enough to support the load without deformation. If it is too brittle it will crack under pressure. If it is sufficiently plastic it will keep cool even under exceptional circumstances. It has been found that tension tests also give valuable information as to the properties of bearing alloys; the higher the tensile strength and elongation, the longer the life of the bearing.

The essential points to be considered in a bearing metal are composition, structure, friction, temperature of running, wear on bearing, wear on journal, compressive strength and cost. No one alloy will reach perfection in all these requirements. The combinations must be studied in detail and the qualifications of each alloy balanced against those of the others according to the special features required. The main properties of the principal classes of alloys used for bearing metals are given in very brief summary.

Lead and antimony alloy in all proportions. The higher the percentage of antimony the more hard and brittle is the alloy. The eutectic contains 13 per cent. antimony. With less than this amount the alloy consists of crystals of lead and eutectic; with more than 13 per cent., of crystals of antimony and eutectic. Above 13 per cent. antimony, therefore, the alloy consists of hard grains in a plastic matrix and fulfils this requirement of an anti-friction alloy. Alloys containing 15 to 20 per cent. antimony are the most suitable, though for light pressures the eutectic alloy is advantageous, the greatly diminished wear offsetting the higher friction. The 13 per cent. alloy has been adopted by the Pennsylvania Railroad as the best all-round bearing metal for railway work. The compressive strength of lead-antimony alloys rises rapidly with increasing proportion of antimony, except between 14 and 30 per cent. when the compressive strength is practically the same as that of the eutectic. When the load reaches a certain limit, however, the crystals of antimony, having no plasticity, break, and the alloy is reduced to fragments.

Lead-tin-bismuth alloys are mentioned only in passing. Of the tin-antimony-copper alloys, or Babbitt metals, the alloy containing 83 per cent. tin, 11½ per cent. copper and 5½ per cent. antimony has been found by Charpy to possess the greatest compressive strength. Alloys for bearings should be within at least 3 or 4 per cent. of this composition.

Ternary alloys of lead, tin and antimony are superior to the binary alloys of lead and antimony, though they have a similar composition. The tin intervenes as a constituent of the hard grains, diminishing their hardness but also their brittleness. Tin also enters the eutectic, increasing its compressive strength. The tin must exceed 10 per cent. but not necessarily 20 per cent.; antimony may vary between 10 and 16 per cent. An alloy with 76 per cent. lead, 14 tin and 10 antimony shows comparatively few hard grains. If the proportion of antimony is reduced the grains disappear. An alloy with 80 per cent. lead, 12 tin, and 8 antimony is used on the Eastern Railway of France as a packing for piston rods. When the proportion of antimony is increased the hard grains become more numerous; an alloy containing 70 per cent. lead, 10 tin and 20 antimony is used for packing for excentric collars.

Lead-copper-antimony alloys are also used. One particular alloy, containing 65 per cent. lead, 25 antimony and 10 copper is employed for packing for locomotives and tenders

There seems to be no ternary compound of zinc, tin and antimony in alloys in which zinc predominates. They are probably formed of zinc, tin and antimonide of zinc, and the alloys may be divided into three groups according to the constituent which crystallizes first. The alloy in which the zinc antimonide is the first to crystallize is the only one suitable for anti-friction purposes. Alloys with excess of zinc have a very high compressive strength, but, though tin diminishes the brittleness of zinc-antimony alloys, they are very liable to brittleness when heated. They cannot be recommended for bearings and are little used except where low price is esteemed.

Bronzes, largely used for bearings may be classed under two heads: alloys of copper and tin with only small quantities of other metals, such as phosphorus, zinc, etc.; and alloys of copper, tin and lead. The compressive strength of the yellow copper-tin alloys is greater than that of the white alloys, and it increases regularly with the proportion of tin. Phosphorus seems to have no marked influence on the compressive strength. Until the proportion of tin reaches 20 per cent, the copper-tin alloys have a uniform structure, a eutectic matrix of copper and $CuSn_3$ containing crystalline needles of copper. Phosphorus when present enters the matrix, modifying its hardness. The eutectic is much stronger than pure copper; on it the compressive strength of the mass depends. The addition of lead increases the plasticity.

Copper-tin-lead alloy is now the chief of the standard bearing bronzes. The addition of lead to the copper-tin makes the alloy less liable to heat under the same lubrication and diminishes the rate of wear. Tests by Dr. Dudley have shown that phosphorus and arsenic exercise no marked influence on wear, that the metal which wears least is capable of undergoing the greatest distortion before breaking, and that the rate of wear decreases with increase of lead. Clamer claims the best alloy for general purposes to be copper 64 per cent., tin 5, lead 30, and nickel 1. Bronzes containing zinc are cheap but zinc increases the rate of wear and has a tendency to segregate lead.

The constitution of bronzes is the reverse of that of white alloys. Instead of hard grains in a plastic eutectic, they have soft grains in a hard eutectic for the same degree of plasticity. Bronzes are inferior to white metals because they are less plastic and do not mould themselves as well around the axle. Their greater strength does not permit a heavier load, for then the lubrication is interfered with and the bearing tends to become heated. Also on account of their constitution bronzes have a greater tendency than white alloys to cut.

In conclusion, "an anti-friction alloy should have hard grains in a plastic matrix, then the load is carried by the hard grains which have a low coefficient of friction, and the cutting can only take place with difficulty. The plasticity of the cement makes it possible for the bearing to adjust itself round the shaft, thus avoiding local pressures, which are the chief cause of accidents. Such properties may be obtained in binary alloys with such metals as antimony, tin, and copper, which form chemical compounds. The requisite properties are better obtained in ternary alloys, which give a good plastic matrix (eutectic). To test an anti-friction alloy, compression tests and the microscope are invaluable aids.

RECENT PROGRESS IN EXPLOSIVES.

A SUMMARY OF THE MORE IMPORTANT ADVANCES IN EXPLOSIVES FOR MINING WORK DURING THE LAST TWENTY YEARS.

Oscar Guttmann—Royal Society of Arts.

EXPLOSIVES formed the subject of the four lectures of the first series of Cantor Lectures delivered before the Royal Society of Arts in November and December last. The lectures, which were delivered by Mr. Oscar Guttmann, long known as an authority on the subject, are printed in full in the *Journal* of the Society for December 25, 1908, *et seq.* Mr. Guttmann covered in broad review the progress in the whole field of blasting and military explosives during the last twenty years and the improvements in methods of manufacture and of testing. We give below in brief outline a few of his interesting comments on explosives adapted to mining work.

Though the last twenty years have seen quite as important progress in explosives as the whole of the previous years, the use of the old black powder shows little sign of dying out. In Great Britain more than half the total weight of explosives used in 1907 consisted of black powder. Practically no progress has been made in this blasting agent since 1886 but a number of rough mixtures similar to black powder have been revived and are used extensively in Germany. Among these may be mentioned "Sprengsalpeter," practically a black powder with sodium nitrate instead of potassium nitrate, "Petroklastite" containing coal pitch and bichromate, and "Cahücite," a mixture of potassium nitrate, sulphur, lamp black, cellulose, and iron sulphate. In America large quantities of sodium nitrate powders are used.

There has been no special improvement in dynamite since blasting gelatine was invented in 1875. This explosive and the gelatine dynamites have in most countries driven "Kieselguhr" dynamite out of the field. Considerable advance, however, has been made in the removal of one of the chief objections to dynamite, its liability to freezing. The addition of nitrobenzine to nitroglycerine was one of the first expedients tried but it was found that the presence of the nitrobenzine reduced the explosive power when used in sufficient quantities to prevent freezing. Later dinitrotoluene was used, and in 1904 the addition of dinitroglycerine to trinitroglycerine explosives was patented, together with a practical method of manufacturing dinitroglycerine. The latter is now made on a large scale in Germany. A large number of other additions have been tried but none has been definitely adopted for the manufacture of unfreezable dynamites. Lately dinitrodichlorhydrine has been used with considerable success.

Perhaps the main advance in explosives during the last two decades has been in the field of safety explosives for gaseous collieries. A large part of this advance has been due to the use of ammonium nitrate as an ingredient in a powder mixture. It has been definitely established that ammonium nitrate is absolutely safe in all quantities. It cannot be used alone but it simply remains to be determined what minimum quantity of combustible can be added to avoid flames of great length and duration. The Wetter-Dynammon made by the Austrian Government for use in fiery mines contains ammonium nitrate, 93.83 per cent., potassium nitrate, 1.98 per cent., charcoal, 3.77 per cent., and 0.42 per cent. of moisture.

Explosives containing potassium chlorate were for long excluded from the list of safety explosives on account of their extreme liability to explode under impact or friction. The recent advent of electrolytic methods for the manufacture of potassium chlorate has brought the price of this chemical down to a point where it can be used commercially in the manufacture of suitable explosives and a great deal of research has been applied to the investigation of methods of eliminating its dangerous qualities. Success has been attained by the addition to the explosive of some oil. Cheddite, the first practical chlorate explosive, contains 80 parts of potassium chlorate, 13 parts of mononitronaphthalene, 2 parts of dinitrotoluene, and 5 parts of castor oil. In 1908 a chlorate explosive was licensed as a safety explosive in England under the name of "Colliery Steelite." It consists of 74 parts of potassium chlorate, 25 parts of oxidized resin and one part of castor oil.

The first real safety explosive was a nitroglycerine explosive, Carbonite. Curiously enough it has not been surpassed for safety, though it has been on the market for twenty years. The composition is saltpeter, cellulose, nitroglycerine and sulphuretted oil. The investigation of nitroglycerine safety explosives has shown that the addition of cellulose to nitroglycerine compositions, as rye flour to Carbonite or wood pulp to other explosives, renders them highly inert in fire-damp mixtures.

In every European country the use of gunpowder is prohibited in fiery mines. One black powder-like mixture, Bobbinite, however, has passed even the most stringent tests in England and has been admitted to the list of permitted explosives. It consists of about 64 parts of potassium nitrate, 2 parts of sulphur, and 19 parts of charcoal, with the addition of 15 parts of a mixture of ammonium and copper sulphates, or alternatively of eight parts of starch and three parts of paraffin wax with a corresponding increase in the other materials. As will be seen from the table below, over a million pounds were used in Great Britain in 1907. It has the advantage of being slow-burning and of not unduly shattering the coal. The facts that the miners are used to black powder, and that of the bore-hole be overcharged as usual, Bobbinite does not break up the coal badly, have also assisted in making it popular.

"Lacking definite information as to what really renders an explosive safe in fire damp and how this is to be ascertained it is natural to seek a solution in practical results. It is not unfair to assume that the statistics showing the quantities of safety explosives actually consumed in a great coal-producing country like Great Britain have a real bearing on the question as to which explosives have given a reasonable amount of safety. The report of the Inspectors of Explosives for 1907 give the following highly instructive table.

"Out of a total consumption of 7,764,122 pounds were used:

Explosive.	Quantity used, pounds.	Percentage of total.
Saxonite	1,721,193	22.18
Bobbinite	1,063,111	13.69
Monobel Powder	711,691	9.17
Ammonite	562,405	7.25
Carbonite	551,948	7.11
Roburite	510,438	6.57
Arkite	437,780	5.64
Westfalite	405,691	5.22
Bellite	371,455	4.78
Rippite	306,408	3.95
Faversham Powder	224,200	2.88
Stowite	180,398	2.32
Ammonal	114,806	1.48

Of these Saxonite, Monobel Powder,

Carbonite, Arkite, Rippite, and Stowite contain large percentages of nitroglycerine. Bobbinite is a black powder mixture. The rest are ammonium nitrate explosives.

"It will thus be seen that a black powder mixture like Bobbinite, which would not be licensed in any other country and would be condemned without trial, ranks second in consumption, being used to the extent of 13.7 per cent. of the total consumption; whilst Saxonite, a nitroglycerine explosive, ranks first with 22.18 per cent. of the total." It is perhaps safe to conclude that the use of explosives has been made infinitely less dangerous than before without the reason for the increased safety being fully known.

THE WORK OF SUPERHEATER AND COMPOUND LOCOMOTIVES.

A COMPARISON OF RESULTS OBTAINED IN EUROPEAN PRACTICE.

Charles R. King—The Engineer.

WE reviewed in these columns some months ago a series of articles by Dr. Wilhelm Schmidt on the economy of superheating in locomotives. In Dr. Schmidt's opinion the engine of the future will be of the four-cylinder simple type using highly superheated steam and working at a moderate boiler pressure. Mr. Charles R. King who contributed to this magazine last year a series of articles on recent European locomotive practice, compares in *The Engineer* for December 25, 1908, recent authentic operating results of superheater and compound locomotives on various European railways, which show uniformly in the compound saturated-steam types a large fuel economy over superheater locomotives. Mr. King is an enthusiastic advocate of the compound locomotive and a few of his comparative data and comments may be of interest.

Mr. King gives an interesting series of charts comparing results obtained with superheater locomotives on the Prussian State Railways with those obtained with compounds in Italy. The charts combine in a single diagram information as to the railway profile, train speeds and loads hauled. The speeds are scaled above the profile and the loads above the speed line; the resulting line shows the relative values of work done on ascending and descending gradients. The records on the Prussian railways have repeatedly been claimed to be "brilliant results showing the enormous capabilities of the method"; they are expressly stated to be "ideal maxima" resulting from special trials under exceptionally favorable conditions of running. The compound-locomotive records are those of comparatively old engines in actual service in Italy. They are not intended to represent the maximum for compound locomotives but are chosen for comparison because they are records of trips comparable for gradient and length of run with those of the superheater locomotives.

Without going into Mr. King's lengthy discussion of these charts, it may be said that they show uniformly a superiority on the part of the compound locomotive. One of the charts compares the results of trials of a superheater engine weighing 61 tons and hauling a car load of 353 tons with compound-locomotive results obtained in regular express service between Milan and Venice, over a more difficult section of line. The weight of the compound was 60.5 tons and that of its car load 413 tons. Notwithstanding the important difference in conditions between a prepared trial run and ordinary every-day traffic, it showed a coal consumption of 24.4 kilogrammes per 1,000 ton-kilometres as against a consumption of 27 kilometres by the superheater locomotive. In a still more striking case, cited by Mr. King, a compound locomotive in service between Florence and Laterina made a coal-consumption record of 5.24 kilogrammes per 100 ton-kilometres under conditions comparable with, but more difficult than, those which obtained in a test of a superheater locomotive on the Prussian railways when a coal consumption of 10 kilogrammes per 100 ton-kilometres was recorded.

But, says Mr. King, "it is perhaps unfair to contrast superheater locomotives with compound engines. It is not usual —or has not been hitherto—to show the saving of fuel in compound engines as compared with superheater locomotives, but only as compared with single expansion saturated engines." He gives therefore a number of data on the economy of compound over single expansion engines, taken for the most part from the quarterly coal reports of the Italian compounds. Over single-expansion engines of three classes a recent type of compound shows fuel savings, on the basis of coal consumption per 100 ton-kilometres, amounting to 36, 34 and 28 per cent respectively. In freight engines with slow piston speeds and for mountain service the saving in coal is about 18 per cent. Four-cylinder balanced compounds show a saving in mountain and freight service of 22 per cent. over single-expansion engines, and in express service of 35 per cent. The latter figure is the average of a long period of service in different locomotive divisions in Italy during the first few years of the use of the "Adriatic" type locomotives. That this economy is still apparent is shown in a recent report by the chief engineer of the testing department of the State Railways. The report states that during the five years they have been in service the compound engines have hauled loads 60 per cent. heavier, with a fuel consumption only 5 per cent. greater, than the single-expansion locomotives.

"In all countries of the Continent—Prussia, South Germany, Austria, France, and Belgium—the gain by double expansion is a most important one, and without involving any extra complication that does not exist in single expansion engines having the same number of cylinders; the number of engine parts being precisely the same in both cases, since a two-cylinder compound engine without starting valve differs in no way from so-called 'simple' engines except in the different diameters of the two cylinders.

"With superheater engines a very complicated and very costly boiler is necessary. Austrian engines fitted with Schmidt apparatus cost £340 per engine extra and the royalties are an additional expense. The weight of engines in some instances becomes two tons heavier in boilers for the same steam pressures." In Belgium where special classes of engines were built for the purpose ot comparing the superheating and compounding systems it is admitted that "it has been recognized in current service that the four-cylinder non-compound engine is less economical than the compounds."

In France an impartial trial of superheating showed an American engine with superheater to be 16 per cent. more economical than the same engine without superheater, but a compound engine of the same class showed a saving of 24 per cent. over the saturated simple engine. "It is obvious," Mr. King says, "that the best results credited to superheaters occur when saturated steam boilers are either designed in such manner, or worked in such manner, as to cause abundant priming, and when such defective conditions are compared with carefully worked superheater locomotives." On the Nord Railway the saving of the compounds is over 17 per cent. The Nord engineers report that the results "show that the compound system is economical at moderate pressures, 147 pounds, and that, in consequence, its advantages have not as a condition the use of high pressures."

"Fuel economy by means of compounding at low pressures has been the common result of practice for twenty years past. The mechanical means of compounding are very simple. If a large boilered superheater engine is to be converted to compound working, the superheater tubes are withdrawn and replaced by ordinary tubes, the gain in heating surface largely compensating for the removal of the superheater. The various accessories are also cleared away and one of the large cylinders replaced by another of smaller bore, so reducing engine weight and diminishing the surface of cylinder walls and the heat losses due to their greater heat radiation. If it is a small-boilered saturated engine to convert, the usual process is to fit one larger cylinder. In either case the number of moving parts in the engine motion and valve gear remains unchanged. The simple outcome of the changed method of working will vary from 10 to 35 per cent. fuel saving, according to the individual skill of the designer, all other things being equal. These examples make clear the fact that there is no complication in compounding, the list of parts for either single or double-expansion engines being the same in each type, although cases exist where the simple engines have more working parts than compounds.

"As there is no mechanical complication in the compounds it may be averred that the two-stage expansion is in itself a complication. But this complication in the movement of the steam itself results in up to 36 per cent. economy—a decided advantage. Again, it will be urged that compounds cannot start quickly. The reply to this is to be found in an examination of the acceleration curves of the compound locomotives in our diagrams—further remark is superfluous. It is sometimes asserted that compounds are heavier, more costly to build, and dearer to keep in repair. As to the weight, compound engines are built which do not weight ¼ ton more than sister-built non-compounds with the same boiler pressure. Take, for instance, goods engines Classes '1002' to '1005' Eastern of France Railways. Of the same weight and built in the same lot their price per pound is the same, but the compounds save so much coal, that, after a period of fifteen years' very rough service it is still necessary with the engines mentioned to keep their coal lists separate, the latest annual returns—1907—still showing 14 per cent. coal economy, and the enginemen of the compounds gaining less in coal premiums because of the higher coal saving capacity of the compounds. Both simple and compound engines have the same number of working parts. If the compounds were to be converted for single expansion there would be no saving in weight in number of parts, in boiler pressure, or in simplicity; there would be at once increase of coal consumption by over 14 per cent.

"Of the more costly maintenance of compounds an excellent authority has already shown in *The Engineer* that on the Prussian State Railways, under his control, single-expansion engines only run 23,500 miles between consecutive repairs, while compound engines run 29,440 miles between consecutive repairs, these being the averages of ten locomotives during about eleven years of service. The greater approximation of the average piston effort to the maximum piston effort is the principal saving in wear and breakage with any form of compound motor; and the fact that, in the cylinder of compound engines which is subject to the highest pressure, the piston rings may be used longer without the same steam losses by leakage, and that the piston rings of the low-pressure cylinders are not subject to such heavy pressures as in single-expansion engines is a very simple reason why compound engines should be, as they have been proved to be, less costly in repairs.

"In conclusion, it is to be noted that though superheated steam boilers give neither the economy in coal nor introduce any mechanical advantages such as are realized every day in the service of compound engines, it by no means follows that superheater boilers are not advantageous applied to any form of motor—compound or non-compound. The experience of 140 years has demonstrated the utility of the superheater, whilst it has also shown that superheaters introduce risks of breakdown of considerable gravity, and exact unremitting care and attention, or otherwise become inefficient. On the contrary, double-expansion engines are much more flexible under variations of boiler pressure, and the mere decreasing or increasing of the diameter of one cylinder in a pair involves no such constructive complication as do boilers with superheaters."

THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE."

The following pages form a descriptive index to the important articles of permanent value published currently in about two-hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

CIVIL ENGINEERING

BRIDGES.

Bascule.

Bascule Bridge on the C. & A. Illustrates and describes the Page bascule bridge on the Chicago & Alton, and its working. 800 w. Ry & Loc Engng—Jan., 1909. No. 1446 C.

Blackwell's Island.

The Footwalks of the Blackwell's Island Bridge. F. W. Abbott, and J. P. H. Perry. Outlines the design of these footwalks and describes their construction. Ills. 6000 w. Eng News—Jan. 28, 1909. No. 2150.

End-Launching.

Bridge Erection by the End-Launching Method (Lançage des Ponts au Moyen de Chalands). Ch. Dantin. Describes the work of erecting the Kyrönsalmi-Sund bridge in Finland and the French River bridge in Canada. Ills. 1600 w. Génie Civil—Dec. 5, 1908. No. 1925 D.

Footwalks.

See Blackwell's Island, under Bridges.

Plate Girders.

Plate Girder Web Splices. C. R. Young. Discusses the design of web splices, criticizing various arrangements. Ills. 4500 w. Ap Sci—Jan., 1909. No. 2093 C.

We supply copies of these articles. See page 1071.

Reinforced Concrete.

Cost of Concrete Bridges. Henry H. Quimby. Read before the Nat. Assn. of Cement Users. General discussion of first cost and maintenance cost as compared with steel. 1500 w. Eng Rec—Jan. 23, 1909. No. 2026.

Cost Account of Seine River Bridge, St. Boniface. Estimate of cost for a reinforced concrete bridge in Manitoba. 1500 w. Can Engr—Jan. 15, 1909. No. 1773.

The Rocky River Concrete Bridge Near Cleveland, O. Illustrates and describes a reinforced-concrete viaduct with a central arch having a clear span of 280 ft. 2500 w. Eng Rec—Jan. 23, 1909. No. 2020.

A Bridge Over the Oberspree Near Berlin (Die Stubenrauch-Brücke über die Oberspree bei Berlin). Karl Bernhard. Illustrated description of a bridge having two reinforced-concrete spans and one steel span. Serial, 1st part. 5000 w. Zeitschr d Ver Deutscher Ing—Dec. 5, 1908. No. 1997 D.

Calculation of the Reinforced-Concrete Bridge Over the Amper at Esting (Statische Berechnung der Eisenbetonbalkenbrücke bei Esting an der Amper). Hans Popp. A mathematical paper describing the designing a bridge of three spans, each 12.84 metres long. Ills. 2800 w. Beton u Eisen—Dec. 14, 1908. No. 1985 F.

See also Steel, and Trestles, under BRIDGES.

Removal.

Removal of Madison Avenue Drawbridge, New York City. George H. Hefele. Illustrates and describes the successful removal of the draw-span from the old bridge to the temporary structure. 1800 w. Eng News—Dec. 31, 1908. No. 1404.

Steel.

Rio Conchos Bridge of the Kansas City, Mexico & Orient. W. W. Colpitts. Illustrated description of a bridge of 17 spans of 50 ft. deck-plate girders, supported on plain concrete piers and reinforced concrete abutments. 2800 w. R R Age Gaz—Jan. 22, 1909. No. 2001.

The New Bridge Crossing the Mississippi River at Clinton, Ia.; Chicago & Northwestern Ry. F. H. Bainbridge. Gives the history of earlier bridges at this point, and illustrated detailed description of the new structure. 7000 w. Eng News—Jan. 21, 1909. No. 1874.

See also Plate Girders, and Reinforced Concrete, under BRIDGES.

Trestles.

Ferro-Concrete Coal Tip and Viaduct at Sharpness Docks. Reviews the history of these docks, illustrating and describing recent improvements. 1500 w. Engr, Lond—Jan. 15, 1909. No. 2084A.

Viaducts.

The Pleasant Run Bridge of the Cincinnati, New Orleans and Texas Pacific Railway. Illustrated description of a new steel structure in Kentucky. 1500 w. Eng Rec—Jan. 9, 1909. No. 1572.

The Cuyahoga Viaduct of the New York, Chicago & St. Louis Railroad. A double track steel bridge of Cleveland, O., having a length of about 3,010½ ft., crossing a river, several streets and a number of tracks. 2000 w. Eng Rec—Jan. 9, 1909. No. 1574.

CONSTRUCTION.

Concrete.

Method of Finishing Concrete Surfaces by Scrubbing Followed by an Acid Wash, With an Estimate of Cost. Views and description with cost analysis. 1500 w. Engng-Con—Jan. 6, 1909. No. 1588.

The Bonding of New to Old Concrete. E. P. Goodrich. Reviews the experimental work in this field, and gives an account of investigations made by the author. Ills. 8500 w. Pro Am Soc of Civ Engrs—Jan., 1909. No. 2123 E.

Concrete Blocks.

The "Eternit" Artificial Stone (La Pietra "Eternit"). Their constituents, making and use are described. Ills. 3500 w. Il Cemento—Nov., 1908. No. 1936 D.

Cost-Keeping.

Cost Keeping on Municipal Contract Work. De Witt V. Moore. Discusses the methods of cost keeping and the benefit. 2500 w. Munic Engng—Jan., 1909. No. 1738 C.

Cost-Keeping on Concrete Construction on the C. B. & Q. Don E. Mowry. Brief explanation of method used. 900 w. R R Age Gaz—Jan. 15, 1909. No. 1794.

A System of Collecting Cost Data With Particular Reference to a Sewer Contract. Explains the system used by two associated companies at Indianapolis, Ind. 2000 w. Engng-Con—Jan. 13, 1909. No. 1784.

Excavation.

Comments on Handling Earth with Wheelbarrows. Discusses their economic limitations. 1200 w. Engng-Con—Dec. 30, 1908. No. 1453.

Methods and Costs of Rock Excavation and Washing Gravel for a Concrete Dam. William C. Steele. Describes work in connection with the building of a hollow concrete-steel dam on the Big Horn River, Wyoming. 800 w. Engng-Con—Jan. 6, 1909. No. 1589.

An Important Legal Decision Regarding Trench Excavation. Editorial on the decision given by the U. S. Circuit Court of Appeals in the case of Gammino v. Town of Dedham. 1200 w. Eng Rec—Jan. 2, 1909. No. 1418.

See also Air Compressors, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

Failures.

The Failure Under Test Load of a Reinforecd-Concrete Reservoir, Annapolis, Md. R. H. Danforth. Describes the construction and the failure. Ills. 1000 w. Eng News—Jan. 14, 1909. No. 1787.

Fireproof.

See Concrete, under MATERIALS OF CONSTRUCTION.

Floors.

See Concrete, under MATERIALS OF CONSTRUCTION.

Grain Elevators.

Grain Elevators at Tempelhof on the Teltow Canal (Magasin à Grains de Tempelhof, près Berlin, sur le Canal de Teltow). A. Bidault des Chaumes. Illustrated description. Plate. 2400 w. Génie Civil—Dec. 12, 1908. No. 1928 D.

Masonry.

Progress of Construction on the Cathedral of St. John the Divine. An illustrated description of recent work on this large cathedral under construction in New York City. 3000 w. Eng Rec—Jan. 23, 1909. No. 2019.

Piling.

Method of Making and Placing Pile Protection at Everett, Wash. Illustrated description of lock joint pipe protection. 2000 w. Eng Rec—Jan. 16, 1909. No. 1767.

The Best Form for Reinforced Concrete Piles (Ueber die günstigste Form der Betonpfähle). Richard Kafka. Discusses the shape of piles with reference to stability and ease of driving. Ills. 4000 w. Oest Wochenschr f d Oeffent Baudienst—Dec. 19, 1908. No. 1977 D.

The Creosoted Pile Bridge from Galveston Island to the Mainland. Describes the effect of sea water on the piles of the old bridge. 500 w. Eng News—Jan. 7, 1909. No. 1643.

See also Coffer Dams, and Dikes, under WATERWAYS AND HARBORS.

Reinforced Concrete.

Reinforced Concrete for Architectural Construction. Walter J. Francis. Read before the Ontario Assn. of Archts. Discussion of its history and principles. Ills. 4000 w. Contract Rev—Jan. 20, 1909. Serial, 1st part. No. 2014.

Cost of Concrete Construction as Applied to Buildings. Leonard C. Wason. Read before the Nat. Assn. of Cement Users. Gives actual costs of various parts of building construction. 3500 w. Eng Rec—Jan. 16, 1909. No. 1770.

Surfaces of Greatest Shearing Stresses for Steel Reinforced in Concrete. M. Koenen, in *Beton u. Eisen*. A discussion of the influence of shape, adhesive resistance, etc. 1000 w. Cement—Dec., 1908. No. 1732 C.

The Graphic Statics of Reinforced Concrete Sections. William Dunn. The treatment is based on Mohr's methods. Descriptive, with diagrams. 3500 w. Engng—Dec. 25, 1908. No. 1536 A.

Graphical Charts for the Determination of the Normal Stresses in Reinforced-Concrete Beams (Graphische Tafeln zur Bestimmung der Normalspannungen in Beton-Eisen-Trägern). J. Rieger. An exhaustive mathematical discussion of the construction and use of the charts. Ills. 70000 w. Oest Wochenschr f d Oeffent Baudienst—Dec. 12, 1908. No. 1976 D.

The Design of Continuous Beams and Slabs in Reinforced Concrete (Berechnung durchgehender Träger und Decken aus Eisenbeton). E. Elwitz. Mathematical. Ills. Serial, 1st part. 3800 w. Beton u Eisen—Dec. 14, 1908. No. 1986 F.

The Use of the Deflection Diagrams (Ueber die Verwertung des Durchbiegungsdiagramms). A. Kleinlogel. Discusses their application to the design of reinforced-concrete beams. Ills. Serial, 1st part. 1100 w. Beton u Eisen—Dec. 14, 1908. No. 1987 F.

The Examination of Designs for Reinforced Concrete Work. William Dunn. Abstract of a paper read before the Concrete Inst. Discusses designs, methods of calculation, importance of superintendence, etc. 2000 w. Surveyor—Dec 25, 1908. No. 1515 A.

Group of Reinforced-Concrete Buildings for a Wood Distillation Plant, Donald, Ont. Illustrates and describes a plant for the destructive distillation of wood into alcohol, with acetate of lime and charcoal as by-products. 2000 w. Eng News—Jan. 28, 1909. No. 2148.

A Notable Industrial Plant of Reinforced Concrete. Illustrates and describes the chemical mills of the Wood Products Co., at Donald, Ontario. 2500 w. Cement Age—Jan., 1909. No. 1734.

Reinforced Concrete Construction in the Hartford Armory. States the requirements and conditions and describes the construction. Ills. 3000 w. Eng Rec—Jan. 9, 1909. No. 1575.

Arch for Supporting a Floor of the Christopher Warehouse, Jacksonville, Fla. Illustrates and describes a reinforced-concrete warehouse in which a portion of the flooring and roof are carried by arches having a clear span of 54 feet. 1500 w. Eng Rec—Jan. 16, 1909. No. 1768.

Reinforced Concrete in Market Street Subway, Philadelphia. S. M. Swaab. A short illustrated description of the plant and construction methods used. 2000 w. Cement Age—Jan., 1909. No. 1733.

Reinforced Concrete Construction in Hall III in the Munich Exhibition Park (Bau der Halle III in Eisenbetonkonstruktion auf dem Ausstellungspark Theresienhöhe in München). Fritz Klette.

Illustrated description of a large building used for exhibition purposes. Plate. 2200 w. Beton u Eisen—Dec. 14, 1908. No. 1984 F.

See also Failures, Piling, Underpinning, and Waterproofing, under CONSTRUCTION; Sewers, under MUNICIPAL; Tanks, and Water Towers, under WATER SUPPLY; and Piers, under WATERWAYS AND HARBORS.

Specifications.

Specifications for Engineering Works. H. Laurence Butler. Read before the Civ. & Mech. Engrs.' Soc. Considers points that are essential to the production of a specification that shall fulfil its purpose. 3500 w. Surveyor—Jan. 15, 1909. No. 2055 A.

Stacks.

New 506-Ft. Chimney at Great Falls Smelter. Edwin Higgins. Illustrated detailed description of this largest chimney in the world. 2500 w. Eng & Min Jour —Jan. 16, 1909. No. 1761.

Steel.

Bending Moment Diagram. On the application of graphic methods to the study of beams and girders. 1000 w. Am Mach—Vol. 32, No. 2. No. 1750.

Structural Details in the New Grand Central Station, New York. Describes features of a very difficult problem in construction work. The building of a very large station on a site where over 1,000 train movements daily are constantly maintained. 3000 w. Eng Rec—Jan. 23. 1909. No. 2023.

See also same title, under MATERIALS OF CONSTRUCTION.

Tunneling Machines.

A Tunnel-Boring Machine. Illustrated description of a machine designed by E. F. Terry and O. S. Proctor, said to be capable of driving an 8-foot tunnel in rock without blasting. 1000 w. Sci Am --Jan. 9, 1909. No. 1644.

Tunnels.

Building the Raton Tunnels. Joseph Weidel. An illustrated account of the construction of the new tunnels on the Santa Fe R. R. in New Mexico. 4000 w. Cal Jour of Tech—Nov., 1908. No. 1796.

Methods Employed in Driving Alpine Tunnels: The Loetschberg Tunnel. Walton I. Aims. Explains methods that have made possible more rapid driving than has yet been attained in America. 1500 w. Eng News—Dec. 31, 1908. No. 1407.

Underpinning.

Method of Underpinning a Building Wall with a 55-Ft. Span Reinforced-Concrete Girder. Explains conditions and describes work at the waterworks pump house at Evansville, Ind. Ills. 1000 w. Engng-Con—Jan. 27, 1909. No. 2141.

Walls.

The Stability of Walls. Henry Adams. Read before the Soc. of Archts. Deals only with walls which have no load but their own weight to support, and no thrust but the wind to resist, discussing the general principles that determine stability. 5000 w. Surveyor—Jan. 15, 1909. No. 2054 A.

Waterproofing.

Tank Construction for Excluding Water from a Basement. Describes the reinforced-concrete tank for waterproofing the sub-basement of the Keyser Building in Baltimore, Md. Ills. 1500 w. Eng Rec—Jan. 9, 1909. No. 1573.

MATERIALS OF CONSTRUCTION.

Brick.

See Concrete, under MATERIALS OF CONSTRUCTION.

Cement.

Hardening Hydraulic Cements. Dr. W. Michaelis, Sr. Abstract of paper before the Assn. of German Cement Mfrs. Describes a new process. 4500 w. Sci Am Sup—Jan. 9, 1909. Serial, 1st part. No. 1648.

The Action of Frost on Cement and Cement Mortar, Together with Other Experiments on These Materials. Ernest R. Matthews, and James Watson. Describes in detail a series of experiments, giving results of interest and value. 3000 w. Pro Am Soc of Civ Engrs—Jan., 1909. No. 2122 E.

The Effect of Electrolytes on the Setting of Cement (Die Wirkung von Elektrolyten auf die Zementabbindung). Dr. Rohland. Considers the influence of various salts. 2500 w. Stahl u Eisen—Dec. 9, 1908. No. 1942 D.

Concrete.

Building Materials. H. D. Searles-Wood. Read before the Archt. Assn., London. Deals with concrete, both plain and reinforced, mortar, bricks, stone, and wood. Discussion. 12000 w. Builder—Jan. 16, 1909. No. 2046 A.

Concrete Aggregates. Explains the scope of a special commission of the British Fire Prevention Committee to report on suitable aggregates for concrete floors intended to be fire-resisting. 2000 w. Surveyor—Jan. 8, 1909. No. 1809A.

Strength of Concrete Joints. Joshua L. Miner. Reports results of a series of tests made in the laboratories of Lafayette College. Ills. Discussion. 4500 w. Pro Engrs' Soc of W Penn—Dec., 1908. No. 1744 D.

Mortar.

See Concrete, under MATERIALS OF CONSTRUCTION.

Reinforced Concrete.

Emperger's Tests on Reinforced Concrete Columns (Empergers Versuche mit betoneisernen Säulen). Max R. v. Thullie. Summarizes and discusses the results of recent tests by Fritz von Emperger. Ills. 4500 w. Zeitschr d Oest Ing u Arch Ver—Dec. 18, 1908. No. 1981 D.

See also Concrete, under MATERIALS OF CONSTRUCTION.

Steel.

Steel Work. C. V. Childs. Remarks on the influence of steel as a building material, tracing the development of steel frame buildings. 1800 w. Archt, Lond—Jan. 8, 1909. Serial, 1st part. No. 1798 A.

Nickel Steel for Bridges. R. E. Chadwick. A review of J. A. L. Waddell's paper on this subject. 2500 w. Can Engr—Jan. 15, 1909. No. 1772.

Stone.

See Concrete, under MATERIALS OF CONSTRUCTION.

Timber.

Forest Conservation. R. S. Kellogg. Timber production and its proper handling and related matters. General discussion. 7000 w. Jour N Eng W-Wks Assn—Dec., 1908. No. 1881 F.

See also Concrete, under MATERIALS OF CONSTRUCTION.

Timber Preservation.

Wood Preservation by the Open Tank Process. Ernest F. Hartmann. Suggestions for the proper treatment of timber, describing the process named. Ills. 4000 w. Eng News—Dec. 31, 1909. No. 1405.

MEASUREMENT.

Asphalt Testing.

Asphalt-Testing — Penetration. Harry Tipper. Recommends a limit of variation in penetrations at different temperatures. 1200 w. Munic Jour & Engr—Jan. 6, 1909. No. 1489.

Cement Testing.

Free Lime in Portland Cement. Alfred H. White. Describes a simple microscopic test for free lime and discusses the result of its application to a number of cements. Ills. 3500 w. Jour Ind & Engng Chem—Jan., 1909. No. 2038 E.

Concrete Testing.

Specifications for Test Specimens of Concrete to be Immersed in Sea Water by the United States Navy Department. Specifications drawn for guidance in conducting a series of tests under government supervision at the Navy Yard at Charlestown, Mass. 1500 w. Engng-Con—Dec. 30, 1908. No. 1452.

Surveying.

The Topographical Survey of the City of Baltimore. Notes from a paper by Joseph W. Shirley, submitted to the Engrs.' Club of Baltimore, giving a general account of this work. 2800 w. Eng Rec—Jan. 2, 1909. No. 1424.

Sketch Mapping in Southern Nigeria. L. H. L. Huddart. Read before the Inst. of Civ. Engrs. On the making of a preliminary sketch map of a little-known district. 2500 w. Min Jour—Dec. 19, 1908. Serial, 1st part. No. 1531 A.

MUNICIPAL.

City Planning.

The New Capital for Australia. Information concerning the site selected, treating it from the topographical, engineering and related points of view. 3000 w. Engr, Lond—Jan. 8, 1909. No. 1823 A.

Drainage.

The Storm Drainage of Pretoria. H. D. Badcock. Describes the situation and conditions, and the means taken to prevent flooding. 1200 w. Engr, Lond—Jan. 15, 1909. No. 2083 A.

Refuse Disposal.

See Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Roads.

Report on the Recent First International Road Congress. Nelson P. Lewis. Condensed report made to the Board of Estimate and Apportionment of the City of New York, summing the information acquired by the American delegates. 8800 w. Eng News—Jan. 21, 1909. No. 1873.

Good Roads in the South. Joseph Hyde Pratt. An account of what is being done in road construction. 3500 w. Mfrs' Rec—Jan. 7, 1909. (Special No.) No. 1565 C.

Highway Construction in New York State. J. C. Gotwals. Describes the steps necessary in state road improvement, and the method of macadam surfacing. 3200 w. Engr, Pa—Dec., 1908. No. 2010 D.

Notes on Highway Improvements. D. McD. Campbell. Suggestions in regard to drainage, location, grades, and other practical matters. Ills. 5000 w. Can Engr—Jan. 8, 1909. No. 1654.

Standard Details for Highway Construction. Cuts and description of construction work under supervision of the Massachusetts state highway commission. 1100 w. Engng-Con—Jan. 6, 1909. No. 1590.

The Construction of Sand-Clay Roads. W. L. Spoon. From an address before the Roads School, at Waterloo, Ia. Discusses the materials and best method of mixing them. 1400 w. Engng-Con—Jan. 27, 1909. No. 2143.

Specifications and Notes on Macadam Road Construction. A. N. Johnson. Considers in detail the road-bed, thickness of macadam, cross-slope, materials, etc., methods of construction, and related subjects. 12500 w. Jour W Soc of Engrs—Dec., 1908. No. 1859 D.

The Tarring of Roads. Prevost Hubbard. Abstract of Bul. 34 of the Office of Public Roads, Dept. of Agriculture. Illustrated explanation of how the work is done. 3500 w. Sci Am Sup—Jan. 2, 1909. No. 1432.

Dust Prevention on Public Roads (Die Staubbekämpfung auf offenlichen Strassen). Herr Fichtner. Discusses the use and effect of various dust preventatives. 4000 w. Zeitschr d Mit Motorwagen Ver—Dec. 31, 1908. No. 1973 D.

Sanitation.

Sanitary Engineering in 1908. Reviews the Report of the Royal Commission, and also progress, new works and other matters. 2500 w. Engr, Lond—Jan. 1, 1909. No. 1714 A.

Sewage Disposal.

An Electrically-Driven Sewage System. Illustrated description of the installation of ejectors at Whickham, near Newcastle-on-Tyne. 1700 w. Elect'n, Lond—Jan. 1, 1909. No. 1700 A.

The Royal Prussian Testing Institute for Water and Sewage Purification A. Elliott Kimberly. Explains the function of the Institute, the departments, general features, etc. 1500 w. Eng News—Jan. 28, 1909. No. 2154.

Sewers.

Cost of a 66-Inch Brick Sewer at Gary, Indiana. E. M. Scheflow. Gives itemized labor cost of the work. 1500 w. Eng Rec—Jan. 2, 1909. No. 1422.

The Use of Concrete in Sewer Construction. Peter Gillespie. Discusses the relative advantages of brick and concrete. 3000 w. Contract Rec—Jan. 6, 1909. No. 1653.

The Construction of the Bronx Valley Sewer. Illustrates and describes the construction of this sanitary sewer which is to serve eight villages along the Bronx River. 5000 w. Eng Rec—Jan. 9, 1909. No. 1570.

Building a Reinforced Concrete Pipe Sewer. Alexander J. Taylor. Read before the Am. Soc. of Munic. Imp. Describes methods of construction. 2500 w. Munic Engng—Jan., 1909. No. 1739 C.

Methods and Cost of Constructing a Concrete Sewer in Freezing Weather. Describes work at Fond-du-Lac, Wis., during Nov. and Dec., 1908, with the thermometer ranging from 15 degrees below zero, to the freezing point. Ills. 1500 w. Engng-Con—Jan. 27, 1909. No. 2142.

Asphalt Sewer-Pipe Joints at Monmouth, Illinois. John S. Bates. Explains conditions requiring a joint-filler, and the use of asphalt. 1500 w. Eng Rec—Jan. 9, 1909. No. 1577.

Sewer Trenches.

See Excavation, under CONSTRUCTION.

WATER SUPPLY.

Aqueducts.

An Old Aqueduct and Its Development. Albert L. Sawyer. A review of the history of the Haverhill (Mass.) Aqueduct Co. Ills. 6500 w. Jour N Eng W.Wks Assn—Dec., 1908. No. 1884 F.

The Hudson River Crossing of the Catskill Aqueduct. William B. Hoke. An account of the engineering work done with the aim of determining the best crossing, the material through which a tunnel must pass, etc. Ills. 2000 w. Engr, Pa—Dec., 1908. No. 2008 D.

Ashokan.

See Aqueducts, and Reservoirs, under WATER SUPPLY.

Conservation.

The Conservation of Water Resources. M. O. Leighton. Brief discussion of the steps necessary in the conservation of the water resources of the United States. 2500 w. Jour N Eng W-Wks Assn—Dec., 1908. No. 1880 F.

Dams.

Stresses in Masonry Dams. William Cain. Report of an investigation made to determine the amounts and distribution of the stresses in a masonry dam, at points not too near the foundations. 3500 w. Pro Am Soc of Civ Engrs—Jan., 1909. No. 2124 E.

The Granite Reef Dam and Gate Mechanism. F. Teichman. Describes particularly the diversion dam and the devices that turn the water into the two canals, in the Salt River Irrigation Project, Arizona. Ills. 2000 w. Eng News—Jan. 7, 1909. No. 1636.

See also Excavation, under CONSTRUCTION; and Lock Gates, under WATERWAYS AND HARBORS.

Discharge Coefficients.

On the Variation of the Coefficient of Discharge for Small Orifices. T. P. Strickland. Describes experimental work and the apparatus used. 4500 w. Can Soc of Civ Engrs—Jan. 7, 1909. No. 1742 N.

Ditches.

The Yukon Ditch. T. A. Rickard. Illustrated description of a system of ditch, pipe and flume which has a total length of more than 70 miles. 2500 w. Min & Sci Pr—Jan. 16, 1909. Serial, 1st part. No. 2018.

Filtration.

The New Covered Filters for Yonkers, N. Y. Illustrated detailed description of plant for filtering the river water. 3000 w. Eng Rec—Jan. 16, 1909. No. 1763.

Electrically Operated Filter Valves at Cincinnati, Ohio. F. H. Stephenson. The methods used are illustrated and described. 900 w. Eng Rec—Jan. 16, 1909 No. 1771.

See also Philadelphia, under WATER SUPPLY.

Fire Protection.

Private Fire Protection and Insurance Rules. Gorham Dana. An explanation of the work of the insurance engineer, discussing the need of private fire protection, especially automatic sprinklers. General discussion. Ills. 8500 w. Jour

N Eng W-Wks Assn—Dec., 1908. No. 1885 F.

Ground Waters.

An Instrument for the Determination of Ground-Water Levels (Messwerkzeug für die Lagebestimmung des Grundwasserspiegels). G. Thiem. Illustrated description of the apparatus and the method of use. 2000 w. Gesundheits-Ing—Dec. 12, 1908. No. 1966 D.

Irrigation.

Mechanical Irrigation Stations on the Nile. J. B. Van Brussel. Illustrates and describes an irrigation scheme carried out at Wadi Kom-Ombo, in Upper Egypt. 3000 w. Engineering Magazine—Feb., 1909. No. 2155 B.

Irrigation in Hawaii. George B. Sturgeon. Describes the conditions, and the irrigation works for the production of sugar-cane. Ills. 2800 w. Cal Jour of Tech—Nov., 1908. No. 1795.

Irrigation in Victoria. H. G. M'Kinney. An account of what has been done and the irrigation policy 2500 w. Eng Rec—Jan. 16, 1909. No. 1764.

Michigan City, Ind.

Method of Investigation of Character of Water Supply of Michigan City, Ind. A report of the investigations made and the results. 2000 w. Munic Engng—Jan., 1909. No. 1740 C.

New Jersey.

Report of the New Jersey State Water Supply Commission. Discusses the water rights troubles. 1800 w. Eng News—Jan 7, 1909. No. 1639.

Orifices.

See Discharge Coefficients, under WATER SUPPLY.

Philadelphia.

A Glance at the Water Supply of Philadelphia. John C. Trautwine, Jr. Notes on the history of the supply, progress and present condition of the filtration plant, etc. Ills. 5500 w. Jour N Eng W-Wks Assn—Dec., 1908. No. 1883 F.

Pipe Lines.

See Ditches, under WATER SUPPLY.

Pipe Strength.

The Collapse of Tubes Under External Pressure. S. E. Slocum. A study of recent experiments. 3500 w. Engng—Jan. 8, 1909. No. 1818 A.

See also Steam Pipes, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Pipe Trenches.

See Excavation, under CONSTRUCTION.

Purification.

Ozone Purification Plants. S. H. Hart. Describes the J. Howard Bridge process as installed in a small municipal plant in Canada. 2000 w. Elec Rev, N Y—Jan. 9, 1909. No. 1656.

See also Sewage Disposal, under MUNICIPAL.

Reservoirs.

Progress on the Ashokan Reservoir. A report of progress on the work in the Catskill Mts. on this reservoir for additional supply of New York City. Ills. 2000 w. Eng Rec—Jan. 16, 1909. No. 1769.

The New High Service Reservoir of the Baltimore Water System. Illustrated detailed description. 2000 w. Eng Rec—Jan. 23, 1909. No. 2027.

See also Failures, under CONSTRUCTION.

Review of 1908.

Water Supply in 1908. A review of works carried out during the year, and related matters. 2800 w. Engr, Lond—Jan. 1, 1909. No. 1713A.

Stream Discharges.

Stream Flow Data. Charles E. Chandler. Gives tables of the flow of the Sudbury River, Nashua River, and Merrimac River, with explanatory notes. 2000 w. Jour N Eng W-Wks Assn—Dec., 1908. No. 1882 F.

Tanks.

A Concrete Feed-Water Storage Tank. Warren H. Miller. Directions for building. Ills. 1500 w. Power—Jan. 26, 1909. No. 2090.

Vancouver.

Vancouver's Water Supply. An illustrated account of the additional supply obtained from Seymour Creek. 1700 w. Can Engr—Jan. 15, 1909. No. 1774

Water Towers.

A Novel Reinforced-Concrete Tower and Tank. R. B. Tufts. Illustrated description of a structure at Atlanta, Ga. 1500 w. Eng News—Jan. 7, 1909. No. 1642.

Reinforced-Concrete Water Tower for the Atlantic Compress Company, Atlanta. R. B. Tufts. Illustrated detailed description. 1500 w. Eng Rec—Jan. 2, 1909. No. 1421.

WATERWAYS AND HARBORS.

Canada.

Canada and Her Waterways. J. G. Sing. Remarks on the extent of Canada, the importance of the waterways, their recent improvement, and work in progress. 3000 w. Can Engr—Jan. 22, 1909. No. 2016.

Cleveland, O.

Recent Improvements to the Harbor at Cleveland, Ohio. Illustrated description of breakwater extensions, and changes, channel deepening, and other important changes. 1500 w. Eng Rec—Jan. 16, 1909. No. 1766.

Cofferdams.

Steel Piling at Power-House Intakes at Omaha. Describes intakes constructed under difficult conditions by handling the work in cofferdams of steel sheet piling. 1000 w. Eng Rec—Jan. 2, 1909. No. 1423.

Dikes.

A Concrete-Pile Dike for River Bank

Revetment. Describes test work constructed near Ellwood, Kansas, giving cost. 1000 w. Eng Rec—Jan. 23, 1909. No. 2025.

Dry Docks.

Extension of Malta Naval Dockyard and Harbor. Maps, plans and illustrated detailed description of new works which have cost nearly three millions sterling. Plates. 6000 w. Engng—Jan. 1, 1909. Serial. 1st part. No. 1704 A.

French West Africa.

Harbors and Rivers of French West Africa (Les Ports et les Fleuves de l'Afrique occidentale Française). Illustrated description of harbors and navigable waterways and a discussion of commercial possibilities. 9000 w. Rev Gen des Sci—Dec. 15, 1908. No. 1916 D.

Georgian Bay Canal.

The Georgian Bay Ship Canal. J. G. G. Kerry. An interesting discussion of the economic and financial elements of the undertaking, and some engineering details relating to water-supply at the summit. 2500 w. Engineering Magazine —Feb., 1909. No. 2159 B.

Harbors.

Hamburg, Antwerp and Other European Harbors (Los Puertos de Hamburgo, Amberes y varios otros de Europa). Review of a publication by the Brazilian Minister of Public Works describing large European harbors and discussing the application of their principles of construction to the port of Buenos Ayres. Ills. Serial. 1st part. 4000 w. Ingenieria—Nov. 15, 1908. No. 1939 D.

Hungary.

Hungarian Waterways (Die Wasserstrassenaktion in Ungarn). Carl Grünhut. Gives in tabular form details of present and projected canals in Hungary. Plates. 5500 w. Oest Wochenschr f d Oeffent Baudienst—Dec. 5, 1908. No. 1974 D.

Lock Gates.

The Design of the Lock Gates and of an Emergency Dam for the Panama Canal. Information from the recent report of the Isthmian Canal Commission in regard to the design of these lock gates and the dam. 1000 w. Eng News—Dec. 31, 1908. No. 1408.

Locks.

See Panama Canal, under WATERWAYS AND HARBORS.

Manitowoc, Wis.

The Improvement of Manitowoc Harbor, Wisconsin. Illustrated description of reconstruction work to meet modern conditions. Cribs from the old works are removed to the new. 2500 w. Eng Rec—Jan. 23, 1909. No. 2024.

Panama Canal.

The Meaning of the Panama Canal to the South. John Barrett. Discusses the effect on South American trade and the importance of preparing by acquiring reliable information concerning these Latin-American countries. 3000 w. Mfrs Rec—Jan. 7, 1909. (Special No.) No. 1558 C.

The Panama Canal Work Cassius E. Gillette. A defense of the day labor method of building the canal, with editorial reply. 4000 w. Engng-Con—Dec. 30, 1908. No. 1455.

The Foundations for the Gatun Locks. Review of a report by Major Chester Harding, giving information based on recent investigations, concerning materials, conditions, etc. Ills. 2000 w. Eng Rec—Jan. 2, 1909. No. 1420.

See also Lock Gates, under WATERWAYS AND HARBORS.

Piers.

Cost of Small Concrete Piers. J. H. Ryckman. Describes work in Canada, giving cost. 1000 w. Eng Rec—Jan. 23, 1909. No. 2029.

The New Piers for Transatlantic Steamships, Chelsea Improvement, New York City. Illustrated description of the largest piece of wharfing construction ever undertaken in the port of New York. 5000 w. Eng News—Jan. 14, 1909. Plate. No. 1785.

Piling.

See same title, under CONSTRUCTION.

Pollution.

The Massachusetts State Board of Health on Pollution of Boston Harbor from the Moon Island Outlet of the Boston Sewerage System. A recent report on this subject. 1000 w. Eng News—Dec. 31, 1908. No. 1409.

Review of 1908.

Harbors and Waterways, 1908. A review of progress during the past year. 3500 w. Engr, Lond—Jan. 1, 1908. No. 1711 A.

River Improvement.

Report of the Waterways Commissioner of Wisconsin. Gives a portion of this report, by Hon. Ray S. Reid. which presents new views concerning the improvement of navigable rivers. Also editorial. 8000 w. Eng News—Jan. 28, 1909. No. 2149.

Shore Protection.

See Dikes, under WATERWAYS AND HARBORS.

U. S. Waterways.

Value of Inland Waterways from a Naval Standpoint. George W. Melville. Read before the Inland Waterways Conference. 2000 w. Naut Gaz—Jan. 14, 1909. No. 1757.

Water Powers.

State Control of Water Power. Curtis E. Lakeman. Presents reasons for the adoption of public policies of water conservation. 4500 w. Am Rev of Revs—Jan., 1909. No. 1736 C.

The Administration's Positon Regarding Water Power Development. A message to the House of Representatives, by President Roosevelt. 3000 w. Eng Rec—Jan. 23, 1909. No. 2021.

Potentiality of Water-Power. Resources of the South. H. von Schon. Information concerning the available power and the explanation of the retarded development. 4000 w. Mfrs Rec—Jan. 7, 1909. (Special No.) No. 1556 C.

The Value of Southern Water-Power Investments. Francis R. Weller. Points for the guidance of those interested in their development. 3000 w. Mfrs Rec—Jan. 7, 1909. (Special No.) No. 1557 C.

The Water Powers of Sweden, Norway and Switzerland (Die Wasserkräfte Schwedens, Norwegens und der Schweiz). Eduard Engelmann. Brief descriptive notes on the leading water powers of these three countries. Ills. Serial. 1st part. 5500 w. Zeitschr f d Gesamte Turbinenwesen—Dec. 10, 1908. No. 1957 D.

MISCELLANY.

Review of 1908.

Engineering in the United States in 1908. A general review, the present number deals with railways and bridges. 6000 w. Engr, Lond—Jan. 15, 1909. Serial. 1st part. No. 2080 A.

ELECTRICAL ENGINEERING

COMMUNICATION.

Radio-Telegraphy.

The Cooling of Rotating Discs Considered in Connection with Marconi's New Generator of Continuous Oscillations. Information from a contribution by R. Rüdenberg in the "Jahrbuch, der Drahtlosen Telegraphie." 1500 w. Elect'n, Lond—Dec. 25, 1908. No. 1524 A.

A Directive System of Wireless Telegraphy. E. Bellini and A. Tosi. Describes the author's bilateral directive wireless telegraph system and gives particulars of a new unilateral directive method. 1500 w. Elect'n, Lond—Jan. 15, 1909. No. 2069 A.

The Bellini-Tosi Directive System of Wireless Telegraphy and Telephony (Télégraphie et Téléphonie sans Fils dirigeables Bellini-Tosi). M. Tosi. Illustrated detailed description. 6000 w. Bul Soc Int des Elecns—Dec., 1908. No. 1906 F.

Telegraphone.

The Telegraphone. Charles K. Fankhauser. Explains the principles embodied, its accomplishments, applications and influence. 3500 w. Jour Fr Inst—Jan., 1909. No. 1848 D.

Telegraphy.

The Technical Problems of Telegraphy and Telephoney (I Problemi tecnico-scientifici della Telegraphia e della Telefonia). G. di Pirro. A general discussion of electrical methods of communication. Ills. 5500 w. Ann d Soc d Ing e d Arch Ital—Dec. 15, 1908. No. 1935 F.

Telephone Tolls.

The Economical Development of Toll Territory. Frank F. Fowle. Considers the principal factors in building up a successful toll plant. 4000 w. Elec Rev, N Y—Jan. 9, 1909. Serial. 1st part. No. 1658.

Telephone Transmitters.

The Two-Tone Vibrating Transmitter and Inductive Signaling. Edward Raymond-Barker. Discusses its application especially to maintaining communication between ship and shore during cable repair. 4000 w. Elect'n, Lond—Jan. 15, 1909. No. 2073 A.

Telephony.

Reflection of Waves in Telephone Lines (Reflexionen in Fernsprechleitungen). F. Breisig. Mathematical discussion. Ills. 3000 w. Elektrotech Zeitschr—Dec. 17, 1908. No. 2113 D.

The Telephone Problem in France (Le Problème Téléphonique actuel en France). Albert Turpain. Discusses faults of practice and the lessons to be learned from the recent destruction by fire of a large exchange in Paris. 3200 w. Rev Gen des Sci—Dec. 30, 1908. No. 1918 D

DISTRIBUTION.

Current Rectifiers.

The Mercury Rectifier. R. P. Jackson. Describes its operation, application, and related matters. Ills. Discussion. 4000 w. Pro Engrs' Soc of W Penn—Dec., 1908. No. 1743 D.

Switches.

The Design of Contact Springs and Contact Brushes for Switching Apparatus (Studien über die Berechnung der Kontaktfedern und Kontaktbürsten für Schaltapparate). Robert Edler. Discusses the calculation and standardization of apparatus of this type. Ills. Serial. 1st part. 4800 w. Elektrotech u Maschinenbau—Dec. 6, 1908. No. 1994 D.

Wiring.

Wiring a Finished Dwelling Without Defacement. Illustrated description of methods used in a house in New York. 1200 w. Elec Wld—Jan. 7, 1909. No. 1672.

The Craze for Cheap Wiring. S. G. Castle Russell. Discusses interests likely to be affected by the adoption of cheap wiring methods, and the systems proposed. 3500 w. Elec Rev, Lond—Jan. 8, 1909. No. 1806 A.

We supply copies of these articles. See page 1071.

DYNAMOS AND MOTORS.

A. C. Dynamos.

Comparative Weights and Costs of Alternating and Continuous-Current Generators. A. G. Ellis. Investigation to determine the relative weights and costs and the influence on the rated speed and output. 2000 w. Elec Engng—Dec. 31, 1908. No. 1690 A.

The Relative Proportions of Copper and Iron in Alternating- and Continuous-Current Generators. A. G. Ellis. Explains the preponderance of copper in c. c. designs as compared with a. c. designs and other comparisons. 1700 w. Elec Engng —Jan. 7, 1909. No. 1803 A.

Deformation of Pressure Curves Due to Load in Alternate Current Generators. Egon Siedek. An oscillographic investigation of the effect of armature reaction in alternators. 1200 w. Elect'n, Lond—Jan. 15, 1909. No. 2071 A.

Fluctuations in the Speed of the Rotors of Alternators Operating in Parallel. George H. Shepard. An analysis of the interactions of two alternators in parallel explaining the means that may be employed for stopping the enlargement of the angle of phase displacement while it is still very small. 1800 w. Elec Wld—Jan. 28, 1909. No. 2126.

A. C. Motors.

The Single-Phase Commutator-Type Motor. B. G. Lamme. From a paper before the Phila. Sec. of the Am. Inst. of Elec Engrs. Explains the cause of trouble in commutating alternating currents and the problems encountered in designing such motors. 4500 w. Elec Jour—Jan., 1909. No. 1842.

Air Gaps.

A Diagram for Correction Coefficients for Air-Gap Reluctances. T. C. Baillie. Quotes experiments verifying Carter's formula, and gives a diagram from which the coefficients can be read. 500 w. Elect'n, Lond—Jan. 8, 1908. No. 1807 A.

Brakes.

Friction Brakes. Henry D. James. Aims to show the importance of careful design and application of friction brakes to suit stated conditions. Ills. 1700 w. Elec Jour—Jan., 1909. No. 1844.

Commutators.

Some Remarks on Flatting and Blackening of Commutator Bars. Considers troubles which, if not rectified, render the machine unfit for service. 1000 w. Elec Rev, Lond—Jan. 15, 1909. No. 2064 A.

Controllers.

Automatic Control of Direct-Current Motors in Industrial Service. D. E. Carpenter. Remarks on the importance of selecting a proper controller with an illustrated description of a type of magnet switch controller and its operation. 3000 w. Elec Jour—Jan., 1909. No. 1843.

D. C. Dynamos.

See A. C. Dynamos, under DYNAMOS AND MOTORS.

D. C. Motors.

See Controllers, under DYNAMOS AND MOTORS.

Induction Motors.

Methods of Starting Large Three-Phase Induction Motors. J. W. Rogers. Briefly describes the construction of such motors and the methods employed for starting them. 2500 w. Prac Engr—Jan. 15, 1909. No. 2050 A.

Belt-Leakage in Induction Motors. R. E. Hellmund. Aims to investigate and demonstrate, in a general way, the characteristics of belt-leakage. 3000 w. Elec Rev, N Y—Jan. 2, 1909. No. 1469.

Some Graphical Solutions to Three-Phase Problems. Leonard Solomon. Gives a graphical method of calculating the resistances to be inserted in the rotor circuit in two cases, based on the Heyland diagram. 1200 w. Elect'n, Lond—Jan. 15, 1909. No. 2068 A.

See also Starters, under DYNAMOS AND MOTORS.

Interpoles.

Some Notes on Commutating-Pole Design. E. O. Turner. Read before the Students' Sec. of the Inst. of Elec. Engrs. at Glasgow. Explains method of finding the necessary ampere-turns and the dimensions for the pole-shoe and pole-core. 2000 w. Elect'n, Lond—Jan. 15, 1909. No. 2067 A.

Railway Motors.

Single-Phase Railway Motors (Les Alternomoteurs monophase de Traction). M. Henry. A general review. The first part discusses the principal types, their characteristics, the choice of frequency, and efficiency. Ills. Serial. 1st part. 3500 w. L'Elecn—Dec. 19, 1908. No. 1923 D.

Starters.

Rheostatic Starters for Induction Motors. Dr. Benjamin F. Bailey. A comparison of the rheostatic starter and the auto-starter. 2000 w. Elec Wld—Jan. 2, 1909. No. 1476.

Windings.

Factors Governing the Space Utilization of Electromagnetic Windings. Charles R. Underhill. Discusses some of the influences affecting the space utilization coefficient. 1200 w. Elec Wld—Jan. 14, 1909. No. 1789.

ELECTRO-CHEMISTRY.

Alkalis.

See Chlorine, under ELECTRO-CHEMISTRY.

Calcium Cyanamide.

The Manufacture of Calcium Cyanamide (La Fabrication industrielle de la Cyanamide de Calcium). H. Marchand. A description of the various electrical methods. 3500 w. Rev Gen des Sciences —Dec. 30, 1908. No. 1919 D.

The Utilization of Atmospheric Nitrogen for the Production of Calcium Cyanamide and the Employment of the Latter in Agriculture and in Chemistry (L'Utilisation de l'Azote atmosphérique dans la production de la Cyanamide de Calcium et son Emploi en Agriculture et en Chemie). Albert Frank. Ills. 5000 w. Rev d'Electrochimie—Nov., 1908. No. 1910 F.

Chlorine.

The Electrolytic Chlorine and Alkali Industry (Etat actuel de l'Industrie du Chlore et des Alcalis électrolytiques). André Brochet. A review of methods and the present status of the industry. Ills. 5600 w. Bul Soc Int des Elecns—Dec., 1908. No. 1905 F.

Detinning.

The Detinning of Tin-Plate Scrap and the Economics of the Process (Der Entzinnung der Weissblechabfälle und ihre wirtschaftliche Bedeutung). K. Goldschmidt. Describes various methods proposed and in use and discusses the economic importance of the detinning industry. Ills. 4400 w. Stahl u Eisen—Dec. 30, 1908. No. 1945 D.

Electro-Metallurgy.

Some Recent Advances in Electro-Chemistry and Electro-Metallurgy. Saul Dushman. Discusses briefly the utilization of atmospheric nitrogen, electric smelting, advances in electro-metallurgy, etc. 2500 w. Ap Sci—Jan., 1909. No. 2095 C.

Silundum, a New Product of the Electric Furnace. F. Bölling. An account of a product obtained when carbon is heated in a vapor of silicon. 2000 w. Elec-Chem & Met Ind—Jan., 1909. No. 1682 C.

Electric Furnace for the Production of Carbon Bisulphide. Explains some of the uses of bisulphide of carbon, and illustrates and describes the furnace used for its manufacture. 1600 w. Elec Rev, Lond—Dec. 25, 1908. No. 1520 A.

The Influence of Cheap Electricity on Electrolytic and Electrothermal Industries. E. A. Aschroft. Read before the Faraday Soc. An interesting paper discussing cost of electrical energy, per kilowatt per annum when produced by steam engines, gas engines, oil engines, and water power. 3500 w. Elec Engr, Lond—Jan. 1, 1909. No. 1691 A.

Heat Conductance and Resistance of Composite Bodies. Carl Hering. Gives formulæ for calculating the heat conducted through the walls of an electric furnace, with explanatory notes. 3500 w. Elec-Chem & Met Ind—Jan., 1909. No. 1675 C.

Galvanizing.

Researches on Electro-Galvanizing (Einige Versuche über galvanische Verzinkung). Carl Richter. Gives results of tests made under various conditions. 2000 w. Elektrochem Zeitschr—Dec., 1908. No. 1946 D.

Ozone.

The Thermal Production of Ozone. Arthur W. Ewell. Reviews the experimental work in this field. 2000 w. Elec-Chem & Met Ind—Jan., 1909. No. 1681 C.

ELECTRO PHYSICS.

Electrons.

Theory of Electrons. Sir Oliver Lodge. An explanation. 2000 w. Sci Am Sup—Jan. 2, 1909. No. 1431.

Recent Electrical Theory. J. Franklin Meyer. Reviews the attempts to formulate an electrical theory and explains the electron theory. 3000 w. Engr, Pa—Dec., 1908. No. 2011 D.

Magnetic Alloys.

Experiments with Heusler's Magnetic Alloy. J. G. Gray. Abstract of paper read before the Roy. Soc. of Edinburgh. Describes investigations of the magnetic properties at different temperatures. 1200 w. Elect'n, Lond—Dec. 25, 1908. No. 1525 A.

Radio-Activity.

Rays of Positive Electricity. Sir J. J. Thomson. Delivered at the Royal Inst. Describes a new investigation of Goldstein's "canal rays." Ills. 5000 w. Sci Am Sup—Jan. 2, 1909. No. 1430.

Skin Effect.

The Superficial Localization of Currents and Variable Fluxes (Sur la Localisation superficielle des Courants et Flux variables). P. Boucherot. A simplified mathematical discussion. Ills. 3800 w. Bul Soc Int des Elecns—Nov., 1908. No. 1904 F.

Spark Gaps.

Note on the Electrical Resistance of Spark Gaps. R. A. Houstun. Abstract of paper read before the Roy. Soc. of Edinburgh. Describes the effect of changing the material of the electrode. 1000 w. Elect'n, Lond—Dec. 25, 1908. No. 1526 A.

GENERATING STATIONS.

Accumulators.

Storage Batteries in Mining Service. George A. Iler. Illustrates and describes a plant installed at Prudence, W. Va. 1000 w. Elec Wld—Jan. 2, 1909. No. 1472.

The Theoretical Calculation of the Battery Capacity Required for a Given Load. Dr. W. Lulofs. Aims to show that the Peukert formula holds good for English makes, and to calculate the respective values of the constants *n* and *a*. 1500 w. Elect'n, Lond—Jan. 1, 1909. No. 1698 A.

Central Stations.

Heat-Losses in an Electric Power Station. Abstract of a paper by F. H. Corson, before the Inst. of Civ. Engrs. A report of trials. 1200 w. Engng—Jan. 1, 1909. No. 1706 A.

Electricity Supply in the Tropics. An account of some of the problems encountered in the erection and operation of a plant. 1800 w. Elec Rev, Lond—Jan. 1, 1909. No. 1696 A.

New Turbine Plant at Allentown, Penn. John I. Baker. Illustrates and describes an alternating-current plant with special facilities for handling coal and ash. 3000 w. Power—Jan. 5, 1909. (Special No.) No. 1484 D.

Hampton Power Plant of the D., L. & W. R. R. Warren O. Rogers. Illustrated description of a large central plant supplying steam to fire collieries and electricity to fifteen additional mines. 3000 w. Power—Jan. 19, 1909. No. 1832.

Station No. 3 of the Rochester Railway & Light Company. Illustrated description of the largest steam generating station of this company. 3500 w. Elec Wld—Jan. 21, 1909. No. 1868.

Quarry Street Station of the Commonwealth Edison Company, Chicago. William Keily. Illustrates and describes the characteristics of this important station, pointing out the reasons for its creation. 5000 w. Elec Wld—Jan. 2, 1909. No. 1470.

Electricity Supply at St. Albans. Illustrated description of an English plant combining a refuse destructor and generating station. 3000 w. Elec Engng—Dec. 24, 1908. No. 1516 A.

Cost Keeping.

Cost Keeping in the Central Station Contracting Department. Ludwig Kemper. From a paper read before the N.-W. Elec. Assn. Describes the system used at Albert Lea, Minn. 1000 w. Elec Wld—Jan. 28, 1908. No. 2127.

Costs.

Representative Steam-Plant Operating Costs. Howard S. Knowlton. A comparative study of itemized costs. 2500 w. Engineering Magazine—Feb., 1909. No. 2163 B.

Hydro-Electric.

The Analysis of an Hydro-Electric Project. H. von Schon. The features of the market analysis are discussed, the power load inquiry, the power output, the cost, etc. General discussion. 13000 w. Jour W Soc of Engrs—Dec., 1908. No. 1856 D.

American Hydro-Electric Construction Work Abroad. H. Lester Hamilton. Illustrates and describes important installations in various countries. 3000 w. Cassier's Mag—Jan., 1909. No. 1728 B.

System of the Rochester Railway & Lighting Company. Illustrated description. The chief source of power is the Genesee River, but steam-driven generators are used and power is also transmitted from Niagara Falls. 2000 w. Elec Wld—Jan. 14, 1909. No. 1788.

Large Water-Power Stations of the Rochester Railway & Light Company. Illustrated descriptions of stations 4 and 5. 2000 w. Elec Wld—Jan. 28, 1909. No. 2125.

An Extensive Power System in the South. Cecil P. Poole. Illustrated account of the development of the Southern Power Co., in the Carolinas. 4000 w. Power—Jan. 5, 1909. (Special No.) No. 1478 D.

The Hemsjö Power Company, Sweden. P. Frenell. Illustrated description of features of this hydro-electric plant showing the latest electrical developments in Sweden. 1400 w. Elect'n, Lond—Jan. 8, 1909. Serial. 1st part. No. 1808 A.

A Recent Swedish Hydro-Electric Plant. P. Frenell. Illustrated description of features of interest in the Hemsjö plant, showing the advantage of storage of water. 4500 w. Elec Wld—Jan. 7, 1909. No. 1667.

Dalmatian Carbide Works Using 30,000-Volt Generator. Frank Koester. Illustrated detailed description of the Manojlovac power plant, Dalmatia. 2800 w. Elec Rev, N Y—Jan. 9, 1909. No. 1657.

A 50000-Volt Transmission System. Frank C. Perkins. The Brusio-Campocologna, the largest hydro-electric plant in Switzerland is illustrated and described. 2000 w. Sci Am Sup—Jan. 9, 1909. No. 1647.

See also Cofferdams, under CIVIL ENGINEERING, WATERWAYS AND HARBORS.

Isolated Plants.

The Model Operation of an Isolated Plant. Illustrated detailed description of the method of operating the mechanical plant of the St. Regis Hotel, New York City; the cost records and efficiency. 2500 w. Elec Age—Jan., 1909. No. 1862.

Engines for Isolated Lighting and Power Plants. Charles L. Hubbard. Discusses the best type of engines to be used for such plants. 1600 w. Elec Rev, N Y—Jan. 23, 1909. No. 2017.

Manufacturers' Interests in Isolated Plants. Charles M. Ripley. A defense of independent power plants as compared with Central stations from the standpoint of operating costs. 3500 w. Ir Age—Jan. 7, 1909. No. 1497.

The New Power Plant of Pacific Mills. Illustrated description of the steam turbine-generator installation at Lawrence, Mass. Mills for the manufacture of textile goods. 2000 w. Elec Rev, N Y—Jan. 2, 1909. No. 1467.

Operation.

Parallel Operation of Turbine-Driven Central Stations. J. E. Fries. Explains the function of the turbine speed regulator, giving examples of arrangements for different conditions. 2000 w. Elec Rev, N Y—Jan. 9, 1909. No. 1659.

Rates.

Rate Regulation of Electric Power. S. S. Wyer. Discusses the legal principles involved in the sale of electricity. 6500 w. Cassier's Mag—Jan., 1909. No. 1727 B.

Central Station Rates. Abstract of paper by R. S. Wallace, at meeting of the Illinois State Elec. Assn., on "Rates and Their Relation to the Cost of Manufacture." 3500 w. Elec Wld—Jan. 7, 1909. No. 1671

Switch Bars.

See Switches, under DISTRIBUTION.

Taxation.

The Proposed Electricity Taxation Law and Electric Lighting (Der Entwurf des Elektrizitätssteuergesetzes in technischer Beleuchtung). Georg Dettmar. A discussion of the probable effects of the law proposed in Germany. Discussion. Ills. 25000 w. Elektrotech Zeitschr—Dec. 10, 1908. No. 2111 D.

Wind Power.

Wind Power for Driving Dynamos (Utilisation du Vent comme Force Motrice pour Actionner des Dynamos). J. A. Montpellier. A discussion of the cost of wind power plants. 2000 w. L'Elecn—Dec. 5, 1908. No. 1920 D.

LIGHTING.

Arc Lamps.

The Relation Between the Efficiency of Alternating-Current Flame Arc Lamps and the Nature and Amount of the Steadying Device (Ueber die Abhängigkeit der Lichtstärke und des Effektverbrauches bei Wechselstrom-Flammbogenlampen von der Art und Grösse der Vorschaltung). Paul Högner. A comparison between induction coils and the resistor in series. Ills. 2000 w. Elek Zeitschr—Dec. 3, 1908. No. 2117 D.

The Dependence of the Efficiency of Alternating-Current Flame Arc Lamps on the Nature and Amount of the Steadying Device. Report of results of recent experiments by Paul Högner. 1200 w. Elec Engr, Lond—Dec. 25, 1908. No. 1517 A.

The Regulation of Arc Lamps with Inclined Electrodes and Deflecting Magnets (Ueber das Regulieren der Bogenlampen mit schrägen Kohlen und Blasmagneten). J. Teichmüller. An explanation of the principles. Ills. Serial. 1st part. 3500 w. Elektrotech Zeitschr—Dec. 17, 1908. No. 2112 D.

Illumination.

Indirect Illumination. Augustus D. Curtis. Illustrates and describes the successful use of tungsten lamps for indirect lighting. 1400 w. Cent Sta—Jan., 1909. No. 1655.

The Lighting of Reading Rooms: With Some Examples. P. Blagg. Criticises the work in English libraries, giving examples of good and bad arrangements. 2500 w. Elec Rev, Lond—Dec. 25, 1908. No. 1519 A.

Incandescent Lamps.

The Incandescent Electric Lamp. J. Findlay. Abstract of a paper read before the Rugby Engng Soc. Remarks on early patents, tests, rating, etc. 1500 w. Elect'n, Lond—Dec. 25, 1908. No. 1522 A.

Metallic Filament Lamps. W. A. Barnes. Abstract of paper before the Manchester Assn. of Engrs. Describes types, giving detailed results of tests, and related information. 2500 w. Prac Engr—Jan. 15, 1909. Serial. 1st part. No. 2051 A.

Standard Lamp Screws of the German Electrical Association and Their Use in Practice (Die Normalgewinde des Verbandes Deutscher Elektrotechniker und ihre Anwendung in der Praxis). Paul A. Perls. A critical discussion. Ills. 3600 w. Elektrotech Zeitschr—Dec. 3, 1908. No. 2110 D.

See also Illumination, under LIGHTING.

Street.

Recent Developments in the Street Lighting of Berlin, and a Comparison with Former Methods of Illumination. Dr. L. Bloch. A detailed comparison of the various methods now in use. 2500 w. Elect'n, Lond—Jan. 1, 1909. Serial. 1st part. No. 1701 A.

A Few Notes on American and European Street Lighting. H. Thurston Owens. A comparison, illustrating and describing fixtures, methods, etc., with suggestions. 2500 w. Eng News—Jan. 7, 1909. No. 1638.

MEASUREMENT.

Dynamo Testing.

On a Method of Using Transformers as Choking Coils and Its Application to the Testing of Alternators. J. D. Coales Abstract of a paper read before the Birmingham Loc. Sec. of Inst. of Elec. Engrs. Describes the method and its application. 1800 w. Elect'n, Lond—Dec. 25, 1908. No. 1521 A.

Instruments.

Alternating-Current Instruments. Paul MacGahan. The present article gives an illustrated description of disc type induction ammeters and voltmeters. their construction and operation. 1800 w. Elec Jour—Jan., 1909. Serial. 1st part. No 1845.

Insulation Testing.

Insulation Testing. E. M. Wood. Deals with tests made to determine if the insulation is sufficient for safe use. 3000 w Ap Sci—Jan., 1909. No. 2094 C.

Meters.

Value of the Care and Maintenance of Meters. H. D. King. Abstract of a paper read before the Nat. Elec. Lgt. Assn. Gives results of tests made of meters. 1000 w. Elect'n, Lond—Dec. 25, 1908. No. 1527 A.

Meter Testing.

Testing Electric Meters. From a paper, by Frank A. Vaughn, read before the N.-W. Elec. Assn., giving an account of the measures adopted at Milwaukee to meet the requirements of the Wisconsin public service commission. 1800 w. Elec Wld—Jan. 28, 1909. No. 2128.

Testing and Adjusting Watt-Hour Meters. O. F. Dubruiel. Gives practical methods of handling Westinghouse instruments, with wiring diagrams. 1500 w. Power—Jan. 5, 1909. (Special No.) No. 1481 D.

Power Factor.

Deduction of the Power Factor in Balanced Three-Phase Circuits from Wattmeter Readings (Deduzione del Fattore di Potenza di un Circuito trifase equilibrato dalle Indicazioni dei Wattmetri). Angelo Barbagelata. A mathematical demonstration of the method. Ills. 3600 w. Elettricita—Dec. 3, 1908. No. 1937 D.

Standards.

See Units, under MEASUREMENT.

Units.

Electrical Units and Standards (Unités et Etalons électriques). M. Devaux-Charbonnel. Discusses the problems to be solved in devising an international system. 6000 w. L'Elecn—Dec. 12, 1908. No. 1921 D.

POWER APPLICATIONS.

Agriculture.

Power from the Farm Brook. Donald Cameron Shafer. An illustrated account of the possible uses to be made of electric power generated. 4000 w. Am Rev of Revs—Jan., 1909. No. 1737 C.

Alternating Currents.

Alternating Currents and Reciprocating Movements (Appareils et Machines à Courant et Mouvement alternatifs). P. Boucherot. Discusses the possibility of producing reciprocating movements direct from the alternations in a. c. circuits without utilizing rotary motion. Ills. 7500 w. Bul Soc Int des Elecns—Dec., 1908. No. 1907 F.

Welding.

See same title, under MECHANICAL ENGINEERING, MACHINE WORKS AND FOUNDRIES.

TRANSMISSION.

Alternating Currents.

Graphical Diagram for Power in an Alternating-Current Circuit. J. Irving Brewer. An explanation of its construction. 1200 w. Elec Wld—Jan. 21, 1909. No. 1871.

The Development of an Alternating-Current Distributing System. H. B. Gear. Discusses problems common to the development of all a. c. systems and also some special cases. Discussion. Ills. 7000 w. Jour W Soc of Engrs—Dec., 1908. No. 1858 D.

Balancing.

The Balancing of a Three-Wire Direct-Current Network. B. Sankey. Suggestions from the writer's experience, describing a successful system. 600 w. Elec Rev, Lond—Jan. 1, 1909. No. 1694 A.

Cable Drawing.

See Conduits, under TRANSMISSION.

Cable Records.

Plans and Records for Electrical Distribution Systems. J. W. Beauchamp. Abstract of a paper before the Leeds Loc. Sec. of the Inst. of Elec. Engrs. Describes the system of mains, records used by the Sheffield Corporation. Diagrams. 1200 w. Elect'n, Lond—Jan. 1, 1909. No. 1697 A.

Circuit Breaking.

Voltage Strains Due to Circuit-Breaking in Direct-Current Systems. L. Silberberg. A mathematical examination of the behavior of voltage and current to ascertain what strains a circuit may undergo during the opening period. 1500 w. Elec Wld—Jan. 7, 1909. No. 1668.

Conduits.

Underground Lines. H. B. Gear and P. F. Williams. Illustrated description of method of installing underground cables in America. 5000 w. Elec Age—Jan., 1909. No. 1863.

Four Wire.

Three-Phase Four-Wire Systems. K. Faye-Hansen. Explains the advantages of this system under certain conditions, and matters relating to its installation. Diagrams. 1200 w. Elect'n, Lond—Dec. 25, 1908. No, 1523 A.

Frequency.

The Influence of Frequency on the Equipment Circuits of Alternating-Current Transmission Lines. A. E. Kennelly. Presents the computed values of resistances, reactances, inductances and capacities of a particular type of transmission-line for different frequencies. 3000 w. Elec Wld—Jan. 21, 1909. No. 1869.

Insulators.

Insulation of High-Tension Transmission Lines. F. S. Denneen. Discusses line insulators and their design. 2500 w. Elect'n, Lond—Jan. 15, 1909. No. 2070 A.

The Electrical Qualities of Porcelain, with Special Reference to Dielectric Losses. H. F. Haworth. Abstract of a paper read before the Royal Soc. Gives particulars of experiments made to determine the capacity, conductivity and dielectric loss of porcelain and their variations in respect to potential, temperature and time. 2500 w. Elect'n, Lond—Jan. 1, 1909. No. 1699 A.

Lightning.

Divisch, a Lightning-Rod Pioneer, 1754. Brother Potamian. An account of early experimental work. 4000 w. Elec Wld—Jan. 2, 1909. No. 1473.

The Theory of Lightning. Daniel S. Carpenter. A study of the accumulation of electricity on the clouds and its close association with the formation of rain-drops is given in the present number. 2500 w. Elec Wld—Jan. 7, 1909. Serial. 1st part. No. 1670.

Line Design.

Chart for the Consultation of the Size of Copper Conductors in Transmission Lines. L. A. Herdt. Chart with explanation of its construction and use. 2000 w. Elec Wld—Jan. 2, 1909. No. 1474.

The Design of Aerial Transmission Lines (Zur Berechnung offener elektrischer Leitungen). J. K. Sumec. A mathematical discussion of various methods. Ills. 4000 w. Elektrotech u Maschinenbau—Dec. 27, 1908. No. 1995 D.

Lines.

A Spanish Power Transmission Plant at 6600 Volts. Brief illustrated description of a high pressure, long distance system of interest. 500 w. Elec Rev, Lond—Jan. 15, 1909. No. 2062 A.

Line Troubles.

The Winter Sleet Storm as a Destroyer of Aerial Lines. Clarence Mayer. An illustrated account of troubles caused by a sleet storm, and the cost. 1500 w. Elec Rev, N Y—Jan. 16, 1909. No. 1758.

Rotary Converters.

Representation of Synchronous Converter Phenomena. Olin J. Ferguson. Gives a graphical method of representing the converter's behavior. 1200 w. Elec Wld—Jan. 21, 1909. No. 1870.

Substations.

Large New Substations of the Chicago Railways Company. Drawings and description of construction details. 1000 w. Elec Ry Jour—Jan. 2, 1909. No. 1433.

Three-Wire.

The Three-Wire System with One Dynamo. Cecil P. Poole. Explains why the neutral wire is needed; methods used for compensating unbalanced load, etc. Ills. 1500 w. Power—Jan. 5, 1909. (Special No.) No. 1485 D.

See also Balancing, under TRANSMISSION; and Conductors, under STREET AND ELECTRIC RAILWAYS.

Transformers.

Transformers. W. B. Kouwenhoven. Explains the principle upon which a transformer operates. 2500 w. Ry & Loc Engng—Jan., 1909. No. 1448 C.

Chart for Determining the Efficiencies of Transformers. Henry C. Stanley. Gives chart for determining efficiencies at 1/4 load intervals from 1/4 load to 1 1/4 load. 500 w. Elec Wld—Jan. 2, 1909. No. 1475.

Tests of a 100,000-Volt Transformer (Versuche mit 100,000 Volt-Transformatoren). Gustav Benischke. Describes the tests and discusses the results. Ills. 1800 w. Elek Kraft u Bahnen—Dec. 4, 1908. No. 1989 D.

See also Dynamo Testing, under MEASUREMENT.

Underground.

See Conduits, under TRANSMISSION.

MISCELLANY.

Review of 1908.

A Review of the Year in the Electrical Industry. Brief review of the important divisions of this industry. 6000 w. Elec Rev, N Y—Jan. 2, 1909. No. 1464.

Electrical Engineering, 1908. A review of progress, especially in Great Britain, and applications made. 4000 w. Engr, Lond—Jan. 1, 1909. No. 1715 A.

Review of Electrical Progress in Great Britain During 1908. Albert H. Bridge. A résumé of present conditions of electrical manufacturing, lighting and power. Ills. 2200 w. Elec Rev, N Y—Jan. 2, 1909. No. 1465.

Electrical Developments on the Continent. C. L. Durand. Considers progress made in electric traction, power, electrochemistry, telegraphy and telephony. 2500 w. Elec Rev, N Y—Jan. 2, 1909. No. 1466.

INDUSTRIAL ECONOMY

Co-partnership.

Co-partnership and Unemployment. George N. Barnes. A reply to the article by Sir Benjamin C. Browne, putting forth the labor view of the subject. 3000 w. Engr, Lond—Jan. 8, 1909. No. 1822 A.

Cost Systems.

Systematic Foundry Operation and Foundry Costs. C. E. Knoeppel. This fifth article of a series deals with apportioning costs to production in various classes of work. 4500 w. Engineering Magazine—Feb., 1909. No. 2156 B.

Errors and Difficulties in Fixing Manufacturing Costs. W. M. S. Miller. Gives a practical plan for correct distribution of expenses. 3300 w. Engineering Magazine—Feb., 1909. No. 2162 B.

See also Cost Keeping, under CIVIL ENGINEERING, CONSTRUCTION; and Cost Keeping, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Depreciation.

The Importance of the Depreciation Question in Industry (Die wirtschaftliche Bedeutung der Abschreibungsfrage für der Industrie). C. M. Lewin. A discussion of the practice of writing off a certain amount each year from plant value to cover depreciation. Ills. 2500 w.

Zeitschr f Werkzeug—Dec. 15, 1908. No. 1983 D.

Education.

On the Systematic Training of Engineers: Are We Practical? Charles A. Bowman. Urges some acquaintance with practical engineering experience before entering a technical college. 2000 w. Can Engr—Jan. 22, 1909. No. 2015.

The Development of the Mechanical Engineer. George Frederic Stratton. Discusses the advantages of scientific training. 2000 w. Cassier's Mag—Feb., 1909. No. 2329 B.

University Degrees in Engineering. J. A. Fleming. Considers the requirements and object of engineering education, and how far they are being met by British universities. 3500 w. Engng—Jan. 8, 1909. No. 1821 A.

Organization and Management of Trade Schools. John M. Shrigley. Address before the Nat. Soc. for Pro. of Ind. Ed. Gives the experience of the Williamson Free School of Trades in developing journeymen mechanics, the instruction being by exercise work only. 4500 w. Am Mach—Vol. 32. No. 3. No. 1867.

Laboratory Instruction in Mechanical Engineering and the Laboratory of the Aachen Technical School (Der Laboratoriumsunterricht an Maschinenbauschulen und das Maschinenlaboratorium der Kgl. Höheren Maschinenbauschule zu Aachen). Herr Heim. Illustrated description of equipment. 4300 w. Zeitschr d Ver Deutscher Ing—Dec. 12, 1908. No. 2100 D.

Filing Systems.

See Records, under STREET AND ELECTRIC RAILWAYS.

Industrial Betterment.

See Welfare Work, under RAILWAY ENGINEERING, MISCELLANY.

Labor Arguments.

The Shipbuilding Trades' Agreement. Text of the agreement made with the view of settling trade disputes without stoppage of work. Also editorial. 3000 w. Engng—Jan. 15, 1909. No. 2078 A.

Labor Insurance.

Insurance against Unemployment (Les Caisses d'Assurances contre le Chomage). P. Maurice. A general discussion of the problems of unemployment. Ills. Serial. 1st part. 4000 w. Génie Civil—Dec. 5, 1908. No. 1926 D.

Management.

The Organization of Small Engineering Works. W. O. Horsnaill. Shows the importance of cost-keeping, systematic methods of work, etc., in the present number. 2200 w. Mech Wld—Jan. 1, 1909. Serial. 1st part. No. 1529 A.

Increasing Production by the Premium System. T. A. Sperry. Discusses the essentials of a successful system. 5500 w. Am Mach—Vol. 32, No. 5. No. 2257.

Efficiency as a Basis for Operation and Wages. Harrington Emerson. This eighth article of a series discusses the efficiency system in operation. 4000 w. Engineering Magazine—Feb., 1909. No. 2161 B.

See also Drafting Rooms, under MECHANICAL ENGINEERING, MACHINE ELEMENTS AND DESIGN.

Natural Resources.

The Conservation Idea as Applied to the American Society of Mechanical Engineers. M. L. Holman. Presidential address, 1908, discussing plans of this problem. 12500 w. Jour Am Soc of Mech Engrs—Jan., 1909. No. 1849 F.

Our National Resources, Their Conservation and Utilization. John Birkinbine. A discussion of some of these resources and their proper conservation and wise utilization. 7500 w. Jour Fr Inst—Jan., 1909. No. 1846 D.

How May the First Steps in Conservation be Taken? Editorial on the prevention of waste of mineral wealth, giving abstracts of two papers showing the waste in the oil fields. 3000 w. Eng News—Jan. 7, 1909. No. 1641.

Report of the National Conservation Commission and Accompanying Message of President Roosevelt. All the inventory portion of the report, with an abstract of the remainder. 6500 w. Eng News—Jan. 28, 1909. No. 2153.

Panama Canal.

See same title, under CIVIL ENGINEERING, WATERWAYS AND HARBORS.

Patents.

Notes on Patent Licenses and Manufacturing Agreements. Theodore Rich. Discusses questions arising between patentee and manufacturer, with special reference to engineering and electrical work. 3500 w. Elec Rev, Lond—Jan. 1, 1909. No. 1695 A.

Review of 1908.

Retrospect of the Year 1908. A review of the industrial activity in civil engineering, naval and military, merchant marine, electricity, etc. 6500 w. Sci Am—Jan. 2, 1909. No. 1428.

Trusts.

The State and the Trusts (Staat und Kartelle). Hugo Bonikowsky. Discusses the proposal for state regulation of the trusts in Germany, with special reference to the "kartelle" in the iron industry. 5500 w. Stahl u Eisen—Dec. 9, 1908. No. 1941 D.

Wages.

Rate Fixing Confined to the fixing of rates in the molding and smithy department, and the erecting or assembling departments. 2000 w. Mech Wld—Jan. 8, 1909. No. 1814 A.

MARINE AND NAVAL ENGINEERING

Battleships.

Progress of Warships and Machinery Under Construction in England. A review of progress made during the last six months. 2200 w. Engr, Lond—Dec. 25, 1908. No. 1543 A.

The Turbine and Reciprocating Engine a Combination for Better All-Around Efficiency in Vessels of War. H. C. Dinger. Suggests a combined arrangement and presents the advantages and disadvantages. 3500 w. Jour Am Soc of Nav Engrs—Nov., 1908. No. 1890 H.

Cruisers.

Description and Official Trials of the U. S. S. Salem. C. B. Edwards. Ills. 3000 w. Jour Am Soc of Nav Engrs—Nov, 1908. No. 1892 H.

U. S. Armored Cruiser Montana. William Russell White. Illustration, with description of machinery and report of the official trial. 14500 w. Jour Am Soc of Nav Engrs—Nov., 1908. No. 1889 H.

The Siamese Revenue Cruiser. Illustrated description of a vessel to be used for the suppression of the practice of opium and fire-arms smuggling in Siam. 700 w. Engng—Jan. 15, 1909. No. 2077 A.

Ferryboats.

A Unique Ferryboat. Illustration, with brief description of an elevating vehicular ferry steamer for service in Glasgow harbor. 600 w. Int Marine Engng—Jan., 1909. No. 1598 C.

Fire Boats.

Modern Fire-Boats. O. H. Caldwell. Illustrated description of the new electrically propelled and controlled fire-boats for the city of Chicago. 2000 w. Elec Rev, N Y—Jan. 2, 1909. No. 1468.

Gas Engines.

The Gas Engine and Producer Plant and Its Adaptability for Marine Work. E. Shackleton. Considers the objections to such plants, and describes a gas plant of the suction type having four generators. 4000 w. Mech Engr—Dec. 25, 1908. No. 1507 A.

Model Basins.

The Development and Present Status of the Experimental Model Towing Basin. Reviews the steps that led to the establishment of these tanks, and describes existing tanks and their operation. 2000 w. Int Marine Engng—Jan., 1909. No. 1600 C.

Port Holes.

Round Port Holes (Runde Schiffs-Seitenfenster). Rudolf Sodemann. A discussion of materials, cost, and construction. Ills. 2800 w. Schiffbau—Dec. 9, 1908. No. 1962 D.

Propellers.

Recent Screw-Propeller Design. Notes the important investigations made of the efficiency of screw propellers, discussing features of design demanding attention to meet recent conditions. Ills. 2000 w. Int Marine Engng—Jan., 1909. No. 1596 C.

Review of 1908.

The World's Shipbuilding. A review of the year 1908. 2000 w. Engng—Jan. 15, 1908. No. 2076 A.

Shipbuilding and Marine Engineering in 1908. A review of the year's work in British shipyards. 10000 w. Engng—Jan. 1, 1909. No. 1710 A.

Sailing Vessels.

The American Sailing Ship. George L. Norton. Illustrates and describes interesting examples of sailing craft. 2000 w. Int Marine Engng—Jan., 1909. No. 1597 C.

Ship Building.

See Review of 1908, under MARINE AND NAVAL ENGINEERING.

Ship Design.

Decrease in the Weight of Ships Through Change in the Regulations of the German Lloyd (Verminderung des Schiffsgewichts durch die Vorschriften des Germanischen Lloyd 1908). Fr. Jappe. Compares the old and new regulations with regard to the change in weight of certain parts of ships. Ills. 2500 w. Schiffbau—Dec. 9, 1908. No. 1961 D.

See also Steamships, under MARINE AND NAVAL ENGINEERING.

Ship Stability.

A Simple Method for the Rapid Determination of the Transverse Stability of Ships (Ein einfaches Verfahren zur raschen Bestimmungen der Querstabilität eines Schiffes). Herr Ulffers. Ills. 2000 w. Schiffbau—Dec. 23, 1908. No. 1963 D.

Ship Vibratons.

Ship Vibrations (Schiffsschwingungen höherer Ordnung). W. Thele. Discusses their cause, etc. Ills. 3800 w. Zeitschr d Ver Deutscher Ing—Dec. 26, 1908. No. 2108 D.

Steam Engines.

Emergency Repairs at Sea. P. J. Giron. Illustrates and describes examples taken from actual experience. 800 w. Prac Engr—Dec. 25, 1908. Serial. 1st part. No. 1514 A.

Steamships.

A Longitudinally-Framed Ship. Benjamin Taylor. Illustrated description of the oil tank steamer Paul Paix, constructed on the Isherwood system. 1200 w. Int Marine Engng—Jan., 1909. No. 1599 C.

The Rathmore. Illustrated detailed description of a fine new passenger steamship in service of the London and Northwestern Railway between Holyhead and Greenore. 2 plates. 2000 w. Engr, Lond—Jan. 15, 1909. No. 2081 A.

Submarines.

The Italian Submersible Boat "Otaria." Brief illustrated description. 400 w. Engng—Jan. 1, 1909. No. 1707 A.

Progress in Submarine Craft. Robert C. Skerrett. Information concerning British, French and Italian developments and general statistics. 1800 w. Ir Age—Jan. 7, 1909. No. 1493.

Submarine Signalling.

Electrically-Operated Submarine Bells. Illustrates and describes bells installed by the French Service des Phares. 800 w. Engr, Lond—Jan. 1, 1909. No. 1712 A.

MECHANICAL ENGINEERING

AUTOMOBILES.

Carbureters.

The Formation of Gasoline Air Mixtures. Discusses vaporization and the considerations affecting it. 5000 w. Automobile—Dec. 31, 1908. No. 1458 C.

Commercial Vehicles.

The Commercial Truck vs. the Horse. Benjamin Rogers. Information in regard to expense of operation, advantages, etc. 1500 w. Sci Am—Jan. 16, 1909. No. 1775.

See also Omnibuses, under AUTOMOBILES.

Construction.

How to Convert a Horse-drawn Buggy Into a Motor Buggy for Less than $300. George Heron. Illustrated detailed description of the work. 1500 w. Sci Am—Jan. 16, 1909. No. 1780.

Electric.

Electric Automobiles (Ueber Elektromobile). E. Sieg. Gives a historical review of their development and discusses the various systems. Ills. Serial. 1st part. 1800 w. Elektrotech Zeitschr—Dec. 24, 1908. No. 2114 D.

Exhibitions.

Level on Which Merit Stands Is Congested. Thomas J. Fay. Calls attention to marks of progress evident in the exhibits at the Palace exhibition in New York. Ills. 2500 w. Automobile—Jan. 7, 1909. No. 1591.

The Mechanical Lesson of the Palace. Thomas J. Fay. A general review of the exhibits at the Grand Central Palace, New York City. Ills. 7500 w. Automobile—Dec. 31, 1908. No. 1457 C.

France.

The Automobile Crisis in France (La Crise automobile en France). E. Girardault. Discusses the causes and probable results of the present unsatisfactory state of the automobile industry. Ills. 3300 w. Génie Civil—Dec. 19, 1908. No. 1930 D.

Fuel Storage.

The Storage of Combustible Liquids (Die Lagerung feuergefahrlicher Flüssigkeiten). Discusses the precautions necessary in handling and storing combustible liquids and describes appliances for the purpose. . Ills. 6000 w. Oest Wochenschr f d Oeffent Baudienst—Dec. 5, 1908. No. 1975 D.

Ignition.

High Tension Ignition by Magneto. Roger B. Whitman. Illustrates and describes typical magnetos used in American cars. 3000 w. Sci Am—Jan. 16, 1909. No. 1776.

Imperia.

The Imperia Petrol Cars. Illustrated description of a 16-20 h.p. car built in Belgium. 1000 w. Auto Jour—Dec. 26, 1908. No. 1505 A.

Lamps.

What Lamp Should a Motorist Buy? The Candle-Powder Problem. An explanation of phenomena produced by light. Diagrams. 1600 w. Auto Jour—Jan. 16, 1909. Serial. 1st part. No. 2048 A.

Lubrication.

Automobile Lubrication.—Some Elementary Principles. Thomas D. Hanauer. The importance of systematic lubrication, lubricants, and related subjects are discussed. Ills. 3500 w. Sci Am—Jan. 16, 1909. No. 1778.

Metallurgique.

The 12-H.P. Metallurgique Car. Illustrated description of a two-passenger car shown at Olympia. 700 w. Auto Jour—Jan. 9, 1909. No. 1799 A.

Motor Cooling.

The Effect of Glycerine on the Cooling Water of an Engine. Henry O'Connor. Gives report of an investigation which showed no effect on the cooling power below 180°. 600 w. Autocar—Jan. 2, 1909. No. 1685 A.

Motors.

The Two-Cycle Automobile Motor. E. W. Roberts. Illustrates and describes types, explaining the term. 2000 w. Sci Am—Jan. 16, 1909. No. 1779.

The Ultimate Internal Combustion Motor and Its Probable Fuel. Thomas L. White. Calls attention to new lines of research and the present outlook. 1800 w. Ir Age—Jan. 7, 1909. No. 1494.

Omnibuses.

The Use of the Motor Omnibus in Europe. Information from a report by Mr. Mauclere, presented at the Munich Congress of the Int. Union of St. Rys. & Light Rys. 1500 w. Eng News—Dec. 31, 1908. No. 1406.

Progress in the Construction of Motor Omnibuses and Heavy Motor Trucks (Fortschritte im Bau von Motoromnibussen und schweren Motorlastwagen). A. Heller. Illustrated description of various recent types. Serial. 1st part. 4000 w. Zeitschr d Ver Deutscher Ing—Dec. 5, 1908. No. 1998 D.

Road Trains.

The Renard Road and Rail Transport Corporation, Limited. A letter giving a report of trials in India. 2500 w. Min Jour—Jan. 16, 1909. No. 2065 A.

Straker-Squire.

The 1909 14-16 H. P. Straker Squire. Illustrated description. 1500 w. Autocar—Dec. 26, 1908. No. 1504 A.

Tires.

Our Legion Tires and Their Troubles. Orrel A. Parker. Discusses types of tires and their troubles, the effect of proper and improper driving, the importance of selecting tires suitable for the kind of service, etc. Ills. 4000 w. Sci Am—Jan. 16, 1909. No. 1777.

Detachable and Demountable Rims Discussed. Hermann F. Cuntz. Discusses what is being done in this field as a solution of the problem of quickly replacing tires. 1100 w. Automobile—Jan. 21, 1909. No. 1897.

Tractors.

Modern Steam Tractors for Rapid and Light Road Haulage Purposes. William Fletcher. An illustrated article dealing with mechanical haulage on common roads. 4000 w. Cassier's Mag—Jan., 1909. No. 1726 B.

Westinghouse.

The 20-30 H. P. Westinghouse. Illustrates and describes details of the chassis. 1500 w. Autocar—Jan. 9, 1909. No. 1800 A.

COMBUSTION MOTORS.

Fuels.

The Properties of Liquid Fuels. E. B. Norris. A study of the methods of using liquid fuels. 3000 w. Engr, Pa—Dec., 1908. No. 2009 D.

Gas Dangers.

Dangers of Water Gas, Suction Gas, and Other Gases in Factories. Memorandum issued by the Factory Department of the Home Office, giving the causes of such accidents and the best means for their prevention. 3000 w. Mech Engr—Jan. 8, 1909. No. 1811 A.

Gas Engines.

Gaseous Explorations. First report of the Committee appointed by the British Association to investigate gaseous explosions, with special reference to temperature. 5000 w. Mech Engr—Jan. 1, 1909. Serial. 1st part. No. 1512 A.

Gas Engine Compression and Efficiency. Paul C. Percy. Explains why the degree of compression affects the efficiency and economy. 2000 w. Power—Jan. 5, 1909. (Special No.) No. 1488 D.

See also Crank Shafts, under MACHINE ELEMENTS AND DESIGN; and Gas Engines, under MARINE AND NAVAL ENGINEERING.

Gas Power Plants.

The Gas Power Plant at the Swift Warehouse in New York. Illustrated description. 2200 w. Eng Rec—Jan. 16, 1909. No. 1765.

Utilizing Blast-Furnace Gases at Gary. Describes a plant to be operated by gases formerly considered waste. 3000 w. Eng & Min Jour—Jan. 2, 1909. No. 1441.

Bituminous Gas-Producer Electrical Generating Plant. Elbert A. Harvey. Illustrated description of the plant of the Garford Company, Elyria, Ohio. 1000 w. Elec Wld—Jan. 2, 1909. No. 1471.

Gas Producers.

The Physical Theory of Coal Carbonization. W. H. Fulweiler. Read before the Am. Gas Inst. Brief review of the development, describing methods of carbonization used, and related matters. 10700 w. Am Gas Lgt Jour—Jan. 4, 1909. Serial. 1st part. No. 1395.

Notes on Anthracite Producer Practice. George C. Stone. An account of experiments made in the effort to improve practice. 1200 w. Jour Ind & Engng Chem—Jan., 1909. No. 2039 E.

Bituminous Producer Plants. Elbert A Harvey. Abstract of paper, with discussion. 6500 w. Jour Am Soc of Mech Engrs—Jan., 1909 No. 1854 F.

Operation of Induced Draft and Suction Producers. Frank P. Peterson. Discusses the danger of explosion, and the use of flame arresters. 2000 w. Power—Jan. 5, 1908. (Special No.) No. 1486 D.

Ignition.

Getting Acquainted with the Jump-Spark. Herbert L. Towle. Diagrams and explanatory notes. 3500 w. Rudder—Jan., 1909. No. 1502 C.

Oil Engines.

The Employment of Hydrocarbon Extracts from Petroleum, Bituminous Shales and Coal in Combustion Motors (Emploi des Hydrocarbures extraits des Pétroles, des Schistes et de la Houille dans les Moteurs à Explosion). A. Grebel. Discusses the advantages of liquid fuels, resources of France in mineral oils, etc. 4400 w. Génie Civil—Dec. 26, 1908. No. 1932 D.

HEATING AND COOLING.

Central Plants.

See Hot-Water Heating, under HEATING AND COOLING.

Electric Heating.

The Relative Advantages of Coal, Gas and Electric Heating (Güteverhältnis zwischen Kohlen-, Gas- und elektrischer Heizung). M. Grellert. A reply to E. R. Ritter's article on electric heating, showing the comparative cheapness of gas. 2800 w. Gesundheits-Ing—Dec. 12, 1908. No. 1967 D.

Hot-Air Heating.

Heating a Montreal Church. Describes an indirect gravity system supplemented by a fan. Ills. 2500 w. Met Work—Jan. 16, 1909. No. 1755.

See also Shop Heating, under MACHINE WORKS AND FOUNDRIES.

Hot-Water Heating.

Design of Hot-Water Heating Systems with Reference to Heat Loss in Pipe Lines (Die Berechnung der Warmwasserheizung unter Berücksichtigung der Wärmeverluste der Rohrleitungen). Dr. Rietschel. Discusses both single and double pipe systems. Ills. 10000 w. Gesundheits-Ing—Dec. 19, 1908. No. 1969 D.

A Comparison Between the Single- and Double-Pipe Hot Water Heating Systems (Ein Vergleich zwischen dem Einrohr- und dem Zweirohrsystem der Warmwasserheizung). H. Roose. Supports the single-pipe system. 2000 w. Gesundheits-Ing—Dec. 5, 1908. No. 1965 D.

Heating by Hot Water Under Pressure (Ueber Druckwasserheizung). Anton Gramberg. An exhaustive discussion of this new method. Ills. Serial. 1st part. 9300 w. Gesundheits-Ing—Dec. 26, 1908. No. 1970 D.

Distant Hot-Water Heating (Fernwarmwasserheizung). Dr. Rietschel. Discusses central plants and distribution systems. Ills. 6600 w. Gesundheits-Ing—Dec. 19, 1908. No. 1968 D.

Domestic and Circulating Hot-Water Boilers. Remarks on their general management and means of preventing explosions, taken from W. H. Fowler's work on steam boilers. Ills. 2000 w. Mech Engr—Jan. 8, 1909. No. 1810 A.

A Large Residence Hot Water Heating System. Plans and description of an interesting system installed at Bernardsville, N. J. 800 w. Met Work—Jan. 2, 1909. No. 1398.

See also Boiler Rating, under STEAM ENGINEERING.

Pipe Corrosion.

Relative Corrosion of Wrought Iron and Steel Pipes. Report of tests made by the Committee appointed by the Am. Soc. of Heat. & Vent. Engrs. 1500 w. Heat & Vent Mag—Jan., 1909. No. 1887.

Refrigeration.

The Uses of Mechanical Refrigeration in Metallurgical Practice. Jos. H. Hart. Discusses its value in increasing furnace output and condensing by-products. 2000 w. Engineering Magazine—Feb., 1909. No. 2157 B.

The Compression Refrigerating System. F. E. Matthews. An explanation. 2500 w. Power—Jan. 5, 1909. (Special No.) No. 1487 D.

Air Cooling by Refrigeration. W. W. Macon. Discusses how to determine the requirements of refrigerating apparatus needed. 6500 w. Heat & Vent Mag—Jan., 1909. No. 1888.

Practical Hints. William Westerfield. Suggestions on the application of the indicator to ammonia compressors. 2500 w. Ice & Refrig—Jan., 1909. No. 1456 C.

Steam Heating.

Heating and Ventilation of the Union Terminal Station at Washington, D. C. Illustrated description of the heating and ventilating facilities for the head-house. 3500 w. Eng Rec—Jan. 2, 1909. No. 1426.

See also Boiler Rating, under STEAM ENGINEERING.

Ventilation.

Ventilation of Three Basement Floors of the Marshall Field Retail Store, Chicago. Illustrated description of method adopted for ventilating three stories below the street level. 2000 w. Eng Rec—Jan. 23, 1909. No. 2022.

See also Steam Heating, under HEATING AND COOLING; and Tunnel Ventilation, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

HYDRAULIC MACHINERY.

Centrifugal Pumps.

Steam Turbo High-Lift Pump. Illustrates and describes a large centrifugal pump operated by a steam turbine constructed for the Montreal Water & Power Co. 1500 w. Engr, Lond—Dec. 25, 1908. No. 1545 A.

Results of Tests on a Low-Head Centrifugal Pump (Besprechung von Versuchsergebnissen einer niederdruck-Kreiselpumpe). Johannes Bente. Gives the results in tabular form and draws conclusions from them. Ills. 1600 w. Die Turbine—Dec. 5, 1908. No. 1958 D.

See also Water, under MEASUREMENT.

Discharge Coefficients.

See same title, under CIVIL ENGINEERING, WATER SUPPLY.

Pumping Plants.

See Irrigation, under CIVIL ENGINEERING, WATER SUPPLY.

Surge Tanks.

The Surge Tank in Water Power Plants. R. D. Johnson. Abstract of paper with continued discussion and author's closure. 9000 w. Jour Am Soc of Mech Engrs—Jan., 1909. No. 1855 F.

Turbine Governors.

See Operation, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Turbine Plants.

Recent Turbine Plants (Neuere Turbinen-Anlagen). Wilhelm Müller. Illustrated description of a number of plants with special reference to high speed and methods of governing. Serial, 1st part. 1300 w. Die Turbine—Dec. 20, 1908. No. 1960 D.

Turbines.

A Comparison of American High Speed Runners for Water Turbines. S. J. Zowski. Aims to show how far American manufacturers have progressed in the attempt to secure high speed and high capacity simultaneously and to compare the results of respective runner types. Ills. 4000 w. Eng News—Jan. 28, 1909. No. 2151.

The Schulz Turbine (Die Schulz-Turbine). Herr Forst. Illustrated description, test results, etc. Serial, 1st part. 1600 w. Die Turbine—Dec. 5, 1908. No. 1959 D.

See also Water, under MEASUREMENT.

MACHINE ELEMENTS AND DESIGN.

Brakes.

See same title, under ELECTRICAL ENGINEERING, DYNAMOS AND MOTORS.

Clutches.

Clutches (Quelques Embrayages). Illustrated detailed description of a large number of recent devices. 5000 w. Rev de Mécan—Dec., 1908. No. 2103 E + F.

Crank Shafts.

Crank Shafts for Gas Engines. Horace Allen. Discusses methods of providing for the special stresses. Diagrams. 1500 w. Cassier's Mag—Jan., 1909. No. 1730 B.

Drafting Rooms.

Some Items of Drawing-Office System. W. Lawrence. Suggests items that may save time and tend to efficiency. 2000 w. Elec Rev, Lond—Dec. 25, 1908. No. 1518 A.

Drawings.

An Important Possibility in Working-Drawings. Describes the advantages of a method of photographic reduction. 2500 w. Eng News—Jan. 28, 1909. No. 2152.

Flywheels.

The Design of Rapidly Rotating Fly Wheels (Zur Berechnung schnellaufender Scheibenräder). Herr Roemmelt. Mathematical. Ills. 5000 w. Elek Kraft u Bahnen—Dec. 4, 1908. No. 1988 D.

Hobs.

How Many Gashes Should a Hob Have? Ralph E. Flanders. Studies the imperfect generating action of the hob, giving diagrams for finding the number of cuts per linear pitch, and discussing the effect of the number of teeth in the wheel. 2000 w. Mach, N Y—Jan., 1909. No. 1550 C.

Levers.

Rolling Levers (Wälzhebel). Heinrich Holzer. A theoretical study of their design. Ills. 6500 w. Zeitschr d Ver Deutscher Ing—Dec. 19, 1908. No. 2105 D.

Riveted Joints.

Calculating Strength of Riveted Joints; How to Use Riveted Joint Diagrams. S. F. Jeter. Two articles, the first giving elaborate diagrams for calculating the strength of joints and the second simple instructions for and illustrations of their use. Ills. 8500 w. Power—Jan. 5, 1909. (Special No.) No. 1482 D.

Speed Variation.

See Electric Driving, under POWER AND TRANSMISSION.

Springs.

Helical Springs. Henry L. Hanson. Gives tables showing the greatest allowable pressure or load in pounds, and the corresponding compression or deflection in inches per coil of helical springs of various sizes, with examples and explanations. 1000 w. Supplement. Mach, N Y—Jan., 1909. No. 1551 C.

The Deflection of Rotating Springs (Die Durchbiegung rotierender Schraubenfedern). M. Tolle. A mathematical discussion. Ills. 3200 w. Zeitschr d Ver Deutscher Ing—Dec. 12, 1908. No. 2101 D.

Thrust Bearings.

Thrust Bearings. G. B. Woodruff. Read at the Inst. of Marine Engrs. Specially describing a new form of thrust bearing said to give results, as regards load-carrying capacity and low friction loss, similar to those of a perfectly lubricated journal bearing. Ills. 3500 w. Can Engr—Jan. 1, 1909. No. 1399.

MACHINE WORKS AND FOUNDRIES.

Automatic Machinery.

Automatic Metal Bottle Cap Machinery. Illustrated description of an automatic equipment for the rapid production of a two-piece bottle-cap. 1500 w. Ir Age—Jan. 7, 1909. No. 1492.

Brass Founding.

See Alloys, under MATERIALS FOR CONSTRUCTION.

Castings.

The Scientific Mixing of Iron for Castings. George Hailstone. Abstract of paper read before the Staffordshire Iron and Steel Inst. Discusses the scientific organization involved in the production of molten iron for castings. 5000 w. Ir & Coal Trade Rev—Dec. 24, 1908. No. 1546 A.

New Method of Making Steel Castings. E. F. Lake. An illustrated article giving information of the kinds of steel used and intricate shapes cast by a shop in Germany. 1500 w. Am Mach—Vol. 31, No. 53. No. 1403.

Manufacture of Steel Castings in Small Quantities. Arthur Simonson. Read before the Phila. Found. Assn. Using a converter of 1000 pounds capacity, by the new Tropenas system. Ills. 2500 w. Ir Trd Rev—Jan. 14, 1909. No. 1753.

Defective Castings. G. E. Lines. Discusses the work of the different departments of the foundry showing that the responsibility lies with no one department. Ills. 1800 w. Mech Wld—Jan. 1, 1909. Serial, 1st part. No. 1528 A.

Sponginess on the Upper Surface of Castings. D. Wilkinson, Junr. Describes this and other defects in castings, considering the causes and remedies. 2000 w. Ir & Coal Trds Rev—Jan. 8, 1909. No. 1830 A.

Steel Foundry Shrinkage Problems. R. A. Bull. A discussion of causes of shrinkage and methods of overcoming them. 4000 w. Foundry—Jan., 1909. No. 1613.

See also Electro-Metallurgy, under MINING AND METALLURGY, IRON AND STEEL.

Cupolas.

Cupola Practice. M. Albütz. Compares statements in papers by Mr. Bellamy and by Mr. Dalrymple, and also other investigators. 4500 w. Ir & Coal Trds Rev—Dec. 24, 1908. No. 1548 A.

A Suggested Change in Cupola Practice. Richard Moldenke. Read before the Phila. Found. Assn. Describes an improved method of charging, discussing related matters. 3000 w. Foundry—Jan., 1909. No. 1615.

Forging Presses.

German Friction-Spindle Presses. I. W. Chubb. Illustrated description. 600 w. Am Mach—Vol. 32. No. 4. No. 2138.

Foundries.

Casting Tramway Crossings. Illustrates and describes a small foundry plant for this purpose at Manchester, Eng. 700 w. Engr, Lond—Jan. 8, 1909. No. 1827 A.

Foundry Management.

Problems of a Congested Foundry. An Illustrated explanation of how they were solved at the Allegheny plant of the Westinghouse Co. 3500 w. Foundry—Jan., 1909. No. 1610.

Foundry Practice.

Repetition Work in Small Quantities. C. Buchanan. Explains a simple match plate process which can be used economically. 2000 w. Foundry—Jan., 1909. No. 1611.

The Use of Chills in Iron Founding (Die Verwendung von Kokillen in der Eisengiesserei). E. Leber. A general discussion of their uses and applications. Ills. Serial, 1st part. 2000 w. Stahl u Eisen—Dec. 2, 1908. No. 1940 D.

Gear Cutting.

The Cutting of Elliptic Gears. Warren E. Thompson. Describes the process. Ills. 900 w. Am Mach—Vol. 32. No. 4. No. 2140.

A Hobbing Cutter for Finishing Wheels. P. A. Thompson. Illustrates and describes a special finishing hob. 1200 w. Am Mach—Vol. 32. No. 4. No. 2136.

See also Hobs, under MACHINE ELEMENTS AND DESIGN.

Grinding Machines.

The New Bath Grinders. Illustrated detailed description of the new universal grinder known as No. 2½. 2500 w. Ir Age—Jan. 28, 1909. No. 2120.

German Designs of Internal Grinding Machines. Oskar Kylin. Illustrates and describes grinding machines for special purposes. 1000 w. Mach, N Y—Jan., 1909. No. 1554 C.

Automatic Machine for Rectifying and Grinding Hobs for Cutting Gear Wheels. Illustrates and describes the invention of Marcel Lejeune. 500 w. Prac Engr—Dec. 25, 1908. No. 1513 A.

See also Lathes, under MACHINE WORKS AND FOUNDRIES.

Lathes.

Multiple Turning and Grinding Shafting Lathe. Illustrated description. 800 w. Engng—Dec. 25, 1908. No. 1539 A.

A Lathe Converted Into a Cylinder Grinder. M. E. Dawson. Line drawings and description. 800 w. Am Mach—Vol. 32. No. 3. No. 1866.

Lathe Chuck and Chuck-Operating Mechanism. Illustrates and describes a mechanism especially applicable to lathes used in finishing small articles, 1200 w. Mech Engr—Jan. 1, 1910. No. 1511 A.

The Whitcomb-Blaisdell Cushion Clutch Geared Head Lathe. Illustrated description of a new single pulley drive all-geared friction head engine lathe designed for a wide range of usefulness. 1800 w. Ir Age—Dec. 31, 1908. No. 1396.

Milling.

Milling Fixtures Used in a Russian Shop. J. W. Carrel. Illustrated description of devices and methods used in the manufacture of cigarette machines. 300 w. Am Mach—Vol. 32. No. 1. No. 1622.

Milling Cutters.

A New High Speed Milling Cutter. William H. Taylor. Illustrates and describes the development of an inserted blade cutter giving remarkable results. 3500 w. Am Mach—Vol. 32. No. 1. Serial, 1st part. No. 1619.

Molding Machines.

A New Rock-Over Molding Machine. Illustrated description of a machine for molding stove plates. 1500 w. Foundry—Jan., 1909. No. 1616.

Wilkinson's Pattern-Plate Moulding Machine. Illustrated description of an appliance for moulding plate patterns. 500 w. Engng—Dec. 25, 1908. No. 1538 A.

Patterns.

The Use of an Adjustable Pattern. H. J. McCaslin. Describes the construction of a pattern for molding a cast-steel travcling crane and carriage of comparatively thin section. Ills. 2000 w. Foundry—Jan. 1909. No. 1612.

Composition and Metal Match Plates. Illustrates and describes methods of making these permanent pattern plates. 4000 w. Foundry—Jan., 1909. No. 1614.

Pipe Making.

The History of Seamless Tubes (Zur Geschichte der nahtlosen Rohren). M. Müller. A review of past and present methods of production. Ills. 3000 w. Stahl u Eisen—Dec. 16, 1908. No. 1943 D.

Planer Drive.

Details of the Mitchell Planer Drive. Illustrated description, explaining the principles. 1800 w. Am Mach—Vol. 32. No. 2. No. 1752.

Planers.

Vertical and Horizontal Planers. W. T. Sears. Illustrates and describes examples of these tools and their applications. 1200 w. Am Mach—Vol. 31. No. 53. No. 1400.

A New 240 x 42 Inch Spur Gear Planer. Illustrated description of a direct driven, simple and effective design. 1200 w. Am Mach—Vol. 32. No. 4. No. 2135.

Polishing.

Finishing Metals by Polishing. Bradford H. Divine. Discusses the considerations governing the art of polishing. 5000 w. Ir Trd Rev—Jan. 28, 1909. Serial, 1st part. No. 2132.

Shop Appliances.

Forming Dies for Railroad Forge Shops. G. M. Steward. Illustrates and describes some of these devices. 600 w. Am Mach—Vol. 32. No. 1. No. 1623.

Shop Design.

Machine Grouping and Factory Layout, as Affecting Cost Data. C. H. Stilson. Discusses the influence of the location of machinery upon factory costs. Ills. 1800 w. Cassier's Mag—Jan., 1909. No. 1725 B.

Shop Heating.

Shop Heating. F. R. Still. Discusses the field of the blower system. 2000 w. Met Work—Jan. 16, 1909. No. 1756.

Shop Lighting.

Notes on Shop Lighting and the Cost of Artificial Illumination (Dispositions générales de l'Eclairage des Ateliers et Dépense de l'Eclairage artificiel). Louis Pichenot. Considers sun light and illumination by oil, electric, gas, and acetylene lamps. 3000 w. Rev d'Econ Indus—Dec. 16, 1908. No. 1900 D.

Shop Practice.

Machine Work in the Rambler Automobile Factory. Ethan Viall. Illustrated description of methods used. 1200 w. Am Mach—Vol. 32. No. 1. No. 1620.

Shops.

Balancing Threshing Machine Cylinders. An illustrated description of a difficult piece of work. 2000 w. Am Mach—Vol. 32. No. 2. No. 1749.

See same title, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Shop Whistles.

Blowing the Works Whistle Automatically. Frank Sawford. Illustrates and describes the arrangement. 2000 w. Power—Jan. 26, 1909. No. 2088.

Stamp Making.

The Making of Steel Stamps for the Machinist. P. E. Noyes. Illustrates and describes the tools and methods used. 2200 w. Am Mach—Dec. 31, 1908. No. 1402.

Tap Making.

The Manufacture of Taps. Illustrates and describes methods employed when taps are made in large quantities, describing the works of Wells Bros. Co., at Greenfield, Massachusetts. 5000 w. Mach, N Y—Jan., 1909. Serial, 1st part. No. 1552 C.

Tempering.

Hardening Carbon and High Speed Steel. Warren E. Thompson. Describes methods used by the author. 1600 w. Am Mach—Vol. 32. No. 1. No. 1621.

Barium Chloride for Hardening Steel. Ethan Viall. Illustrated description of the design of furnace, heating and composition of the barium mixture, cost of operation, and results obtained. 1200 w. Am Mach—Jan. 7, 1909. No. 1624.

Welding.

Electric Welding. Illustrated detailed description of machines for electric welding by the Thompson process. 5000 w. Engng—Jan. 15, 1909. Serial, 1st part. No. 2075 A.

Autogenous Welding with Oxy-Acetylene. Henry Cave. Condensed paper read before the Auto. Engrs. of America. Illustrated article describing torches used, methods, etc. 4500 w. Am Mach—Vol. 32. No. 4. No. 2137.

Oxy-Acetylene Welding and Cutting. H. R. Cobleigh. Illustrates and describes the process and some applications. 5000 w. Ir Age—Jan. 7, 1909. No. 1501.

Woodworking Machines.

Universal Dovetailing Machine. Illustrates and describes a new machine for dovetailing boards used for making boxes. 700 w. Engng—Jan. 1, 1909. No. 1709 A.

Wrenches.

Classification and Uses of Wrenches. Hubert E. Collins. On the proper names, uses and abuses of wrenches. Ills. 4500 w. Power—Jan. 5, 1909. (Special No.) No. 1480 D.

Wrench Making.

The Making of Spanner Wrenches. Describes the successive operations. Ills. 1200 w. Mach, N Y—Jan., 1909. No. 1553 C.

MATERIALS OF CONSTRUCTION.

Alloys.

Increasing the Tensile Strength of Aluminum-Bronze and Muntz-Metal by Quenching. Erwin S. Sperry. Gives report of tests showing the effect of quenching. Ills. 1200 w. Brass Wld—Jan., 1909. No. 1839.

See also Bearing Metals and Manganese Bronze, under MATERIALS OF CONSTRUCTION.

Alloy Steels.

The Nature and Treatment of Alloy Steel. Dr. John A. Mathews. General information relating to the construction of alloy steels, the problems involved, and precautions necessary. 2500 w. Ir Age—Jan. 7, 1909. No. 1496.

The Nature and Characteristics of the New Steels. O. M. Becker. The present article deals with the physical constituents of steel and the nature of hardening. Ills. 5000 w. Engineering Magazine—Feb., 1909. No. 2160 B.

Bearing Metals.

The Problem of Bearing Metals. Samuel K. Patteson. A general review of the present bearing metal situation. 2000 w. Elec-Chem & Met Ind—Jan., 1909. No. 1680 C.

Anti-Friction Alloys for Bearings. A H. Hiorns. Read before the Birmingham Assn. of Mech Engrs. A study of the qualities required for an anti-friction alloy, and the essential points to be considered in a bearing metal. 4000 w. Mech Engr—Dec. 25, 1908. No. 1506 A.

Cast Iron.

Tests of Cast Iron (Versuche mit Gusseisen). C. Bach. Gives results of bending, tension and impact tests. Ills. Serial, 1st part. 4400 w. Zeitschr d Ver Deutscher Ing—Dec. 26, 1908. No. 2106 D.

Heat Insulation.

The Thermal Conductivity of Heat-Insulators. A review of the research work of Dr. Wilhelm Nusselt. 3300 w. Engng—Jan. 1, 1909. No. 1703 A.

See also same title, under MEASUREMENT.

Manganese Bronze.

Making Manganese Bronze. K. Kinn. Suggestions for making this alloy. 2000 w. Am Mach—Vol. 32. No. 4. No. 2139.

Metallography.

A New Polishing Machine for Metallographic Work. James Aston. Describes a machine devised in the Chem. Engng. Dept. of the Univ. of Wisconsin. 800 w. Elec-Chem & Met Ind—Jan., 1909. No. 1677 C.

See also Laboratories, under MEASUREMENT.

Refractory Materials.

See Blast-Furnace Lining, under MINING AND METALLURGY, IRON AND STEEL.

Steel.

The Modulus of Elasticity of High Tensile and Mild Steels. Describes recent experiments made by David Colville and Sons, Ltd., giving results. 1600 w. Mech Engr—Jan. 8, 1909. No. 1812 A.

The Hardness of Steel at Different Temperatures (La Dureté à Chaud des Aciers). M. Robin. Reports the results of careful tests on various steels at temperatures from 0 to 700 degrees C. Ills. 5000 w. Rev de Métal—Dec., 1908. No. 1909 E + F.

MEASUREMENT.

Calorimetry.

A New Bomb Calorimeter. Charles J. Emerson. Illustrated description of a new bomb of the Berthelot type. 1000 w. Jour Ind & Engng Chem—Jan., 1909. No. 2040 E.

See also Analysis, under MINING AND METALLURGY, COAL AND COKE.

Dynamometers.

Electric Dynamometers. G. Everett Quick. Illustrates and describes types. 1500 w. Power—Jan. 26, 1909. No. 2091.

Hardness.

The Comparative Method of Making Brinell Hardness Tests (Essai de Dureté Brinell par Méthode comparative). L. Grenet. A statement of its advantages, comparing its results with those of the ordinary method. 2000 w. Rev de Métal—Dec., 1908. No. 1912 E + F.

Heat Insulation.

The Testing of Heat Insulating Materials (Le Esperienze sui Materiali coibenti). Alfredo Bertella. Illustrated description of methods. 4800 w. Riv Marit—Dec., 1908. No. 1933 E + F.

Impact Tests.

The Definition of Resilience and Shock Tests (La Définition de la Résilience et les Essais au Choc). L. Révillon. Report of tests to determine the extent to which shock tests on bars of different sizes are comparable. Tables. 2500 w. Rev de Métal—Dec., 1908. 1908 E + F.

Laboratories.

A Modern Metallurgical Laboratory. A M. Portevin. Illustrated description of the apparatus used and methods employed in the chemical, mechanical and microscopical departments of the De Dion-Bouton works laboratory in France. 4500 w. Am Mach—Vol. 32. No. 3. No. 1864.

See also Education, under INDUSTRIAL ECONOMY.

Testing Machines.

A Mirror Apparatus for the Measurement of Elastic Deformations (Ueber einen Spiegelapparat zur Messung elastischer Längenänderungen). Bernhard Kirsch. Description of the device with discussion of its mathematics. Ills. 2500 w. Oest Wochenschr f d Oeffent Baudienst—Dec. 19, 1908. No. 1978 D.

Torsion Tests.

Torsion Tests (Essais de Torsion). Pierre Breuil. Considers torsion tests as a means of selecting materials, and the relation between torsion and tensile tests. Results of investigations. Ills. 7000 w. Bul du Lab d'Essais—No. 14. No. 1902 N.

Water.

The Measurement of Large Quantities of Water (Jaugeages de gros Débits). MM. Boyer-Guillon, Auclair and Laedlein. Describes the calibration of weirs at the testing laboratories of the Conservatoire National des Arts et Métiers and tests on a centrifugal pump and on two hydraulic turbines. Ills. 20000 w. Bul du Lab d'Essais—No. 15. No. 1903 N.

POWER AND TRANSMISSION.

Air Compressors.

Rock Excavation with a Portable Compressor Outfit. Illustrates and describes the portable gasoline-engine compressor recently used for shallow trench work in New York City. 1600 w. Eng Rec—Jan. 2, 1909. No. 1427.

Belt Driving.

The Transmission of Power by Leather Belting. Carl G. Barth. Conclusions based principally on the experiments of Lewis and Bancroft. Gives diagrams and explanations of their use. Ills. 8000 w. Jour Am Soc of Mech Engrs—Jan., 1909. No. 1850 F.

Belt or Positive Chain Drive for Machine Tools (Riemenantrieb oder positiver Kettenantrieb für Werkzeugmaschinen). A. Bauschlicher. A comparison of the systems. Ills. Serial, 1st part. 2000 w. Zeitschr f Werkzeng—Dec. 15, 1908. No. 1982 D.

See also Pulleys, under POWER AND TRANSMISSION.

Chain Driving.

See Belt Driving, under POWER AND TRANSMISSION.

Compressed Air.

Researches on the Escape of Compressed Air from Small Tubes and the Eddy Currents Set Up (Untersuchungen über den Ausfluss komprimierter Luft aus Kapillaren und die dabie auftretenden Turbulenzerscheinungen). Dr. Ruckes. Reports researches similar to those of Osborne Reynolds on water. Ills. 2500 w. Zeitschr d Ver Deutscher Ing—Dec. 26, 1908. No. 2107 D.

Electric Driving.

Speed Regulation of Machine Tools at the Fore River Shipyard. Illustrated article describing the interesting system for speed variations, the H. Ward Leonard multi-stage system of the Allis-Chalmers Co. 2500 w. Eng Rec—Jan. 2, 1909. No. 1425.

Electrically Driven Woodworking Machinery. James F. Hobart. A summary of shop power conditions and their treatment. 2500 w. Wood Craft—Jan., 1909. No. 1490.

Lubrication.

See same title, under AUTOMOBILES.

Mechanical Plants.

New Power Plant of Carnegie Institute. Thomas Wilson. Illustrated detailed description of a mechanical plant for an immense building. 7500 w. Power—Jan. 12, 1909. No. 1660.

Power Plants.

The Small Economics of a Power Plant. A. S. Atkinson. Urges the adoption of more scientific methods in a plant supplied with the ordinary reciprocating engines and their auxiliaries. 2200 w. Boiler-Maker—Jan., 1909. No. 1666.

See also Gas Power Plants, under COMBUSTION MOTORS; and Isolated Plants, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Pulleys.

The Crowning of Pulleys. J. Stormouth. The reason for crowning is explained and the usual practice discussed. 2000 w. Mech Wld—Jan. 15, 1909. No. 2056 A.

Pulley Data: Ratio of Diameters, Distance Between Centers and Arc of Contact. F. C. Helms. Gives curves for calculating the various dimensions, with explanation. 600 w. Elec Wld—Jan. 7, 1909. No. 1669.

Shafting.

The Alinement of New and Realinement of Old Shafting. James Lomas. An explanation of methods, illustrating devices. 1800 w. Am Mach—Vol. 32. No. 2. No. 1751.

STEAM ENGINEERING.

Boiler Draught.

Induced Draught in the Power House, and Modern Practice in Its Application. C. L. Browne. Presents the advantages of mechanical draught and discusses some points to be considered in connection with its installation. 2500 w. Elec Engr, Lond—Jan. 8, 1909. Serial, 1st part. No. 1804 A.

A Comparison of Natural and Induced Draught Systems. W. N. Y. King. Read before the Leeds Loc. Soc. of the Inst. of Elec. Engrs. A comparison of results based upon a particular case, under usual conditions. Ills. 5000 w. Elec Engr, Lond—Jan. 1, 1909. No. 1692 A.

See also Stacks, under STEAM ENGINEERING.

Boiler Fittings.

See Safety Valves, under STEAM ENGINEERING.

Boiler Furnaces.

Methods of Studying the Heat-Absorbing Properties of Steam Boilers. Loyd R. Stowe. Explains methods of study that will give facts helpful in determining the arrangement of heating surface that will absorb the highest per cent. of heat. Discussion. 11800 w. Jour W Soc of Engrs—Dec., 1908. No. 1857 D.

Boiler Management.

See Hot Water Heating, under HEATING AND COOLING.

Boiler Rating.

A Standard Rating for Steam and Hot Water Heating Boilers. P. H. Seward. Contribution to committee on Rating House Heating Boilers. Thinks the capacity should be determined by tests made under standard conditions. 3000 w. Met Work—Jan. 23, 1909. No. 2013.

The Rating of House-Heating Boilers. William Kent. Suggests a method of testing small-sized boilers. 900 w. Heat & Vent Mag—Jan., 1909. No. 1886.

Boiler Repairs.

Driving Up Bags in Steam Boilers. M. Kennett. Explains the cause of bags and methods of repairing. 1000 w. Power—Jan. 19, 1909. No. 1834.

Boilers.

Notes on Water-Tube Boilers (Neuere Anschauungen über Wasserrohrkessel). Herman Garbe. A review of progress in this field. Ills. Serial, 1st part. 1600 w. Zeitschr f d Gesamte Turbinenwesen—Dec. 10, 1908. No. 1956 D.

Boiler Scale.

The Influence of Scale on Heat Transmission in Steam Boilers (De Invloed van Ketelsteen en andere Weerstanden op de Warmte-Transmissie bij Stoomketels). Chr. Muller. Reviews much of the literature of the subject. Ills. 5000 w. De Ingenieur—Dec. 5, 1908. No. 2116 D.

Boiler Waters.

Prevention of Scale-Formation in Steam Boilers by Electricity. F. A. Lart. Extract from an article in the *Engng. Rev.* A report of recently conducted experiments in the application of electricity to water purification. 2500 w. Ry & Engng Rev—Jan. 23, 1909. No. 2041.

The Chemical Aspect of Impurities in Steam Boilers. J. C. William Greth. Read before the Am. Inst. of Chem. Engrs. Describes the salts that enter into scale formation, the action of corrosive acids and salts, the requirements to properly soften and purify a water, etc. 6000 w. Ind Wld—Jan. 1909. No. 1477.

Condensers.

Saturated Air as a Cooling Agent. Arthur Pennell. Illustrates and describes the Pennell condensers. 1200 w. Power—Jan. 12, 1909. No. 1664.

Engine Design.

Present-Day Practice in High-Speed Engine Design. Considers points that govern the design and some of the details found successful. 1500 w. Mech Wld—Jan. 8, 1909. Serial. 1st part. No. 1815 A.

Engine Failures.

Some Recent Steam Engine Failures. Howard S. Knowlton. Illustrates and describes accidents reported by the engineering expert of a Casualty Co. 3000 w. Power—Jan. 12, 1909. No. 1663.

Engines.

Business Aspects of Early Engineering. H. W. Dickinson. Notes on the ways of conducting business in the early days of the introduction of the steam engine. 3000 w. Engr, Lond—Dec. 25, 1908. No. 1544 A.

Development of the High Speed Steam Engine. Abstract of lecture by Frank H. Ball before the Modern Science Club of Brooklyn, N. Y. Why the compound single valve engine is preferable where high efficiency is necessary. 2000 w. Power—Jan. 19, 1909. No. 1833.

Compound Horizontal Engine with Recke-Ruston Valve-Gear. Illustrated description of a large compound side-by-side engine designed to work with superheated steam. 700 w. Engng—Jan. 1, 1909. No. 1705 A.

Exhaust Steam.

See Turbine Plants, under STEAM ENGINEERING.

Feed-Water Heating.

Means and Methods for Heating the Feed-Water of Steam Boilers. Reginald Pelham Bolton. This third and last article of a series examines the economy of heating feed-water by exhaust steam. Ills. 1600 w. Engineering Magazine—Feb., 1909. No. 2158 B.

Relative Rate of Heat Transfer to Water At and Below the Boiling Point. W. M. Sawdon. Reports some tests made at Sibley College laboratory, giving results. 1500 w. Power—Jan. 12, 1909. No. 1661.

Fuels.

Some Fundamental Considerations on Coal. W. Jones. Considers the use of coal in raising steam and the importance of analysis, and of building the furnace to suit the coal to be used. 1300 w. Elec-Chem & Met Ind—Jan., 1909. No. 1676 C.

Coal; Its Composition and Combustion. William H. Booth. Discussion of the elements which combine to promote combustion. 3000 w. Power—Jan. 12, 1909. No. 1662.

See also Locomotive Fuels, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

Fuel Testing.

See Analysis, under MINING AND METALLURGY, COAL AND COKE.

Indicator Diagrams.

Inaccuracies Due to Drum Motion Distortion. Julian C. Smallwood. Analysis of the cause of errors in indicator diagrams, with results of tests. 2500 w. Power—Jan. 26, 1909. No. 2089.

Mechanical Stokers.

Mechanical Stokers (Mechanische Feuerungen). Karl Rubricius. A description and discussion of several German types. Ills. 2200 w. Elektrotech u Maschinenbau—Dec. 27, 1908. No. 1996 D.

Safety Valves.

A Cause of Rupture of Safety-Valve Seats (Sur une Cause de Rupture des Sièges de Soupapes). L. Lecornu. A discussion of faults due to improper casting. 1200 w. Rev de Mécan—Dec., 1908. No. 2102 E + F.

Stacks.

Furnace Draught in Central Heating Plants (Die Unterdruckverhältnisse im Innern einer Zentralheizungs-Kesselanlage). M. Hottinger. A theoretical discussion of chimney design and draught. Ills. 4000 w. Gesundheits-Ing—Dec. 5, 1908. No. 1964 D.

Steam Pipes.

The Strength of Oval Pipes under External or Internal Fluid Pressure (Festigkeit von ovalen Röhren gegen innern oder äusseren Flüssigkeitsdruck). M. Westphal. A mathematical demonstration of the method of calculation. Ills. 2000 w. Zeitschr d Ver Deutscher Ing—Dec. 26, 1908. No. 2109 D.

See also Water Hammer, under STEAM ENGINEERING.

Steam Properties.

Heat in Steam. Joseph H. Hart. An explanation of the connection between heat and steam and related matters. 2000 w. Power—Jan. 26, 1909. No. 2092.

Superheating.

Duscussion. Thermal Properties of Superheated Steam. Brief abstract of paper by R. C. H. Heck, with author's reply to discussion. 900 w. Jour Am Soc of Mech Engrs—Jan. 1909. No. 1852 F.

Turbine Design.

The Design of the de Laval Steam Turbine. A brief summary of the stages of design, giving the formulae involved. 2000 w. Prac Engr—Jan. 1, 1909. No. 1689 A.

The Design of Steam Turbines (Sul Calcolo delle Turbine a Vapore). G. B. Dall'Armi. A theoretical discussion with curves plotted from fundamental equations. Ills. 8000 w. Ann d Soc d Ing e d Arch Ital—Dec. 1, 1908. No. 1934 F.

Turbine Governors.

See Operation, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Turbine Plants.

A Notable Low Pressure Turbine Installation. Illustrated description of a Rattau regenerator and a 600 K. W. turbo-generator set at Vandergrift, Pa., supplying direct-current at 250 volts. 2500 w. Ir Age—Jan. 7, 1909. No. 1495.

Exhaust-Steam Turbine Plant at the Osterfeld Mine (Die Abdampfturbinenanlage der Zeche-Osterfeld). K. J. Müller. Illustrated description of the plant and its working and report of its economy. 3000 w. Glückauf—Dec. 5, 1908. No. 1951 D.

Turbines.

Melms-Pfenninger Steam Turbines. Trans. from *Die Turbine*. Ernest N. Jansen. Illustrated description. 1000 w. Jour Am Soc of Nav Engrs—Nov., 1908. No. 1891 H.

Valve Gears.

Setting the Valves of the Cummer Engine. H. E. Collins and J. H. Francis. An illustrated study of valve movement, with directions for overhauling and valve setting. 3000 w. Power—Jan. 26, 1909. No. 2087.

Valves.

The Use and Abuse of Globe Valves. W. H. Wakeman. Illustrates and describes the principal features of the different types. 2500 w. Power—Jan. 5, 1909. (Special No.) No. 1479 D.

Water Hammer.

Water Hammer. From the memorandum of the Chief Engineer to the Manchester Steam Users' Assn., explaining the danger and giving the solution of water hammer blows and the conditions that may cause explosions. 3000 w. Prac Engr—Jan. 15, 1909. Serial, 1st part. No. 2053 A.

TRANSPORTING AND CONVEYING.

Aerial Tramways.

Electrically Operated Aerial Tramways and their Applications (Die Elektrohängebahnen und ihre Verwendung). C. Claus. Illustrated description of various types and various applications. 2000 w. Elek Kraft u Bahnen—Dec. 14, 1908. No. 1991 D.

Cableways.

The Wetterhorn Cable Way (Der Wetterhornaufzug I Sektion). Illustrated description of the first section of a steeply inclined cable hoist on the slope of this mountain in Switzerland. Serial, 1st part. 2500 w. Schweiz Bau—Dec. 12, 1908. No. 1955 B.

Coal Handling.

Loading and Conveying Plants in German Gas Works. Illustrates and describes various plants. 3000 w. Sci Am Sup—Jan. 16, 1909. No. 1781.

Handling Coal by Electric Shovels. Edgar H. Wattington. Illustrates and describes the use of electric motors for crane driving. 1200 w. Ir Age—Jan. 14, 1909. No. 1747.

Coal Handling in Docks (Grundzüge für die Kohlenverladung beim Schiffsumschlag). Herr Berkenkamp. Illustrated vices. Serial, 1st part. 3500 w. Glückauf description of various methods and de- —Dec. 12, 1908. No. 1953 D.

We supply copies of these articles. See page 1071.

Conveyors.

The Conveying of Materials. The Belt Conveyor. C. Kemble Baldwin. Abstract of paper with the author's reply to discussion. 3500 w. Jour Am Soc of Mech Engrs—Jan., 1909. No. 1853 F.

Cranes.

Design and Construction of Electric Overhead Cranes. R. B. Brown. A record of present practice in electrically-operated overhead cranes, with facts of value to designers. 2000 w. Mach, N Y—Jan., 1909. Serial, 1st part. No. 1549 C.

The Electric Traveling Crane. Walter G. Stephan. An illustrated discussion of the principles governing the design. 6500 w. Ir Trd Rev—Jan. 7, 1909. No. 1608.

Temperley Transporters. An illustrated article dealing with the various designs and the conditions they had to meet. 5000 w. Engng—Jan. 8, 1909. Serial, 1st part. Plate. No. 1819 A.

Elevators.

Design of a Short-run Plunger Elevator. C. R. Harris. Illustrated detailed description of the building and installing of such an elevator. 2000 w. Am Mach—Vol. 31. No. 53. No. 1401.

Design of a Balanced Plunger Elevator. C. R. Harris. Gives details for the design, building and installation of such an elevator. Ills. 1500 w. Am Mach—Vol. 32. No. 3. No. 1865.

Industrial Railways.

Miniature Railroads for Country Transportation. Illustrated description of the Blakesley Hall miniature railroad and other lines on English estates. 1200 w. Sci Am—Jan. 2, 1909. No. 1429.

Novel Industrial Railroad Installation. John M. Bruce. Illustrated description of the installation at the Cambridgeport plant of the Boston Woven Hose & Rubber Co. 1600 w. Ir Age—Jan. 14, 1909. No. 1748.

Ore Handling.

Ore-Handling Machinery at the N. Y. P. & O. Dock at Cleveland, Ohio. Harry E. Scott. Illustrated detailed description of the plant near the foot of W. 25th St., the electrical unloaders, their operation, speed, etc. 4000 w. Jour Worcester Poly Inst—Jan., 1909. No. 1841 C.

The Ore-Handling Plant of the Steel Works at Gary, Indiana. Illustrated detailed description of the equipment, as an example of the best American practice. 3000 w. Eng Rec—Jan. 2, 1909. No. 1419.

Recent Ore-Handling Plants at Iron Works (Einige neuere Beförderungsanlagen auf Hochofenwerken). Describes aerial tramway and cableway installations. 3500 w. Stahl u Eisen—Dec. 2, 1908. No. 1940 D.

See also Ore Bins, under MINING AND METALLURGY, MINING.

MISCELLANY.

Aeronautics.

The Conquest of the Air. J. F. Springer. An illustrated historical review of what has been accomplished. 4500 w. Ir Age—Jan. 7, 1909. No. 1500.

Mechanical Flight. Reviews the developments of the past year. Ills. 2200 w. Engr, Lond—Jan. 1, 1909. No. 1719 A.

The Theory of Air Propellers (Beitrag zur Theorie der Luftschrauben). Georg Wellner. Mathematical discussion of the theory and design of airship propellers. Ills. 4000 w. Zeitschr d Oest Ing u Arch Ver—Dec. 18, 1908. No. 1980 D.

Some Anchored Tests of Aerial Propellers. Walter A. Scoble. Gives results of some experiments made at the Blythewood Laboratory to determine the effect of varying the different elements and methods of construction. 1200 w. Engng—Dec. 25, 1908. No. 1535 A.

Some Considerations on the Flight of Birds (Quelques Considérations sur le Vol des Oiseaux). Wilhelm Kress. From L'Aéro-Mécanique. Ills. 5000 w. All Indus—Dec., 1908. No. 1924 D.

Birds and Aeroplanes (Oiseaux et Aeroplanes). Ch. Weyher. An argument to show that the most successful type of aeroplane will imitate as closely as possible the flight of birds. Ills. 4000 w. Rev Gen des Sci—Dec. 30, 1908. No. 1917 D.

Form and Stability of Aeroplanes. W. R. Turnbull. A report of researches on five types of aeroplanes. 4000 w. Sci Am Sup—Jan. 30, 1909. No. 2097.

Aeroplane Design and Construction. Discusses types, frames, systems of control, etc. Ills. 3500 w. Auto Jour—Jan. 2, 1909. No. 1686 A.

Difficulties in the Construction of Aeroplanes. Herbert Chatley. Describes some of the difficulties in applying the fundamental principles to the construction of actual machines. 5000 w. Jour Soc of Arts—Jan. 1, 1909. No. 1684 A.

Aeroplane Exhibition in Paris. A brief review, with remarks on the aeroplanes exhibited. 1000 w. Engr, Lond—Jan. 1, 1909. Serial, 1st part. No. 1717 A.

Aeroplanes and Motors at the First Paris Aeronautical Salon. Illustrates some of the exhibits, giving brief descriptions. 1800 w. Sci Am—Jan. 23, 1909. No. 2005.

The British Army Aeroplane. Brief illustrated description. 600 w. Sci Am—Jan. 30, 1909. No. 2096.

German and French Airships (Die deutschen und französischen Motorballons). Ansbert Vorreiter. Describes various airships and reviews progress in this field. Ills. Serial, 1st part. 3500 w. Zeitschr d Mit Motorwagen Ver—Dec. 15, 1908. No. 1972 D.

Calculating Machines.

Mechanical Arithmetic and Time-Saving Devices. The first of a series of articles explaining devices for facilitating mathematical calculations. 800 w. Auto Jour—Jan. 16, 1909. Serial, 1st part. No. 2049 A.

Mathematics.

Mathematical Methods in the Investigation of Mechanical Problems (Mathematische Methoden zur Untersuchung mechanischer Probleme). Paul Stäckel. A discussion of the relation between mathematical theory and practical experiment. 4400 w. Zeitschr d Ver Deutscher Ing—Dec. 19, 1908. No. 2104 D.

Review of 1908.

Mechanical Engineering. Reviews improvements in marine engines, rolling stock, automatic couplers, internal combustion engines, etc. 5500 w. Engr, Lond—Jan. 1, 1909. No. 1718 A.

Textile Mills.

The Modern Cotton Spinning Factory. William H. Booth. An illustrated review of the present state of the cotton textile art. 8800 w. Cassier's Mag—Jan., 1909. Serial, 1st part. No. 1724 B.

Type-Setting Machines.

Type-casting and Composing Machinery. L. A. Legros. Deals with typographic surfaces which are produced directly by movable type or indirectly by means of movable matrices. Ills. 32500 w. Inst of Mech Engrs—Dec. 18, 1908. No. 1508 N.

MINING AND METALLURGY

COAL AND COKE.

Accidents.

The First Aid Movement in the Anthracite Region. H. H. Stoek. History and illustrated description of the methods and organizations. 5500 w. Mines & Min—Jan., 1909. No. 1417 C.

Analysis.

The Analysis of Coal and the Determination of the Calorific Value Therefrom. Arthur Caddick. Describes the method adopted by the author. 1000 w. Prac Engr—Jan. 15, 1909. No. 2052 A.

Bohemia.

The Eger Lignite Basin (Das Egerlander Braunkohlenbecken). Herr Bälz. Illustrated description of the coal deposits of this district in Bohemia. 7000 w. Glückauf—Dec. 26, 1908. No. 1954 D.

See also Mining, under COAL AND COKE.

Briquetting.

Coal Briquetting. R. M. Hale. Illustrated detailed description of the briquetting machine used by the Standard Fuel Co., Birmingham, Ala. 3500 w. Ir Age—Jan. 28, 1909. No. 2119.

China.

Coal Mining in China. Thomas T. Read. Information concerning the principal coal fields. Map. 2000 w. Min. & Sci Pr—Jan. 2, 1909. No. 1633.

Coking Plants.

See Washing, under COAL AND COKE.

Dust Extractors.

Appliances for Dealing With Coal Dust at the Pit Mouth. Illustrates and describes devices in use at different collieries for preventing the spread of coal dust or removing it. 3000 w. Ir & Coal Trds Rev—Jan. 8, 1909. No. 1829 A.

Electric Power.

Some Applications of Electric Power in Belgium (Quelques Applications de l'Electrotechnique en Belgique). Alfred Lambotte. This sixth and last article of the series on electric power in mining describes the electric installations of the Ressaix, Leval, Péronnes, Sainte-Aldegonde and Genck Collieries Company. Ills. Tables. 1500 w. Soc Belge d'Elecns—Dec., 1908. No. 1901 E.

See also Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

England.

The Geology of the Country between Newark and Nottingham. Information concerning these coal measures in England taken from a recent report of the Geol. Survey. 5000 w. Ir & Coal Trds Rev—Jan. 15, 1909. No. 2085 A.

Explosions.

Views Respecting Coal Mine Explosions. A symposium of opinions from engineers in reply to recent arguments advanced to explain causes of coal mine explosions. 6000 w. Eng & Min Jour—Jan. 2, 1909. No. 1439.

The Marianna Explosion. Plan and description of this mine in Western Pennsylvania and the accident, with reports of inspectors, etc. 8500 w. Mines & Min—Jan., 1909. No. 1414 C.

See also Mine Dust, under COAL AND COKE.

Explosives.

Tests of Safety Explosives (Versuche mit Sicherheitsprengstoffen). Herr Beyling. Report of tests of various explosives in an atmosphere of fire damp. 2500 w. Glückauf—Dec. 5, 1908. No. 1950 D.

Mine Dust.

The Present Position of the Coal Dust Problem. James and John Ashworth.

Discusses various phases of this problem. 2500 w. Bul Can Min Inst—Jan., 1909. No. 2044 N.

Is Coal Dust, as Such, Explosive? Audley H. Stow. A study of the chemical reactions that occur in dust explosions. 4000 w. Eng & Min Jour—Jan. 2, 1909. No. 1440.

Spraying Coal Dust as a Colliery Safeguard. D. Harrington. Describes a sprinkling system, giving detailed costs of installation and operating as carried on in the mines of Utah. 3500 w. Eng & Min Jour—Jan. 23, 1909. No. 2030.

Dust Removal Devices in the Rhine Lignite District (Ueber Entstaubungsanlagen im rheinischen Braunkohlenindustriebezirk). Herr Baldus. Illustrated description of methods of removing dust from mine air. Serial. 1st part. 2600 w. Glückauf—Dec. 5, 1908. No. 1952 D.

Mine Ventilation.

The Principles of the Ventilation of Mines. A report of the second lecture of W. H. Hepplewhite, entitled, "Some Aspects of Mine Ventilation." 2500 w. Col Guard—Dec. 24, 1908. No. 1534 A.

Mining.

Lignite Coal Mining in Bohemia. William S. Hall. Describes methods employed in working thick pitching seams. Ills. 2800 w. Mines & Min—Jan., 1909. No. 1412 C.

Production.

Coal Mining in the United States in 1908. Reviews the mining conditions in important anthracite and bituminous centers. 11500 w. Eng & Min Jour—Jan. 9, 1909. No. 1583.

The Coal and Coke Trades of the United Kingdom in 1908. General and district reviews of the past year. 17500 w. Ir & Coal Trds Rev—Jan. 1, 1909. No. 1721 A.

Rescue Appliances.

Rescue Methods, with Special Reference to Underground Rescue Stations, and Recent Disasters (Das Grubenrettungswesen mit besonderer Berücksichtigung von unterirdischen Rettungsstationen und Beziehung auf die jüngsten Katastrophen). J. Mayer. Serial, 1st part. 5200 w. Oest Zeitschr f Berg u Hüttenwesen —Dec. 5, 1908. No. 1947 D.

Safety Lamps.

German Tests with Igniters for Safety Lamps. Bergassessor Beyling, in *Glückauf*. Reports results of experiments carried out at the experinemtal colliery, Gelsen-Kirchen. 1200 w. Col Guard—Dec. 24, 1908. No. 1533 A.

United States.

The Coalfields of the United States. Map and estimate tonnage, describing the character of the coals and annual production. 2000 w. Eng & Min Jour—Jan. 16, 1907. No. 1762.

The Coal Resources of the Southern States. Edward W. Parker. Reviews the development of the coal mining industry. 2500 w. Mfrs Rec—Jan. 7, 1909. (Special No.) No. 1561 C.

Washing.

Ernest Coal-Washing Plant. Illustrates and describes recent additions and improvements to this plant, located at Ernest, Pa. 1600 w. Mines & Min—Jan., 1909. No. 1411 C.

Surface Plant at the Crigglestone Colliery, near Wakefield. Describes the Lührig coal washers and the installation of Otto Hilgenstock Coke Ovens. Ills. 1200 w. Col Guard—Jan. 15, 1909. No. 2066 A.

COPPER.

British Columbia.

The Importance of Low Grade Boundary Ores in the Copper Production of Canada. A. B. W. Hodges. Information concerning these ores and their treatment. General discussion. 4500 w. Bul Can Min Inst—Jan., 1909. No. 2043 N.

Colorado.

Some Copper Deposits in the Sangre de Christo Range, Colorado. Rufus Mather Bagg, Jr. Describes the geology of this range and discusses the probable origin of the deposits. Ills. 3000 w. Ec-Geol—Dec., 1908. No. 1878 D.

Korea.

The Kosan Mine, Korea. A. D. Weigall. Brief account of this copper mine. 1200 w. Min & Sci Pr—Dec. 26, 1908. No. 1445.

Nevada.

Copper Mining at Ely, Nevada. Courtenay DeKalb. Gives the history of this important district, the geology, method of mining, etc. Ills. 2500 w. Min & Sci Pr —Jan. 2, 1909. No. 1635.

Ontario.

Canadian Copper Company. D. F. Browne. Plan and description of a new concrete building. 3500 w. Can Min Jour—Jan. 15, 1909. No. 1835.

Pennsylvania.

The Newark Copper Deposits of Southeastern Pennsylvania. Edgar T. Wherry. A study of these deposits, giving the history, geology and description. Map. 4000 w. Ec-Geol—Dec., 1908. No. 1877 D.

Pot Roasting.

The Pot Roasting of Copper Ores. S. Radcliff. An account of the development of the process in Australia, with a statement of the advantages. 3300 w. Aust Min Stand—Dec. 2, 1908. No. 1745 B.

Production.

The Copper Production of North America. Review of the production for 1908 in the United States, Mexico, and Canada. 6500 w. Eng & Min Jour—Jan. 9, 1909. No. 1580.

Rolling Mills.

Electrically-Driven Brass and Copper Rolling Mills. C. A. Ablett. Abstract of paper read before the Birmingham Assn. of Mech. Engrs. An account of the methods of driving rolling mills for brass, copper and such metals. 3000 w. Mech Engr—Jan. 8, 1909. No. 1813 A.

Slag Car.

Slag Car Used at the Cananea Smelting Works. Charles F. Shelby. Illustrated description of cast steel bowl held upright by steel spring latches. 500 w. Eng & Min Jour—Jan. 23, 1909. No. 2033.

Smelter Fumes.

Copper Fumes Converted Into a Fertilizer Ingredient. Dr. John Sharshall Grasty. Explains how sulphuric acid is to be utilized in the manufacture of acid phosphate. 3000 w. Mfrs Rec—Jan. 7, 1909. (Special No.) No. 1568 C.

Smelter Stacks.

See Stacks, under CIVIL ENGINEERING, CONSTRUCTION.

Trade.

The Copper Situation. James Douglas. Discusses the factors controlling the copper mining industry. 1200 w. Min & Sci Pr—Jan. 2, 1909. No. 1625.

The year 1908 in the Copper Trade. H. M. Cole. A review of the remarkable rise and depression of this metal, the consumption, export, production, etc. 3000 w. Ir Age—Jan. 21, 1909. No. 1860.

Utah.

Smelting Conditions at Salt Lake. Courtenay De Kalb. Describes the conditions controlling the smelting industry in Utah. Also editorial. 4500 w. Min & Sci Pr—Jan. 2, 1909. No. 1628.

See also Copper, under ORE DRESSING AND CONCENTRATION.

GOLD AND SILVER.

Alaska.

Alaska and Yukon. T. A. Rickard. Maps and illustrated review of the mining centers, the discoveries of gold and the future possibilities. 3300 w. Min & Sci Pr—Jan. 2, 1909. Serial, 1st part. No. 1627.

Assaying.

The Mill Test for Gold versus the Assay—A Comparison in the Methods for Non-Technical Men. H. E. Haultain. Considers the assay much more reliable than the mill test. 2000 w. Can Min Jour—Jan. 1, 1909. No. 1460.

Colorado.

Cripple Creek in 1908. W. W. Travell. An account of the present condition of these gold mines. 2000 w. Min & Sci Pr—Jan. 2, 1909. No. 1632.

Cyaniding.

Progress in Cyanidation. Alfred James. A review of progress in different mining regions. Ills. 5000 w. Min & Sci Pr—Jan. 2, 1909. No. 1634.

B. & M. Circulating Tank. F. C. Brown. Illustrated description of an apparatus for the efficient treatment of ore by the cyanide process. 3000 w. Aust Min Stand—Dec. 9, 1908. No. 1895 B.

See also Electro-Cyaniding, under GOLD AND SILVER.

Dredging.

Developments in Gold Dredging During 1908. John Power Hutchins. Review of the year reporting great activity in California and progress in the Klondike. 4000 w. Eng & Min Jour—Jan. 23, 1908. No. 2032.

The Metallurgy of Gold Dredging. Explains some of the troubles and causes of failure, showing the necessity of improving the present practice. 4000 w. Min Jour—Jan. 9, 1909. No. 1817 A.

The Recovery of Values from River Bottoms. W. D. Egilbert. Describes the DuBois suction dredge of the latest type, and its operation. 2000 w. Min Wld—Jan. 16, 1909. No. 1783.

Electro-Cyaniding.

Operation of the Parks Electro-Cyanide Process. John R. Parks. Illustrated description, with a few practical results. 1800 w. Min Wld—Jan. 23, 1909. No. 2042.

Hydraulic Mining.

Alluvial Working at Addison's Flat, New Zealand. A. Gordon Macdonald. Illustrates and describes a system of hydraulic sluicing, the tailings being elevated by means of a "back balance." 1000 w. Eng & Min Jour—Jan. 23, 1909. No. 2031.

See also Ditches, under CIVIL ENGINEERING, WATER SUPPLY

Mexico.

Ore Deposits of the Velardena District, Mexico. J. E. Spurr and G. H. Garrey. A detailed description of the geology of the region, with a study of the silver-lead deposits. 12500 w. Ec-Geol—Dec., 1908. No. 1876 D.

Rio Plata Mine and Mill, Western Chihuahua. H. J. Baron. Illustrated description of this silver mine, the mining and ore treatment. 3300 w. Eng & Min Jour—Jan. 16, 1909. No. 1759.

Santa Eulalia Mines, Chihuahua. F. J. H. Merrill. Reviews the history of this group of silver mines which have been worked since 1703. Ills. 2500 w. Min & Sci Pr—Jan. 2, 1909. No. 1631.

Ontario.

The South Lorraine Silver District, Ontario. William B. Phillips. An account of the development of a district likely to become important. 1500 w. Eng & Min Jour—Jan. 23, 1909. No. 2037.

Production.

Gold, Silver and Platinum in 1908. A review of the influences and commercial conditions which governed the production and prices. 3000 w. Eng & Min Jour—Jan. 9, 1907. No. 1579.

Rhodesia.

See Gold Milling, under Ore Dressing and Concentration.

Tasmania.

The Magnet Silver Mining Company, N. L., Tasmania. E. A. de Lautour. Illustrated description of this property and its development. 1200 w. Aust Min Stand—Nov. 25, 1909. No. 1688 B.

Tierra del Fuego.

The Gold Regions of the Strait of Magellan and Tierra del Fuego. R. A. F. Penrose, Jr. A general account of the occurrence of gold in this little-known region. Ills. 3500 w. Jour of Geol—Nov.-Dec., 1908. No. 1731 D.

West Africa.

West Africa Goldfields at the Close of 1908. Examines the causes of the recent revival and discusses the future prospects of this field. 3500 w. Min Jour—Jan. 9, 1909. No. 1816 A.

Yukon.

See Alaska, under Gold and Silver.

IRON AND STEEL.

Australia.

Iron Ores and Iron Production in Australia. J. Findlay. A review of the deposits in the different states and the extent of their development. 2500 w. Ir Trd Rev—Jan. 7, 1909. No. 1605.

Blast-Furnace Charges.

Blast Furnace Charge Calculator. Describes a circular rule, designed by R. Marshall, for enabling the smelter of copper to calculate the various quantities of fluxes for any given weight of charge. 800 w. Engr, Lond—Jan. 8, 1909. No. 1828 A.

Blast-Furnace Gas.

See Gas Power Plants, under MECHANICAL ENGINEERING, Combustion Motors.

Blast-Furnace Lining.

The Selection of Refractories. Considers the kind and quality of brick best suited for various parts of different furnaces. Ills. 8500 w. Ir Trd Rev—Jan. 7, 1909. No. 1609.

Blast-Furnace Practice.

See Electro-Metallurgy, under Iron and Steel.

Blast Furnaces.

Some American Blast Furnace Plants. The present article gives plan and description of the Haselton furnaces of the Republic Iron & Steel Co., and the plant of the Inland Steel Co., on the west shore of Lake Michigan. 2000 w. Engr, Lond—Jan. 8, 1909. Serial, 1st part. No. 1826 A.

British Columbia.

See Washington, under Iron and Steel.

Electro-Metallurgy.

Smelting of Iron Ore in the Electric Furnace, in Comparison with Blast Furnace Practice. Joh. Härdén. Compares the various classes of furnaces proposed for the purpose, with the blast furnace. 4000 w. Elec-Chem & Met Ind—Jan., 1909. No. 1678 C.

Experiments on Melting in the Induction Furnace. F. A. J. FitzGerald. An account of an experiment at the plant of the Am. Elec. Furnace Co., on the melting capacity of the induction furnace. 800 w. Elec-Chem & Met Ind—Jan., 1909. No. 1674 C.

The Largest Electric Steel Works. Joseph W. Richards. An account of the Girod works now building at Ugine, in Savoy, France. 1500 w. Elec-Chem & Met Ind—Jan., 1909. No. 1673 C.

The Girod Electrical Process for the Manufacture of Steel Castings. Illustrated description of an installation in Switzerland, with report of operative methods, cost, etc. 2500 w. Ir & Coal Trds Rev—Dec. 24, 1908. No. 1547 A.

See also same title, under ELECTRICAL ENGINEERING, Electro-Chemistry.

Ferro-Alloys.

The Dangers of Ferro-Silicon. Gives the report of D. R. Wilson, on "The Properties of Ferro-Silicon," showing the danger connected with its transport. 1500 w. Engng—Dec. 25, 1908. No. 1537 A.

Georgia.

Clinton or Red Ores of Georgia. Edwin C. Eckel. A review of a recent report by Dr. S. W. McCallie, concerning the distribution, character and origin of these ores. Ills. 2000 w. Ir Trd Rev—Jan. 7, 1909. No. 1603.

Germany.

The Sedimentary Brown Ore Deposits near Hollfeld in Bavaria (Die eluvialen Brauneisenerze der nördlichen Fränkischen Alb bei Hollfeld in Bayern). F. Klockmann. Describes the deposits and the ores. Ills. 4000 w. Stahl u Eisen—Dec. 30, 1908. No. 1944 D.

See also Trusts, under INDUSTRIAL ECONOMY.

Japan.

Steel Making in Japan. Theodore D. Morgan. Discusses the present standing and possibilities of the industry. 4000 w. Ir Age—Jan. 28, 1909. No. 2121.

Michigan.

The Swanzy Iron Ore District. An illustrated description of the operations of the Cleveland Cliffs Iron Co., and the laying out of the beautiful mining town of Gwynn. 1800 w. Ir Trd Rev—Jan. 7, 1909. No. 1602.

Minnesota.

Much Work Done During a Dull Year. Oliver J. Abell. An illustrated account of extensive stripping operations at Mesabi Range mines and the sinking of concrete shafts. 6500 w. Ir Trd Rev—Jan. 7, 1909. No. 1601.

Ohio.

The Mahoning Valley as an Iron Center. Joseph F. Froggett. Reviews the history of this iron district in Ohio, the present article covering the pioneer period. Ills. 3800 w. Ir Trd Rev—Jan. 21, 1909. Serial. 1st part. No. 1899.

Pig Casting.

The Gary Pig Casting Plant. Brief illustrated description of the Heyl & Patterson machines at Gary, Ind. 800 w. Ir Age—Jan. 14, 1909. No. 1746.

Piping.

Piping in Steel Ingots. J. F. Springer. An illustrated discussion of methods for its reduction and elimination. 5000 w. Cassier's Mag—Jan., 1909. No. 1729 B.

Rolling Mills.

Gas-Electric vs. Steam Equipment for Steel Mills. J. A. Knesche. A study of whether it would pay to discard good steam equipment and replace it with gas-electric equipment. 8500 w. Ir Trd Rev—Jan. 7, 1909. No. 1607.

The Bray Continuous Sheet Mill. Illustrated description of a mill at South Sharon, Pa. 1500 w. Ir Age—Dec. 31, 1908. No. 1397.

The Development and Present Condition of the Electric Power and Lighting Plants of the Peine Rolling Mills (Die Entwicklung und jetzige Berschaffenheit der elektrischen Kraftübertragungs- und Beleuchtungsanlagen der Akt.-Ges. Peiner Walzwerk). F. Hartig. Discusses the transformation and distribution of power in these large works. Ills. Serial. 1st part. 1900 w. Elek Kraft u Bahnen—Dec. 14, 1908. No. 1990 D.

Russia.

Russian Iron Trade Conditions. Gives the history of the proposed pool of the South Russian Iron Works. 2500 w. Ir Age—Jan. 21, 1909. No. 1861.

Steel Works.

The Works of the Indiana Steel Co. at Gary, Ind. This first of a series of illustrated articles describes the blast furnace equipment of a great plant under construction on the shore of Lake Michigan. 10000 w. Ir Trd Rev—Jan. 7, 1909. Serial. 1st part. No. 1606.

The Greatest Steel Plant in the World. First of a series of illustrated articles describing in detail the Gary Works of the Indiana Steel Co. 7000 w. Ir Age—Jan. 7, 1909. Serial. 1st part. No. 1491.

See also Electro-Metallurgy, under IRON AND STEEL; and Ore Handling, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Tennessee.

Iron Operations in the Chattanooga District. Edwin Higgins. An illustrated description of the general conditions and methods. 2500 w. Eng & Min Jour—Jan. 2, 1909. No. 1437.

Trade.

The Iron and Steel Industry in 1908. Reports a year of depression and small demand with gradual recovery. 8500 w. Eng & Min Jour—Jan. 9, 1909. No. 1582.

The Iron and Steel Trades in 1908. General and district reviews for the year. 15500 w. Ir & Coal Trds Rev—Jan. 1, 1909. No. 1722 A.

The Chicago, Philadelphia, Pittsburgh and Cincinnati Iron Trade in 1908. Reviews by T. J. Wright, A. A. Miller, Robert A. Walker, and H. Eugene Hall. 18000 w. Ir Age—Jan. 7, 1909. No. 1498.

The Tin Plate and Sheet Steel Trades in 1908. B. E. V. Luty. A review of the production and related statistics. 3300 w. Ir Age—Jan. 7, 1909. No. 1499.

United States.

The Delay in Southern Iron Development. Edwin C. Eckel. A review of the southern iron industry. 1800 w. Mfrs Rec—Jan. 7, 1909. (Special No.) No. 1563 C.

Washington.

Iron Ore Deposits of the Pacific Northwest. H. Cole Estep. A study of these deposits, particularly in Washington and British Columbia, their location, nature, extent and mining problems. Ills. 4000 w. Ir Trd Rev—Jan. 7, 1909. No. 1604.

LEAD AND ZINC.

Lead Alloys.

See Alloys, under MISCELLANY.

Lead Assaying.

The Electrolytic Estimation of Lead and of Manganese by the Use of the Filtering Crucible. F. A. Gooch and F. B. Beyer. Demonstrates processes for the electrolytic deposition of lead dioxide and manganese dioxide. 1200 w. Am Jour of Sci—Jan., 1909. No. 1741 D.

Production.

The Production of Lead and Spelter in 1908. A review of mining conditions, production, prices, exports and imports during 1908. Also report of tin. 10000 w. Eng & Min Jour—Jan. 9, 1909. No. 1581.

Zinc Trade.

The London Spelter Market in 1908. A review by months. 1500 w. Eng & Min Jour—Jan. 23, 1909. No. 2035.

MINOR MINERALS.

Aluminium.

The Electrolytic Reduction of Aluminium as a Laboratory Experiment. M. deKay Thompson. Describes difficulties encountered in attempting to electrolyze a solution of aluminium oxide in melted cryolite according to the Hall patent, showing how they may be overcome to a certain extent. 1500 w. Elec-Chem & Met Ind—Jan., 1909. No. 1679 C.

Three new British **Aluminium Works.** Illustrated description of the Dolgarrog works in North Wales, the Wallsend works and the Kinlochleven works in western Scotland. 3500 w. Elec-Chem & Met. Ind—Jan., 1909. No. 1683 C.

Building Stone.

Building Stone of Oklahoma. L. L. Hutchison. Reports an unlimited supply of granite, sandstone, limestone and marble of good quality. 3500 w. Mfrs Rec—Jan. 7, 1909. (Special No.) No. 1566 C.

Granite and Marble Resources of the South. Ernest F. Burchard. Information concerning production, the distribution and quality of the deposits. 4000 w. Mfrs Rec—Jan. 7, 1909. (Special No.) No. 1564 C.

Cement.

A New Viewpoint of the American Portland Cement Industry. Edwin C. Eckel. Read before the Assn. of Am. Portland Cement Mfrs. Discusses the future growth of the industry, future prices, influence of patents, etc. 4500 w. Eng Rec—Jan. 9, 1909. No. 1571.

Cement Works at Southam. Illustrated detailed description. 2000 w. Engr, Lond—Jan. 1, 1909. Serial. 1st part. No. 1716 A.

Diamonds.

Diamond Mine in Pike County, Arkansas. John T. Fuller. Illustrated account of these diamond-bearing peridotites. 2500 w. Eng & Min Jour—Jan. 16, 1909. No. 1760.

Graphite.

Graphite in the South. Dr. F. W. Ihne. Information concerning the varieties of graphite, where found, the value of southern deposits, the development, etc. Ills. 10000 w. Mfrs Rec—Jan. 7, 1909. (Special No.) No. 1567 C.

Manganese.

See Lead Assaying, under LEAD AND ZINC.

Molybdenum.

Occurrence and Uses of Molybdenum Ores. Summary of facts in regard to the occurrence, production and uses, as given in a Bulletin of the Imperial Institute. 2500 w. Aust Min Stand—Dec. 9, 1908. No. 1894 B.

Natural Gas.

See Oil, under MINOR MINERALS.

Oil.

The Petroleum Resources of the United States. David T. Day. Considers the store of petroleum known within the limits of the country, the rate at which it is being exhausted, the extent of waste, and suggests methods by which its use may better serve both present and future needs. Map. 4000 w. Am Rev of Revs—Jan., 1909. No. 1735 C.

The Petroleum Industry of the United States. A review of developments in the various districts during the past year. 10000 w. Eng & Min Jour—Jan. 9, 1909. No. 1584.

Broad Survey of Southern Potentialities in Mineral Development. Dr. David T. Day. Information concerning the development of oil-fields, sulphur beds, natural gas, and the chemical industries. 6000 w. Mfrs Rec—Jan. 7, 1909. (Special No.) No. 1555 C.

Oil and Gas in Oklahoma. Charles N. Gould. Reviews the discoveries thus far made and their development. 2000 w. Mfrs Rec—Jan. 7, 1909. (Special No.) No. 1562 C.

S. Pearson & Son's Uncontrollable Oil Gusher. Illustrated account of the well near Dos Bocas, Mexico, which burned nearly two months and defeated all efforts to save the oil. 2000 w. Eng & Min Jour—Jan. 2, 1909. No. 1438.

See also Natural Resources, under INDUSTRIAL ECONOMY.

Phosphate.

Tennessee's Big Phosphate Field. W. D. Hastings. An account of the discovery and development. Ills. 2500 w. Mfrs' Rec—Jan. 7, 1909. (Special No.) No. 1569 C.

Platinum.

See Production under GOLD AND SILVER.

Production.

Production of Other Metals and Minerals. Report for the past year concerning the production of aluminum barytes, borax, phosphate rock, quicksilver, cyanamide, etc. 6500 w. Eng & Min Jour—Jan. 9, 1909. No. 1587.

Salt.

The Stassfurt Salt Mines in Harz Mts., Germany. Albert B. Green. Brief illustrated description. 2000 w. Min Wld—Jan. 16, 1909. No. 1782.

The Schernthanner Method of Opening Up Salt Mines by Means of Boreholes (Die Schernthannersche Werks-Veröffnung mit Bohrlochwässerung). Hans Vogl. Illustrated description of method of opening up rock-salt workings by leaching methods. 2700 w. Oest Zeitschr f Berg- u Hüttenwesen—Dec. 19, 1908. No. 1949 D.

Sulphur.

See Oil, under MINOR MINERALS.

Tin.

The Origin of the Tin Ores of the Rooiberg District, Transvaal. Information from a recent paper by Mr. Recknagel, published in the Trans. of the Geol. Soc. of S. Africa. 1200 w. Min Jour—Dec. 19, 1908. No. 1530 A.

Mining in the Malay States. E. Seaborn Marks. An illustrated account of this mining region which produces over 60% of the world's tin supply. 4000 w. Min & Sci Pr—Jan. 2, 1909. No. 1630.

The London Tin Market in 1908. A review by months. 3000 w. Eng & Min Jour—Jan 23, 1909. No. 2034.

Tungsten.

Tungsten Deposits and Surface Enrichment. Gordon Surr. Describes tungsten deposits, and discusses the possibility of secondary enrichment. 3000 w. Min Wld—Jan. 2, 1909. No. 1444.

MINING.

Blasting.

The Gases Resulting from the Use of High Explosives. William Cullen. The effect of explosives on the atmosphere of mines, giving results of experiments and points bearing on mine ventilation. 7800 w. Jour Chem, Met & Min Soc of S Africa—Nov., 1908. No. 1801 E.

Diamond Drilling.

Important Features of Diamond Core Drilling. C. J. McCord. Presents unusual features of the work. Ills. 4500 w. Min Wld—Jan. 2, 1909. Serial. 1st part. No. 1442.

Electric Hoisting.

Electrical Winding in South Wales. Illustrated description of the installation at the Maritime pit of the Great Western Colliery Co. 2000 w. Elec Rev, Lond—Jan. 1, 1909. No 1693 A.

Losses in the Ilgner Hoisting System and Determination of the Most Economical Slip of Its Starting Motors (Verluste bei Ilgner-Förderanlagen und Bestimmung der wirtschaftlichsten Schlüpfung ihrer Anlassmotoren). L. Becker. Mathematical and theoretical. Ills. 2000 w. Elektrotech Zeitschr—Dec. 24, 1908. No. 2115 D.

Electric Power.

See Accumulators, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Explosives.

Twenty Years' Progress in Explosives. Oscar Guttmann. A review of progress giving information concerning their manufacture, composition, etc. 5500 w. Jour Soc of Arts—Dec. 25, 1908. Serial. 1st part. No. 1503 A.

See also same title, under RAILWAY ENGINEERING, TRAFFIC.

Haulage.

The Mosgrove Incline. William L. Affelder. Describes the method of construction used to avoid common defects. Of interest to coal operators. 1200 w. Mines & Min—Jan., 1909. No. 1415 C.

New Hauling Station, Great Boulder Mine, W. A. Illustrated description of a new station at Kalgoorlie, W. A. 1800 w. Aust Min Stand—Dec. 9, 1908. No. 1893 B.

Electrically Operated Slag Railway of the Alpine Mining Company, Donawitz, Austria (Elektrisch betriebner Haldenaufzug der österreichischen Alpinen Montangesellschaft in Donawitz). Illustrated description of this electrically operated rope-haulage plant. 1500 w. Oest Zeitschr f Berg-u Hüttenwesen—Dec. 12, 1908. No. 1948 D.

Hoisting.

Dynamics of Colliery Winding Ropes, Cages, Guide Ropes, and Tubs. A. Hanley. Read before the Nat. Assn. of Col. Mgrs. Illustrated discussion of methods of testing and description of the author's inventions. 2500 w. Ir & Coal Trds Rev —Jan. 15, 1909. No. 2086 A.

Hoisting Engines.

Automatic Throttle-Closing Device for Hoisting Machinery. Spencer S. Rumsey. Describes an invention in use at the mines of the Oliver Iron Mining Co. 1500 w. Mines & Min—Jan., 1909. No. 1416 C.

Mine-Lamps.

Acetylene Mine-Lamps. A. Cressy Morrison. Information concerning their use and cost. 1000 w. Min & Sci Pr—Jan. 23, 1909. No. 2129.

Ore Bins.

Construction and Method of Operation of Ore Bunkers at Skagway. A. L. Bardoe. Brief illustrated description. 600 w. Bul Can Min Inst—Jan., 1909. No. 2045 N.

Ore Handling.

See same title, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Quarries.

The Pen Lee Stone Quarries. Illustrated description. 1500 w. Quarry—Jan., 1909. No. 1723 A.

Tunneling.

See Tunneling Machines, under CIVIL ENGINEERING, CONSTRUCTION.

Wire Ropes.

Cross-Laid Double-Layer Wire Ropes. An account of experiments recently made with such ropes, and some serious objections to their use. 800 w. Engr, Lond —Jan. 15, 1909. No. 2082 A.

ORE DRESSING AND CONCENTRATION.

Classification.

Classification at El Tiro Mill, Pima County, Arizona. George W. Brown. Gives a report of working results with the Richards pulsator classifier. 1200 w. Mines & Min—Jan., 1909. No. 1410 C.

Classification of Ores at the Butte Reduction Works. A. H. Wethey. Describes the use of the Pratt centrifugal screen for sizing without regard to specific gravity. 1500 w. Mines & Min—Jan., 1909. No. 1413 C.

Classifiers.

The Richards Pulsator Jig and Pulsator Classifier. Frank E. Shepard. Read before the Colo. Sci. Soc. Illustrated detailed description. 2200 w. Min Wld—Jan. 9, 1909. No. 1652.

Copper.

The Boston Consolidated Mill at Garfield, Utah. Leroy A. Palmer. Illustrates and describes the large mill built to treat sulphides with gold and silver values amounting to only 20 cts. per ton. The property can produce 50,000,000 lb. of copper annually with the estimated tonnage and values. 3500 w. Min Wld—Jan. 12, 1909. No. 1443.

Gold Milling.

Description of Ore Treatment at the Giant Mine, Hartley District, Rhodesia. Reginald C. H. Cooke. Describes the process of extraction used for a heavily mineralized chloride schist,' intermixed with ironstone and quartz. 2500 w. Jour Chem, Met, & Min Soc of S Africa—Nov., 1908. No. 1802 E.

Grinding.

The Computation of Crushing Efficiency of Fine Grinding Machines. H. Stadler. A study, giving tables and calculations, and emphasizing the importance of care in making grading analyses. 3000 w. Jour S African Assn of Engrs—Dec., 1908. No. 2047 F.

Jigs.

See Classifiers, under ORE DRESSING AND CONCENTRATION.

Lead Milling.

Milling Costs. R. S. Handy. Suggestions for arriving at milling costs and efficiency, with daily report blank. 1000 w. Min & Soc Pr—Jan. 23, 1909. No. 2130.

Mill Tests.

See Assaying, under GOLD AND SILVER.

Sampling.

Methods of Sampling Iron Ore. J. M. Camp. Explains the systems of commercial sampling adopted by the U. S. Steel Corporation. 2200 w. Ir Trd Rev—Jan. 28, 1909. No. 2131.

Silver Milling.

See Mexico, under GOLD AND SILVER.

MISCELLANY.

Alloys.

The Alloys of Lead (Les Alliages de Plomb). A. Portevin. Summarizes the results of Prof. Tammann's researches on alloys of lead with calcium, cobalt, chromium, indium, potassium, sodium, palladium, platinum, antimony, thallium, etc. Ills. 3500 w. Rev de Métal—Dec., 1908. No. 1911 E + F.

Ore Deposits.

See Tin, and Tungsten, under MINOR MINERALS.

Review of 1908.

Mining and Metallurgy in 1908. Editorial review. 7000 w. Min Jour—Dec., 26, 1908. No. 1532 A.

Mining in the United States During 1908. Reviews progress at the various camps. Maps. 2400 w. Eng & Min Jour—Jan. 9, 1909. No. 1585.

Mineral and Metal Production in 1908 A summary of the production of the more important minerals and metals in the United States. 700 w. Eng & Min Jour—Jan. 9, 1909. No. 1578.

Review of Mining in Foreign Countries. Reviews the developments of the past year in the Transvaal, Peru, Chile, Colombia, Mexico, Ontario and Australia. 17000 w. Eng & Min Jour—Jan. 9, 1909. No. 1586.

The Mining Market in 1908. Briefly reviews the general characteristics of the year and the course of the market. 3000 w. Min Jour—Jan. 2, 1909. Serial. 1st part. No. 1702 A.

U. S. Geological Survey.

Work of the United States Geological Survey in 1908. 2500 w. Eng & Min Jour—Jan. 23, 1909. No. 2036.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

The Safety of British Railways. Reviews the accident records for various years and Acts passed that have a bearing on the safety of railways. 1600 w. Engr, Lond—Jan. 8, 1909. No. 1825 A.

Dispatching.

Telephone Train Dispatching. Discusses the elements that make up an operative system. 2500 w. Sig Engr—Jan., 1909. No. 1837.

Signaling.

Block Signal and Control Board: First Annual Report to the Interstate Commerce Commission. The report of a board appointed to investigate the use and necessity for block signal systems and automatic control appliances on railways is given nearly in full. 8000 w. Eng News—Jan. 14, 1909. No. 1786.

Interlocking Facilities of the St. Louis Terminal Railroad Assn. of St. Louis. A. D. Cloud. An illustrated account of extensive improvements made to handle the traffic in connection with the World's Fair of 1904. 8000 w. Sig Engr—Jan., 1909. No. 1836.

Trains.

The Southern Belle Express. Illustrated description of a fine train recently put in service on the L., B. & S. C. Ry. of England. 1000 w. Engr, Lond—Jan. 8, 1909. No. 1824 A.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

High Brake Cylinder Pressures. G. W. Kiehm. Explains the action of air brakes and discusses the arguments for and against the employment of higher pressures. 1500 w. Ry & Loc Engng—Jan., 1909. No. 1447 C.

Car Heating.

Vapor Car Heating System. Illustrated description of the system invented by Edward E. Gold. 2200 w. Ry & Loc Engng—Jan., 1909. No. 1450 C.

Car Trucks.

Cast Steel Frames of the Arch-Bar Type for Car Trucks. Illustrated description of an arch-bar frame with the journal boxes cast as a part of the frame. 900 w. Eng News—Jan. 7, 1909. No. 1640.

Couplers.

Polar Coupler on the Pennsylvania. Illustrated description of new coupler designed for new steel cars. 800 w. Ry & Loc Engng—Jan., 1909. No. 1451 C.

Draft Gear.

Southern Pacific Draft Gear Tests. A report of tests made on the Los Angeles division of the So. Pacific to show the advantage of the Westinghouse friction draft gear in freight service. 1800 w. R R Age Gaz—Jan. 8, 1909. No. 1650.

Electrification.

New York Central Railway Electrification. Brief illustrated description of the conversion of a part of this steam railway to electric traction on the continuous current system. 3000 w. Tram & Ry Wld—Jan. 7, 1909. No. 2057 B.

Freight Cars.

Summers Ore Car for the Duluth & Iron Range. Illustrated description of a self-clearing car. 600 w. R R Age Gaz—Jan. 29, 1909. No. 2145.

Fruit and Vegetable Cars for the San Antonio & Aransas Pass. Illustrated description of cars containing new features in the ventilating arrangements. 400 w. R R Age Gaz—Jan. 29, 1909. No. 2144.

Lifting Jacks.

Mechanical Lifting of Railway Rolling Stock (Note sur le Levage mécanique des Véhicules de Chemins de Fer et notamment des Voitures à Bogies). M. Oudet. Describes compressed air, hydraulic, and electric apparatus for lifting cars from their trucks. Ills. Plates. 3300 w. Rev Gen des Chemins de Fer—Dec., 1908. No. 1914 G.

Locomotive Boilers.

Regulating Valves for Locomotive Boilers. Describes an improved design recently patented in England. Ills. 700 w. Mech Engr—Jan. 1, 1909. No. 1510 A.

Locomotive Cleaning.

Scouring Plant in the Saarbrücken Shops (Auskochanlage in der Hauptwerkstätte Saarbrücken). Herr Halfmann. Illustrated description of a successful plant for cleaning locomotive parts by steam, with costs 2500 w. Glasers Ann—Dec. 15, 1908. No. 1971 D.

Locomotive Crank Axles.

Tests of Frémont-Type Crank Axles (Essais d' Essieux condés à Flasques évidées). E. Hallard. The results of tests on the Chemin de Fer du Midi show that the form of crank devised by M. Frémont is an improvement over that commonly used. Ills. 1500 w. Rev Gen des Chemins de Fer—Dec., 1908. No. 1913 G.

Locomotive Design.

Design of Oil Burning Locomotives. Harrington Emerson. Presents a comparison between the limitations of coal burning and oil burning locomotives, and the effect on design. 1000 w. Am Engr & R R Jour—Jan., 1909. No. 1592 C.

Locomotive Fireboxes.

The Life of Side Sheets of Wide Fireboxes. C. A. Seley. Discusses their design. General discussion. Ills. 13000 w. Pro W Ry Club—Dec. 15, 1908. No. 1797 C.

A New Departure in Flexible Stay-Bolts. H. V. Wille. Proposes the use of high carbon spring steel and to increase the unit tensile stress. Ills. 1200 w. Jour Am Soc of Mech Engrs—Jan., 1909. No. 1851 F.

Locomotive Flues.

Endurance of Flue Material in Locomotives. Alexander Kearney. Read before the Richmond R. R. Club. Considers the method of application, the composition and the changes which affect its endurance under service conditions. 1700 w. Boiler Maker—Jan., 1909. No. 1665.

Locomotive Fuels.

Petroleum Residues as Fuel on the Roumanian Railways. Information concerning this fuel and the method of burning it. 2000 w. Engr, Lond—Dec. 25, 1908. No. 1542 A.

Installations and Apparatus used on Roumanian Railways for Firing Locomotive Boilers with Petroleum Residues (Description des Installations et des Appareils en Usage aux Chemins de Fer de l'Etat Roumain pour l'Emploi des Résidus de Pétrole au Chauffage des Locomotives). Th. Dragen. Detailed description. Ills. 8500 w. Rev Gen des Chemins de Fer—Dec., 1908. No. 1915 G.

Locomotive Performance.

The Work of Superheater and Compound Locomotives. Charles R. King. Gives charts showing the power capacity of such engines for comparison, with a study of the results shown. 3500 w. Engr, Lond—Dec. 25, 1908. No. 1540 A.

Locomotives.

Standard Atlantic and Mogul Locomotives for the Harriman Lines. Illustrated descriptions, with explanatory remarks. 1500 w. R R Age Gaz—Jan. 1, 1909. No. 1463.

Locomotives of the Pacific Type of the French Western Railway. Robert Dubois. Gives the proposed specification and an illustrated description of the engines. 2000 w. Bul. Int Ry Cong—Dec., 1908. No. 2006 G.

We supply copies of these articles. See page 1071.

Compound Goods Locomotive, 0-10-0 Type, Servian State Railways. Illustration, with brief description. 500 w. Mech Engr—Jan. 1, 1909. No. 1509 A.

Twelve-Wheeled Duplex Tank Locomotive; Nitrate Railways Co., Chili. Illustrates and describes tank-engines of unusual size, weight, and power. 1500 w. Engng—Jan. 1, 1909. No. 1708 A.

Schmidt Superheater Locomotives Outside of Germany (Die Heissdampflokomotive, Bauart Schmidt, im Auslande). C. Guillery. Reviews their use in other European countries. Ills. 6000 w. Zeitschr d Ver Deutscher Ing—Dec. 5, 1908. No. 1999 D.

Mallet Compound Locomotive of the Hedjaz Railway (Locomotive compound Mallet du Chemin de Fer de l'Hedjaz, Arabia). Illustrated description with detailed drawing. 1000 w. Génie Civil—Dec. 5, 1908. No. 1927 D.

Locomotive Valve Gears.

Baker-Pilliod Locomotive Valve Gear. Illustrates and describes this new gear and its application. 700 w. Am Engr & R R Jour—Jan., 1908. No. 1595 C.

Locomotive Wheels.

Flange Lubrication on Southern Pacific System. Illustrated description of the flange lubricator with report of the results of its use. 700 w. R R Age Gaz—Jan. 15, 1909. No. 1792.

Motor Cars.

The McKeen Motor Cars. Illustrated description of a combination passenger and baggage car driven by gasolene. 1000 w. R R Age Gaz—Jan. 14, 1909. No. 1791.

Accumulator Motor Cars of the Prussian State Railways (Automotrices à Accumulateurs des Chemins de Fer de l'Etat prussien). Illustrated detailed description. Plate. 2900 w. Génie Civil—Dec. 26, 1908. No. 1931 D.

Traction by Petrol-Electric Motor Cars on the Arad-Csanad Railways, Hungary (La Traction par Automotrices pétrolés-électriques sur les Chemins de Fer d'Arad-Csanad, Hongrie). Illustrated description of the mechanical details of the cars and a discussion of the economic results. 3000 w. L'Elecn—Dec. 19, 1908. No. 1922 D.

Passenger Cars.

All-Steel Suburban Cars. Brief illustrated description of cars for the Long Island R. R. 500 w. Am Engr & R R Jour—Jan., 1909. No. 1594 C.

Shops.

The New Car Shops of the Union Pacific at Omaha. Illustrated detailed description. 1500 w. R R Age Gaz—Jan. 29, 1909. No. 2147.

Battle Creek Shops of the Grand Trunk Ry. Illustrated description of shops recently opened for service. 3000 w. Ry & Engng Rev—Jan. 16, 1909. No. 1831.

The Works of the Chicago, New York & Boston Refrigerator Company. A reconstructed plant in Chicago, for the construction and repair of freight cars is illustrated and described. 2500 w. Eng Rec—Jan. 23, 1909. No. 2028.

See also Yards, under PERMANENT WAY AND BUILDINGS.

Trucks.

See Wheel Base, under MOTIVE POWER AND EQUIPMENT.

Wheel Base.

The Wheel Base of Railway Rolling Stock. Roger Atkinson. A study of the action of different arrangements of wheel base and trucks. Ills. 3000 w. Ry & Loc Engng—Jan, 1909. No. 1449 C.

NEW PROJECTS.

Mexico.

The Mexican Central Railway's Pacific Extension. Detailed description with plan of the extension and the Manzanillo terminal. 3500 w. Eng Rec—Jan. 9, 1909. No. 1576.

Southern Pacific.

The Southern Pacific Lines in Mexico. Map and illustrated account of the construction of a main trunk line and branches on the west coast. 3000 w. R R Age Gaz—Jan. 1, 1909. No. 1461.

Virginia.

The Carolina, Clinchfield & Ohio Ry. Illustrated detailed description of the physical characteristics of a new line, to develop a new coal district of Virginia. 6000 w. Eng News—Jan. 21, 1909. No. 1872.

PERMANENT WAY AND BUILDINGS.

Crossings.

Building and Maintaining Railroad Crossings. W. C Sparks. Read before the Cent. Elec. Ry. Assn. Discusses points that should be considered in their construction and economical maintenance. 1500 w. Engng-Con—Dec. 30, 1908. No. 1454.

Cut Slopes.

The Use of Locomotive Ashes for Maintaining the Slopes of Cuttings. W. Bauer. Describes the method of application so as to protect the slopes against wet and frost. 1800 w. Bul Int Ry Cong—Dec., 1908. No. 2007 G.

Grade Reduction.

Reconstruction of a Portion of the Canadian Pacific Railway. An illustrated account of improvement in grades in the Kicking Horse Valley. 2000 w. Engr, Lond—Dec. 25, 1908. No. 1541 A.

Rail Records.

Pennsylvania Rail Record-Blanks. Gives blanks used for keeping a record of rail failures, with related information. 1000 w. R R Age Gaz—Jan. 1, 1909. No. 1462.

Reconstruction.

Revision of Line of the Kanawha &

Michigan Ry.; With Unit Costs of the Work. J. A. Stocker. Describes revisions of line and grade in Ohio, eliminating many objectionable curves. Ills. 2000 w. Eng News—Jan. 7, 1909. No. 1637.

See also Grade Reduction, under PERMANENT WAY AND BUILDINGS.

Roundhouses.

East Buffalo Roundhouse. Illustrated description of a new 30 stall roundhouse for passenger locomotives of the N. Y. C. & H. R. R. R. 3000 w. Am Engr & R R Jour—Jan, 1909. No. 1593 C.

Stations.

See Steel, under CIVIL ENGINEERING, CONSTRUCTION.

Tunnel Ventilation.

A Study of Tunnel Ventilation (Studi delle Ferrovie dello Stato sulla Ventilazione delle Galerie). An illustrated account of a study made by the Italian state railways. Serial. 1st part. 4000 w. Ing Ferro—Dec. 1, 1908. No. 1938 D.

Yards.

Gary Classification Yard of the Chicago, Lake Shore & Eastern. Gives plan and brief description of the 15000 car classification yard at Gary, Ind., and the new shop plant. 700 w. R R Age Gaz—Jan. 8, 1909. No. 1649.

TRAFFIC.

Explosives.

Safe Handling and Transportation of Explosives and Inflammables. Col. B. W. Dunn. Gives an idea of the extent of this Business Administration. 2200 w. R R of regulations wisely enforced., Ills. 10500 w. Pro Ry Club of Pittsburgh—Dec., 1908. No. 2098 C.

The American Railway Association's Bureau for the Safe Transportation of Explosives and Other Dangerous Articles. Col. B. W. Dunn. A sketch of the origin of this Bureau, the general nature of the work, and its possible lines of development. 5500 w. Pro N Y R R Club—Feb. 19, 1909. No. 2099.

MISCELLANY.

Associations.

Work of the American Railway Association. W. F. Allen. From an address on "Railway Operating Associations," delivered before the Harvard School of business, accounts of accidents, and need Age Gaz—Jan. 22. 1909. Serial. 1st part. No. 2002.

India.

A Railway to India. C. E. D. Black. Map and discussion of a projected line through Northern Arabia and Southern Persia, connecting Egypt and India. 3000 w. Nineteenth Cent—Jan., 1909. No. 1838 D.

New Zealand.

New Zealand Government Railways. A review of the report for the year ending March 31, 1908. 2500 w. Engng—Jan. 8, 1909. No. 1820 A.

Review of 1908.

Railways and Tramways. A summary of railway work in different parts of the world. 6000 w. Engr, Lond—Jan. 1, 1909. No. 1720 A.

South Africa.

The Working of the Railways in the South African War. W. Hyde Kelly. On the organization and work of a military railway staff. 4000 w. Engng—Jan. 15, 1909. No. 2079 A.

United States.

Twenty-Second Annual Report of Interstate Commerce Commission. Extracts from the report transmitted to Congress Jan. 11. 3500 w. R R Age Gaz—Jan. 15, 1909. No. 1790.

STREET AND ELECTRIC RAILWAYS

Adhesion System.

See Switzerland, under STREET AND ELECTRIC RAILWAYS.

Cars.

The Life and Wear of Rolling-Stock. M. Stahl. A report dealing with answers to questions sent out in regard to improvements in axles, wheels and tires, with a study of new types of cars. Ills. 3000 w. Elect'n, Lond—Jan. 15, 1909. Serial. 1st part. No. 2072 A.

Suggested Improvements in the Construction of Our Electric Tramways. Gerald H. J. Hooghwinkel. Presents the advantages of the single-track, single-deck car urging its adoption in England. 1500 w. Tram & Ry Wld—Jan. 7, 1909. No. 2059 B.

Combination Closed and Open Car of Pay-As-You-Enter Type for the Third Avenue Railroad Company, New York. Illustrated description of the design of new cars ordered. 3000 w. Elec Ry Jour —Jan. 23, 1909. No. 1898.

See also Track, under STREET AND ELECTRIC RAILWAYS.

Car Testing.

An Autographic Recording Apparatus for Electric Railway Tests. Albert T. Childs. Illustrated description of an autographic testing apparatus which records in curves the continuous electrical performance of a car. 1800 w. Jour Worcester Poly Inst—Jan., 1909. No. 1840 C.

Conductors.

Three-Wire System for Tramways. E. Goulding. Presents the advantages and economics of this system. Ills. 1500 w. Tram & Ry Wld—Jan. 7, 1909. No. 2058 B.

Interurban.

New Interurban Railways in the Central States. Map and general information. 2000 w. Elec Ry Jour—Jan. 2, 1909. No. 1435.

Pittsburg, Harmony, Butler & New Castle 1200-Volt D. C. Railway. John R. Hewett. Illustrated detailed description of the electrification scheme. 2200 w. Elec Ry Jour—Jan. 16, 1909. No. 1754.

Locomotives.

Electric Locomotives for the Great Northern. Illustrates and describes the mechanical construction which is a distinct departure from previous practice. 600 w. R R Age Gaz—Jan. 15, 1909. No. 1793.

Rack Railways.

See Switzerland, under STREET AND ELECTRIC RAILWAYS.

Records.

A System of Record Keeping as Applied to Electric Railway and Tramway Equipment. R. J. M. Holmes. Outlines a card filing system of record keeping. 1000 w. Elec Rev, Lond—Jan. 15, 1909. No. 2063 A.

Substations.

See same title, under ELECTRICAL ENGINEERING, TRANSMISSION.

Subways.

Engineering Features of the Washington Street Tunnel. Illustrated description of this Boston tunnel and its relation to the rapid transit facilities. 3500 w. Engng—Jan. 15, 1909. No. 2074 A.

Arnold Report on New York Subway Traffic. The sixth report by Bion J. Arnold, dated Dec. 31, 1908. 4000 w. Elec Ry Jour—Jan. 30, 1909. No. 2133.

See also Reinforced Concrete, under CIVIL ENGINEERING, CONSTRUCTION.

Surface Contact.

The "G. B." System from a Tramway Manager's Point of View. Stanley Clegg. Read before the Inst of Elec. Engrs. Describes the system as installed at Lincoln, giving the writer's experience of it under working conditions. 7500 w. Elec Engr, Lond—Jan. 15, 1909. No. 2061 B.

Switzerland.

The Martigny-Châtelard Electric Railway (Elektrisch betriebene Bahn Martigny-Châtelard). S. Herzog. Illustrated detailed description of this mountain line which includes stretches on both the adhesion and rack systems. Serial. 1st part. 1000 w. Elektrotech Rundschau—Dec. 5, 1908. No. 1993 D.

Track Construction.

Methods and Cost of Constructing T-Rail Track with Carnegie Steel Ties, Utica & Mohawk Valley Ry. M. J. French. Read before the N. Y. State St. Ry. Assn. A report of work in Utica, N. Y. 1600 w. Engng-Con—Jan. 20, 1909. No. 2000.

Track Maintenance.

Some Maintenance Features of Street Railway Track. J. H. M. Andrews. Discusses joints, the facing switch, curves, frogs, etc. Ills. 2500 w. Engr, Pa—Dec., 1908. No. 2012 D.

Tracks.

The Influence of Track Upon Railway and Tramway Carriages. James Sutherland Warner. Read before the Civ & Mech. Engrs. Soc. Explains the principles upon which "Warner's lines" are based—a method of recording the riding qualities of tram cars. 4000 w. Tram & Ry Wld—Jan. 7, 1909. No. 2060 B.

Track Specifications.

Special Work Specifications of the Interstate Railways. Gives specifications adopted by a Philadelphia corporation operating lines in Pennsylvania, New Jersey and Delaware. 1000 w. Elec Ry Jour—Jan. 9, 1909. No. 1618.

Trains.

Electric Railway Rolling Stock for Urban and Suburban Service. H. M. Hobart. Estimates the weights and costs of continuous current, and single-phase trains. 1800 w. R R Age Gaz—Jan. 8, 1909. No. 1651.

Trolleys.

High Tension Current Collection—Some Results of the Swedish Electric Railway Tests. Otis Allen Kenyon. Notes on recent European practice in overhead construction and current collection, based largely on the report of recent tests made by the Swedish Government. 3500 w. Elec Ry Jour—Jan. 9, 1909. No. 1617.

Trolley Wires.

Factors Determining the Efficiency of Trolley Wire. Carl F. Woods. Abstract of a paper before the Am. Chem. Soc. States five essential qualities and methods of determining the extent wire possesses these properties. 2000 w. Elec Ry Jour—Jan. 30, 1909. No. 2134.

Trucks.

Single-Axle Flexible Trucks for Street Cars (Einachsige Drehgestelle für Strassenbahnwagen). Paul Herrmann. Refers particularly to the type of truck built by the Bergischen Stahlindustrie, Remscheid. Ills. 1500 w. Elek Kraft u Bahnen—Dec. 24, 1908. No. 1992 D.

Trunk Lines.

Electric Trunk Lines (Bahntechnische Forderungen an den elektrischen Vollbahnbetrieb). Artur Heuschka. Discusses the problems of applying electric traction to trunk line operation. Ills. Serial. 1st part. 3800 w. Zeitschr d Oest Ing u Arch Ver—Dec. 4, 1908. No. 1979 D.

Wire Suspension.

See Trolleys, under STREET AND ELECTRIC RAILWAYS.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated: W—Words; Anon—Anonymous.

Alliance Industrielle. *m*. Brussels.
American Architect. *w*. New York.
Am. Engineer and R. R. Journal. *m*. New York.
American Jl. of Science. *m*. New Haven, U. S. A.
American Machinist. *w*. New York.
Anales de la Soc. Cien. Argentina. *m*. Buenos Aires.
Annales des Ponts et Chaussées. *m*. Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w*. Rome.
Applied Science. *m*. Toronto, Ont.
Architect. *w*. London.
Architectural Record. *m*. New York.
Architectural Review. *s-q*. Boston.
Architect's and Builder's Magazine. *m*. New York.
Australian Mining Standard. *w*. Melbourne.
Autocar. *w*. Coventry, England.
Automobile. *w*. New York.
Automotor Journal. *w*. London.
Beton und Eisen. *qr*. Vienna.
Boiler Maker. *m*. New York.
Brass World. *m*. Bridgeport, Conn.
Brit. Columbia Mining Rec. *m*. Victoria, B. C.
Builder. *w*. London.
Bull. Bur. of Standards. *qr*. Washington.
Bulletin de la Société d'Encouragement. *m*. Paris.
Bulletin du Lab. d'Essais. *m*. Paris.
Bulletin of Dept. of Labor. *b-m*. Washington.
Bull. of Can. Min. Inst. *qr*. Montreal.
Bull. Soc. Int. d'Electriciens. *m*. Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m*. Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m*. Liége.
Bull. Tech. de la Suisse Romande. *s-m*. Lausanne.
California Jour. of Tech. *m*. Berkeley, Cal.
Canadian Architect. *m*. Toronto.
Canadian Electrical News. *m*. Toronto.
Canadian Engineer. *w*. Toronto and Montreal.
Canadian Mining Journal. *b-w*. Toronto.
Cassier's Magazine. *m*. New York and London.
Cement. *m*. New York.
Cement Age. *m*. New York.
Central Station. *m*. New York.
Chem. Met. Soc. of S. Africa. *m*. Johannesburg.
Clay Record. *s-m*. Chicago.
Colliery Guardian. *w*. London.
Compressed Air. *m*. New York.

Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *w.* London.
Electrieal Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elcktrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *m.* Milan.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Jour. Ind. & Engng. Chem. *m.* Easton, Pa.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *w.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *b-m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Age Gazette. *w.* New York.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Signal Engineer. *m.* Chicago.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Surveyor. *w.* London.
Technology Quarterly. *qr.* Boston, U. S. A.
Technik und Wirtschaft. *m.* Berlin.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagon Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.