sized into five sizes by means of Edison Tower screens. Each size is run separately over a magnetic concentrator of the Wetherill type. These machines utilise the Wetherill process of separating ores of very slight magnetic attractability; in fact, such ores which previous to the invention of this process were considered incapable of magnetic concentration. Over each feed belt on these machines there are six magnets, which divide the product into different classes, depending on the magnetic attractability of the material removed. Three products are obtained: First, franklinite, from which oxide of zinc and spiegeisen are produced; second, middlings, which consist of a mixture of manganese and iron silicates, as well as some proportions of the willemite which has particles of the franklinite or other magnetic material attached to it. This material is used for production of oxide of zinc only; third, a mixture of willemite, red oxide of zinc, and calcite, practically free from iron and manganese. This product, constituting the tails from the magnetic separator, is passed over jigs which remove the calcite, leaving practically clean willemite and red oxide of zinc. This product is used in the spelter furnace. Almost chemically pure metal is obtained from it, as it contains no lead, cadmium, or other materials, which commonly contaminate spelter. The concentrating plant has a capacity of about 350 to 400 tons per day of 24 hours. A new concentrating plant is now in process of erection which will handle 1000 tons of ore in 10 hours. The foundations for this building have been completed, and some of the crushing machinery, which will be on the Edison principle, is in course of erection. The Edison scheme of crushing does away entirely with the jawbreaker, handling the material from the beginning with rolls.

We climbed a very steep hill on our arrival, and waded through a conglomerate of clay and mineral deposits, "&c.," aforementioned, quite a little of which adhered in a friendly manner to our clothes, until at last we reached the summit, from which we could look down and see the entrance to a tunnel. It reminded us of *Punch's* story, when the little girl called her companions to look under the circus tent because they "could see the 'oofs of the 'orses." However, we were all happy, and the mountain air was lovely, so we returned to our train somewhat fatigued, but in a cheerful glow from the climb, then we went to a fine club-house and enjoyed one of the best meals attainable, and no trouble had been spared; even the celebrated "Fish House" punch of Philadelphia was in evidence, and was thoroughly appreciated. The meal itself would not have discredited Delmonico, and everyone had enough, and was in a humour to examine the mill and especially the ore separator.

We found on entering the mill the reason of the precautions which our host had insisted that the visitors should take, in the form of goggles and respirators. The air was full of fine dust which settled on hats and clothes, and was somewhat trying to breathe. The attraction was, however, great; and in case of our watches so very great that we left them behind before entering. The belts were slowly moving to their work, and the ore was going into just the places it should with the greatest ease, being assorted according to its magnetic character, and after leaving one belt goes through a shoot to another, until it has been passed through the influence of six magnets. We were so much interested in all we saw that we neglected to note the flight of time, and as the railway was a single track for some miles, our train was "laid out" at several meeting points to await the West-bound trains, and instead of reaching New York at 6 P.M., schedule time, we arrived at 8.30, which might be denominated "mean time." But the trip was so enjoyable no one seemed to feel unhappy, but only very hungry.

On Saturday the members visited the New Jersey Zinc Works at Newark, and saw the magnetic separator parting monazite from its ore. In the first pass a current of 7 amperes removes monaconite and rutile from the ore, the second and third pass, the latter with 25 amperes, removes monaconite and garnet, and the fourth, with 35 amperes, removes the monazite, containing 3 or 4 per cent. of thorium, which is used in making the mantles for Welsbach lamps. The tailings from the last pass contain a great variety of impurities. Then later the visitors viewed the working of the Wetherill concentrator. The first parts separated, which contain 20 per cent. of zinc oxide, are mixed with fine anthracite coal and roasted. The fumes are collected in flues, settling chambers, and cloth sacks, and are barrelled for shipment. A large amount is exported, mostly in barrels containing about 224 lb., the American trade being supplied in 300-lb. barrels.

The cinder residuum, which contains 30 to 35 per cent. iron and 14 to 18 per cent. manganese, is made into spiegeleisen by an ordinary blast-furnace, the fuel being coke and anthracite. There is a considerable loss of manganese in the slag. Much of the slag is granulated, and sold to makers of cement.

Another party visited the fine brick and terra-cotta works of H. Maurer and Son, and saw the Hofman continuous kiln. The product of this factory is wonderful, some of the mouldings being real works of art. Next, and last, the Guggenheim gold, silver, and copper smelting and parting works at Perth Amboy were examined, and here the visitors were permitted to see an electrolytic copper refinery, which required no apology, and where nothing was concealed, but all questions were freely answered. The copper comes mostly from Mexico and Arizona, although some is from Mount Lyell, Tasmania. The process in general is as follows:

The copper matte, after smelting in reverberatory furnaces, is cast into anodes, and goes to the electrolytic department. This contains 395 tanks, with 27 or 29 cathodes each. The plant, when mining full capacity, can turn out 265,000 lb. of refined copper daily. The precipitated silver and gold are washed and separated by treating with acid. A current of 25 to 30 volts and 3000 amperes or over is used in the tanks. In the smelting department the visitors saw the method used in refining lead silver-bars from Western smelters by smelting, adding zinc, separating the zinc as oxide and the lead by cupellation, parting the gold and silver in the silver ingots. This final parting is by electrolysis. The Moebius process in two forms, one with anodes suspended in the solution, the other with anodes on a rack beneath, which passes the silver-belt cathode, is used. Here the ingot of bullion is enclosed in a canvas bag, and placed as an anode in a bath of nitrate of silver. The cathode is a silver plate, upon which the silver is deposited in the form of tree-like crystals, which are continually brushed off by wooden rods, moved by machinery, so as to prevent their accumulation on the plate, which would cause short-circuiting. The gold remains in the anode in the bag in the form of a black powder.

This closed the meeting, and we separated in the hope of assembling in San Francisco in October, at which meeting a large number are expected, as the trip itself will be full of interest, to say nothing of the hearty welcome which will await the Institute from the well-known hospitality of the residents of the Pacific Coast. This will be a most fitting occasion for some of our English friends to visit the United States and accompany the Institute. We can promise them a hearty welcome in New York and a good time from their arrival to their departure for home.

MESSRS. SCHNEIDER AND CO.'S WORKS AT CREUSOT.—No. LIII.

QUICK-FIRING GUNS—(*continued*).

THE Schneider-Canet two-motion type of quick-firing gun embodies an improvement over the types already described, which consists in reducing the operations for opening and closing the breech, to two distinct movements. The smaller number of parts that constitute the mechanism constitutes another improvement. The arrangement has, moreover, shown, after protracted and severe tests, as well as in actual practice, such good qualities, that it has been fitted to quick-firing Schneider-Canet guns of the most recent manufacture and which, owing to the conditions required in service, have to undergo rough handling. Breech-blocks of this model have been fitted to guns of calibres from 75 millimetres (2.952 in.) to 15 centimetres (5.905 in.) inclusive, the latter calibre not being regarded as a maximum, as the system is well adapted for application to larger calibres. With this type, either fixed obturators or brass cartridge-cases can be used, and the mechanism lends itself therefore equally well to firing by friction, by percussion, or by electricity. The following examples, chosen among many others, will serve to illustrate the system.

Two-Motion Mechanism with Repeating Firing Device (Figs. 481 to 484, page 576).—This consists of the breech-block, the breech-block carrying device, and the firing mechanism. The hand lever is in one piece with the rear disc of the block, which is made with two threaded parts and two interruptions; it is therefore necessary to turn this starting lever, only a quarter round, to disengage it; the shape and dimensions are so calculated that it is not necessary to pull the breech-block back to cause it to leave the gun, as it turns round laterally, as soon as it is unscrewed. The breech-block carrying device consists of a horizontal extension hinged to the projections on the side of the gun; this extension is provided with a screwed end, on which the block is fixed by means of a bayonet joint, and it is made with a groove in which the firing striker acts and the safety arrangement against miss-fires, is placed. The firing arrangement consists of a percussion pointed striker, the trigger acting in the body and head of the striker; the arrangement, as a whole, is similar to that which will be described hereafter as fitted to the breech-pieces which open in one action.

In firing the gun, the trigger is worked by a line, the striker is drawn back, the action pressing down a spring; the trigger then frees itself, and the striker is thrown forward against the fuse. This operation can be renewed as many times as necessary without touching the breech-piece.

As a security against premature fire, the end of the trigger lever presses, through the interposition of a friction roller, on a spring bolt, which slides in a suitable latch fitted to the rear end of the breech-block. If the end of the trigger is not exactly opposite the bolt, in other words, if the breech is not completely closed, the trigger has not a sufficient range to operate the striker, and there is, therefore, no risk of premature fire. When the gun is fired, the spring bolt falls down in the latch; if there is a miss-fire, the gun does not recoil, the bolt remains in place, and the breech cannot be opened.

The extractor is placed in a groove made in the wall of the breech end of the gun; the breech-block operates it by swinging round.

To open the breech the lever is given a quarter-turn from right to left to disengage the threads; the breech-block then pivots round the hinge, and when it has turned completely, it acts on the extractor, and the cartridge-case is ejected. To close the breech the two actions are repeated inversely.

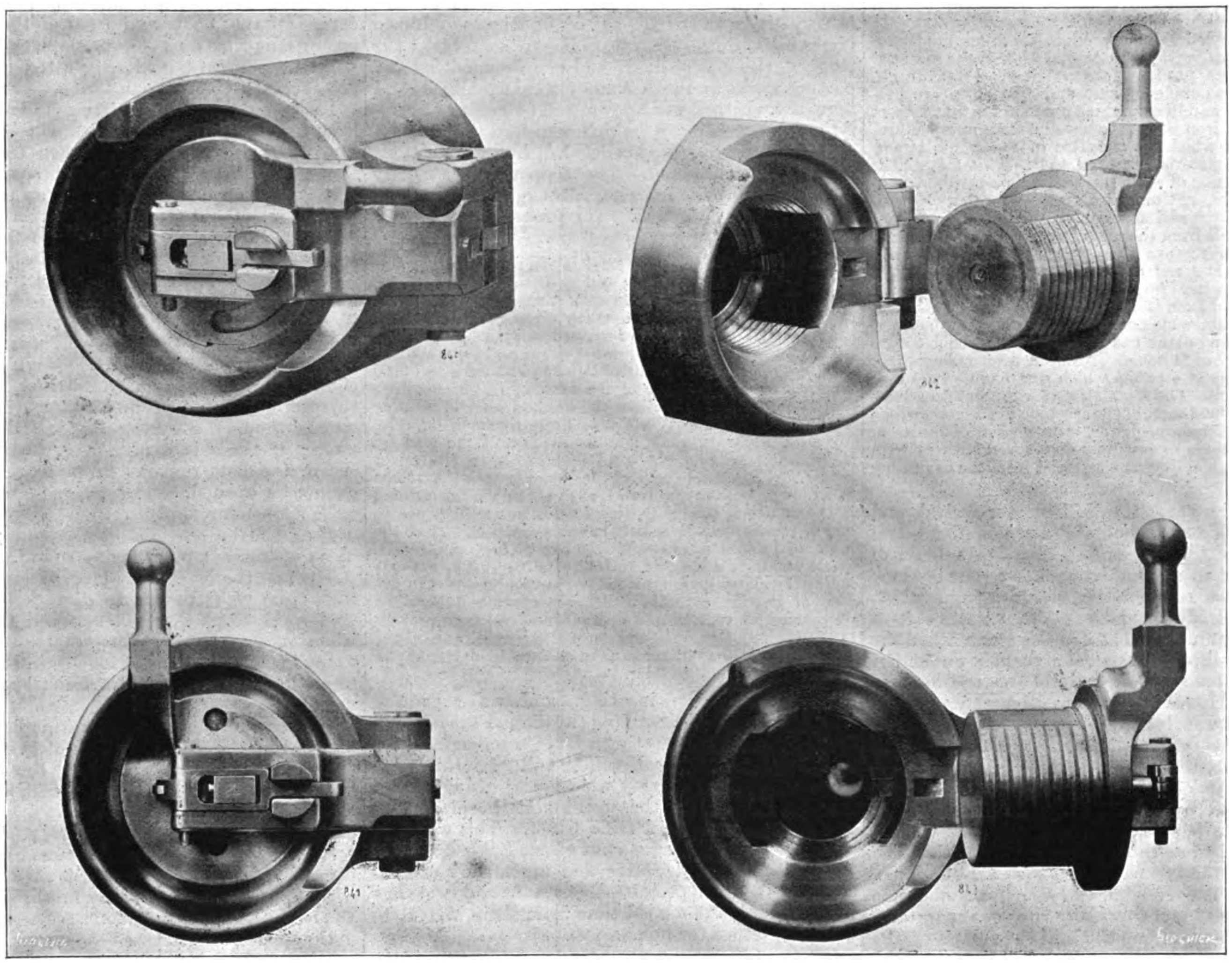
In these actions a special spring latch unites the breech-block carrier to the block-screw and to the gun. Figs. 481 to 484 show the breech closed, locked, the breech-block unscrewed, and the breech opened.

Two-Motion Breech Mechanism, with Plastic Obturator and Percussion Firing Device (Figs. 485 to 493, page 577).—This type consists of a breech-screw, with obturator and movable head; of its support, and of the firing arrangement. The breech-block is in the shape of a truncated cone, with three threaded parts and three interruptions. The obturator consists of a Schneider-Canet composite plastic elastic disc placed between the movable head and the front end of the breech-screw. The breech-block support is mounted on a vertical hinge, and it carries the block in its action. The hand lever is jointed on the rear end of the breech-screw, and when the breech is completely closed it fits in a hollow, as is shown in Fig. 485. The end of the lever opposite from the handle is finished with a projection (Fig. 491), which, when the breech-block is unscrewed, lodges in a suitably shaped catch, on the rear end of the breech-screw support. This gives a bearing point to withdraw the breech-screw and push it aside. Firing is insured by a bolt made movable in the breech-screw, and which carries the striker; this works under the action of a catch-spring. To fire the gun when the breech is completely closed, the trigger is operated by means of a line, the striker being driven forward by the working of the spring. A latch made with inclined planes, similar to that already mentioned in connection with the preceding type, serves to connect the support to the block, and to the gun.

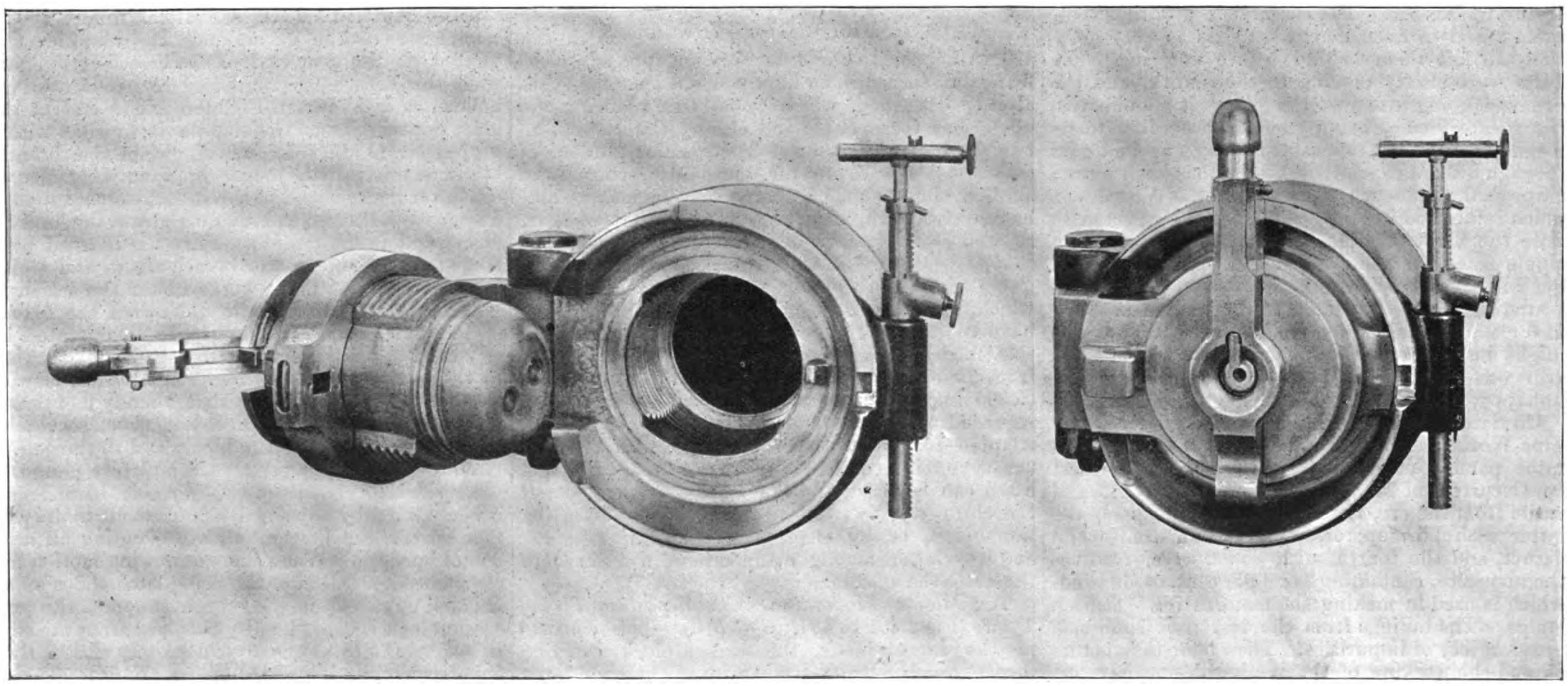
While the breech remains completely closed, a pawl which forms part of the movable hand lever, is maintained by a spring in a notch made in the part that covers the breech, thus preventing all accidental opening. When the unscrewing motion has commenced, the heel of the firing latch slides on an inclined guide cut in the breech support, the percussion lock is consequently removed from the vent as long as the breech is not completely closed, thus doing away with all risk of premature fire.

To open the breech, the hand lever is pushed on its hinge to press down the inside spring and disengage the pawl from the notch above referred to. The lever is then turned round 60 degrees on a plane normal with the centre line of the gun, during which time the pawl of the hand lever slides in the groove made on the lower part of the rear end of the gun. When the unscrewing is completed, the jointed heel of the hand lever is placed in the socket on the breech-screw support. The breech-screw can then be pulled back by means of the hand lever, the joint of this bearing in the

BREECH-MECHANISM FOR SCHNEIDER-CANET QUICK-FIRING GUNS.



FIGS. 481 TO 484. TWO-MOTION BREECH-MECHANISM WITH REPEATING DEVICE.

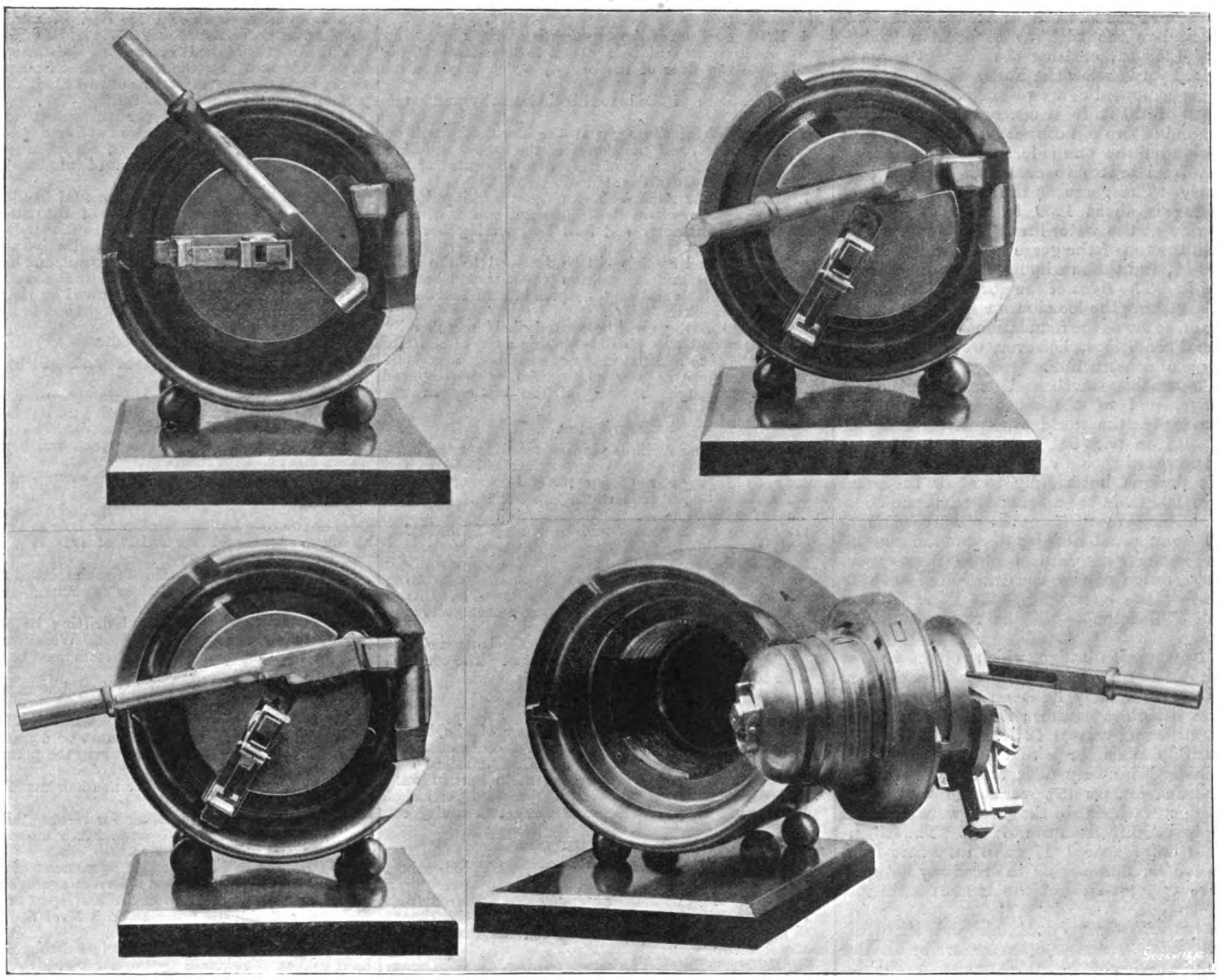


FIGS. 494 AND 495. TWO-MOTION BREECH-MECHANISM WITH FRICTION-TUBE FIRING DEVICE.

socket of the breech-block support, one of the clutch bolts getting disengaged from the body of the gun, the other entering the breech-block. The mechanism can then be made to pivot to the side round the vertical hinge bolt. To close the breech the above actions are repeated inversely. Figs. 489 to 493 are various sections which explain the detailed description of this mechanism.

Two-Motion Breech Mechanism, with Friction-Tube Firing Device (Figs. 494 and 495).—This breech-piece is of more recent application than the preceding one; it is based on the same principles, but is of a simpler design. The breech-screw is cylindrical and firing is effected by friction. A description of it is given in order to point out the progress made since the date when this type of breech was first manufactured. The breech-block is provided with two threaded parts and two interruptions. The obturator consists of a plastic elastic composite disc, placed between the front end of the breech-screw and the movable head; the latter is in one piece with its shank, the vent being in the centre and ending in the rear in a socket, in which is screwed the friction tube, a

BREECH-MECHANISM FOR SCHNEIDER-CANET QUICK-FIRING GUNS.



FIGS. 485 TO 488. TWO-MOTION BREECH-MECHANISM WITH PERCUSSION FIRING DEVICE.

Fig. 489.

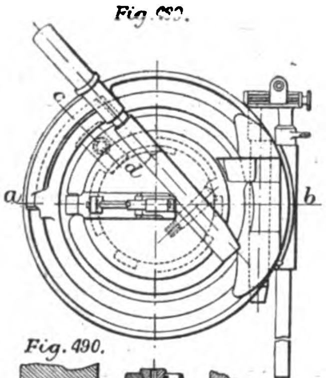


Fig. 492.

Fig. 493.

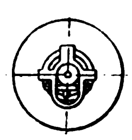


Fig. 490.

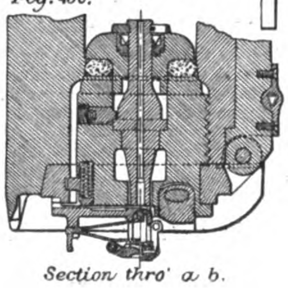
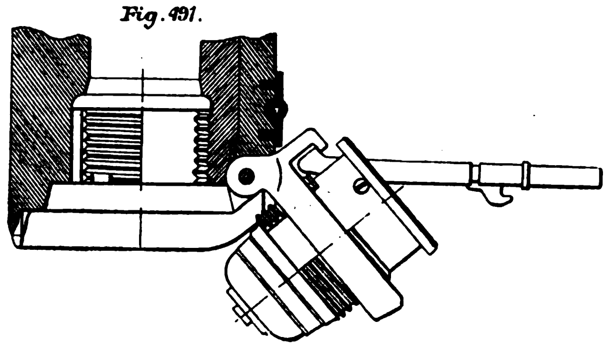


Fig. 491.



safety device preventing the insertion of the tube until the breech is completely closed. The breech-block is carried by a jointed support which pivots round a hinge bolt placed to the left of the gun, the dimensions of the various parts being such that the pivoting to the side of the breech mechanism can take place, without it being necessary to draw the breech-screw completely back in the support; the travel of the block for extraction is very much reduced, which enables the breech to be opened in two actions only.

The head of the hand lever is slotted and is in one piece with a double latch; it is governed in its sliding action by an inside spring. The lever is moreover fitted with a joint, which, after the unscrewing of the breech-piece, lodges in a socket which forms part of the breech-screw support. Firing is effected by means of a line that causes the friction tube to act.

An automatic double-ended latch on the right-hand of the breech-block support serves to fix this to the gun when the breech is closed, and also to hold the breech-screw to the carrying ring during the opening of the breech.

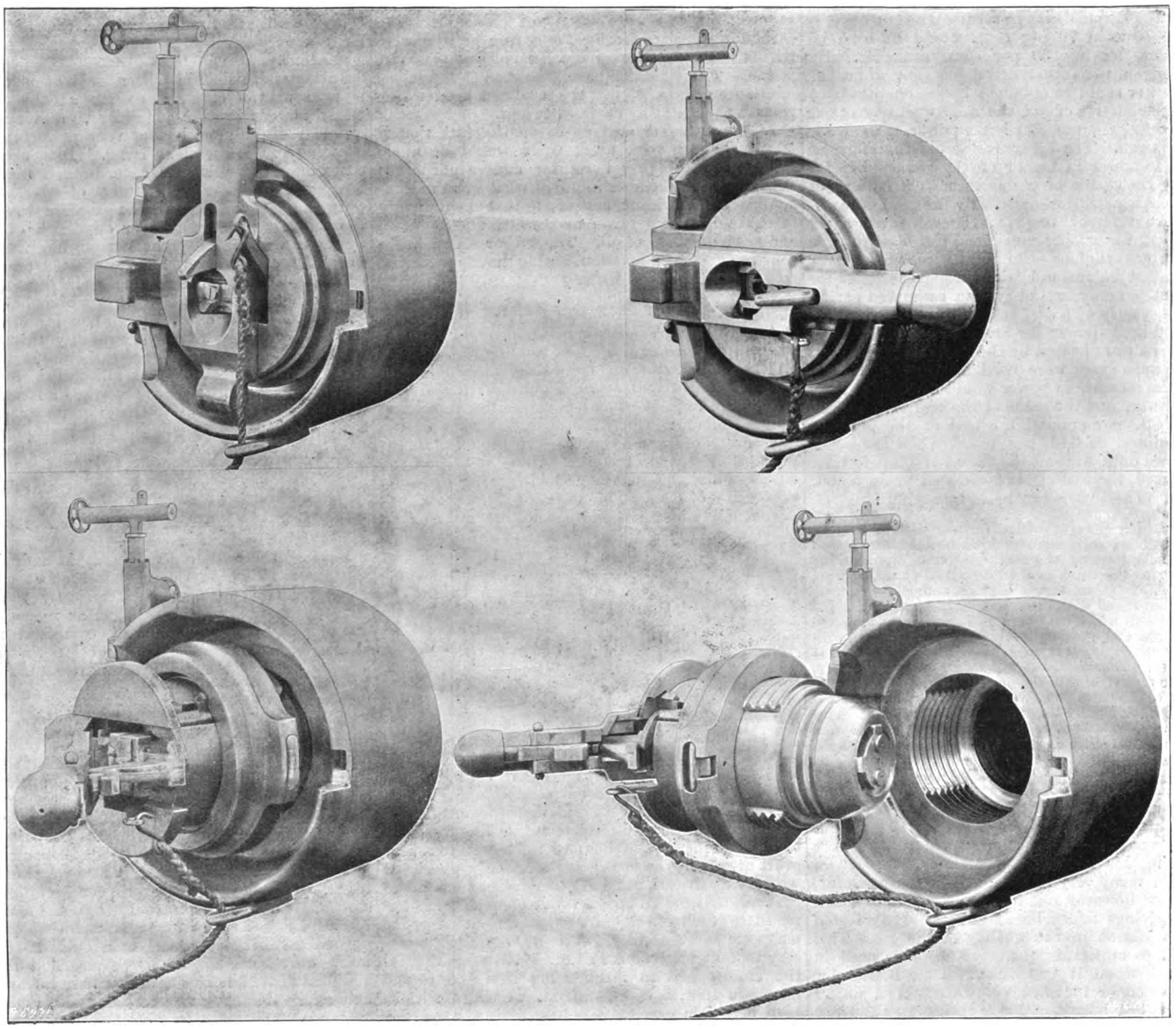
The head of the hand lever in conjunction with the double latch above referred to, constitutes the means that prevent the accidental opening of the breech while affording complete safety against premature fire; one of the heads of the latch holds the lever to the gun when the breech is closed, the other head leaves the vent free only when the breech-block is placed completely home.

To open the breech-block the hand lever is brought to the right to disengage the breech-screw; the lever is then pulled back, thus withdrawing the breech-screw in its support and causing the whole of the mechanism to turn round on the vertical hinge bolt. To close the breech these movements are repeated inversely.

This breech-closing arrangement is specially characterised by great simplicity and by a small number of parts; it is therefore easily worked and kept in order.

COAL IN FRANCE.—The extraction of coal in France would appear to be steadily increasing. Last year's output was 32,439,786 tons, as compared with 30,797,629 tons in 1897. Coal is now raised in 40 of the 86 departments into which France is divided, but the production is principally effected in the north.

SCHNEIDER-CANET BREECH MECHANISM FOR QUICK-FIRING GUNS.



FIGS. 496 to 499. TWO-MOTION BREECH MECHANISM WITH PERCUSSION FUSE.

the permeability might be studied in connection with a purpose for which it was claimed certain amounts of silicon were of use in the prevention of magnetic ageing or fatigue in iron. If only because they were a record of work in a comparatively unexplored field, the author's experiments on cast-iron permanent magnets were of interest. Permanent magnets of steel, used in the beginning for the field magnets of generators, had given place to the more permeable soft iron and mild steel, because of the reduction of size or increase in power; this in spite of the constant loss in magnetising such magnets. The author did not seem to have succeeded in getting magnetisation dense enough to be of practical use, but it was to be hoped he would not be discouraged from further investigation in that direction. Another point of very great interest might be mentioned—the relation between electrical resistance and magnetic permeability in iron. Many years ago Professor Hughes showed a singularly close inverse relation in these properties in wrought iron. Curiously, in cast iron this relation is very different, the electrical resistance being about ten times that of wrought iron, although the magnetic permeability is only about half. The electric resistance of iron is often of considerably greater importance than the quality of low hysteresis, to which great attention has been paid. It is of importance on account of its bearing on the losses in electrical apparatus and in the steel rails of tramways.

STEEL DIRECT FROM THE BLAST-FURNACE.

A short paper by Mr. Dimitrius Tschernoff, on "The Manufacture of Steel Direct from the Ore in the Blast-Furnace," was taken as read, as also was a paper on the "Solution Theory of Iron and Steel," by the Baron H. Jüptner von Jonstorff, of Donawitz, Austria.

The meeting was brought to a conclusion by the usual votes of thanks. The next meeting will be held in Manchester during the autumn.

On the evening of Friday, May 5, a very successful reception was held by Lady Roberts-Austen at the Royal Mint, a large number of members being present.

MESSRS. SCHNEIDER AND CO.'S WORKS AT CREUSOT.—No. LIV.

QUICK-FIRING GUNS—(*continued*).

Two-Motion Breech Mechanism, with Percussion Firing (Fig. 496 to 499).—This type differs from the preceding one (see page 577 *ante*) only as regards the firing device, which is specially arranged for a percussion fuse. Percussion is effected direct, with repeating action, the fired fuse being ejected automatically; the whole of the device is fitted in the breech-block. All the pieces are so arranged that they can be fitted together separately from the gun, so as to form a whole block, which it suffices to place on the end of the movable head shank before attaching the lever, the latter holding in place the whole mechanism.

The gun is absolutely safe against premature fire, for the action of opening the breech causes the automatic ejection of the fuse, whether it be fired or not, and as long as the breech is not completely closed, it is impossible to introduce a fresh fuse in the vent or to set the striker. The firing mechanism consists of a fuse-cover, a fuse-cover support, a key for the working of the fuse-cover, a percussion frame, with main-spring and needle; a trigger, and an extractor.

To open the breech, by pressing on the lever handle, the clutch leaves the socket made in the gun, the lever is then turned a quarter round to the right; this disengages the breech-screw. In this action the working key driven by the breech-block and bearing on the breech-block support, turns round on its centre and lifts the fuse-cover which acts on the heel of the extractor, thus forcing it to eject the fuse. When the breech-block is disengaged, the working key bears on the block support, thus preventing all action of the firing mechanism.

By drawing the breech-block out of the breech, the key is withdrawn also, but is prevented from turning owing to its heel; the various parts keep their relative positions and render the introduction of a fresh fuse impossible, thus insuring complete safety. To close the breech the above actions are repeated inversely.

SCHNEIDER-CANET BREECH MECHANISM FOR QUICK-FIRING GUNS.

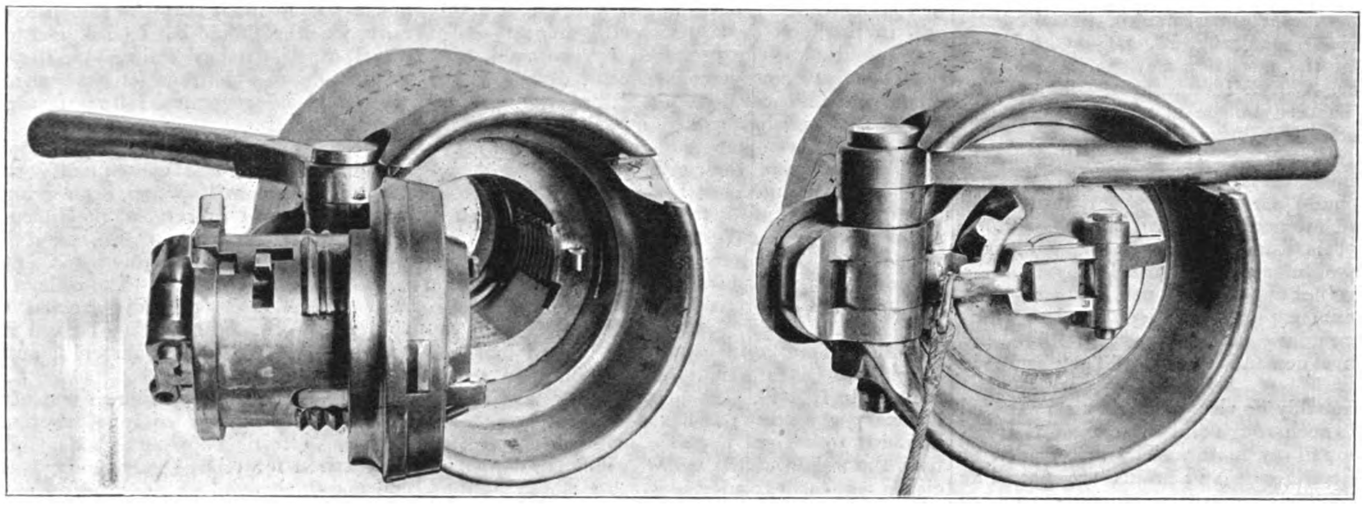
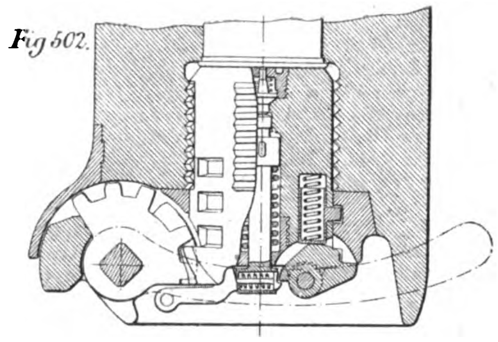
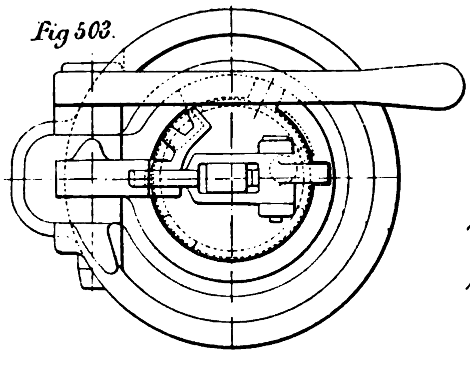
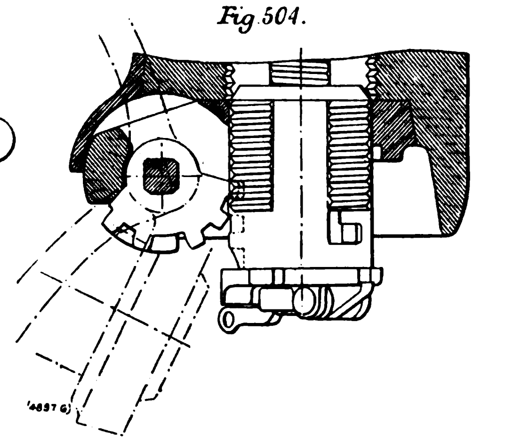


Fig. 500. Fig. 501.







Figs. 500 to 504. One-Motion Breech Mechanism with Repeating Firing Device.

When the breech-block is completely screwed home, the key under the action of the fixed handle, returns into position with the fuse-cover and frame. The fuse can then be placed in the vent after raising the fuse-cover. Firing is effected by means of a line attached to the trigger lever. The percussion frame, on being drawn back, presses on the main spring which bears on the trigger-return device; after a certain travel, the frame is released, the spring driving it on the fuse. In case of a missfire, it suffices to pull again on the line to produce another percussion action.

One-Motion Breech Opening Mechanism.—The Schneider-Canet guns were the first to be fitted with this type of screw breech mechanism; they were quick-firing guns of 57 millimetres (2.244 in.), 65 millimetres (2.559 in.), 10 centimetres (3.937 in.), 12 centimetres (4.724 in.), and 15 centimetres (5.905 in.) in calibre.

From the commencement, the designing of the various types of Schneider-Canet guns with a view to obtain rapid firing, did not refer chiefly to the various parts of the carriage, but to the breech mechanism. The principal considerations which served as a basis in the calculation of this all-important part were the following:

a. The reduction to a minimum of the necessary operations for opening, closing, and firing.

b. Complete safety afforded to the *personnel* so that the attention of the men serving the gun might be concentrated upon the rapid manœuvres required, and this state of safety results from (1) the automatic succession in the various positions of the breech-block, which does away with all hesitation as regards the order in which the various actions should be effected; and (2) the providing of three safety apparatus against premature fire, hanging fire, and accidental opening of the breech.

c. The possibility of using indifferently a plastic obturator or a metallic cartridge-case, and electric or percussion firing.

d. Reduction in the effort necessary to effect the complete opening of the breech.

The first type of Schneider-Canet one-action breech mechanism fulfilled all these conditions, and their appearance in the service proved a great success. During the early period, and up to the present date, they have undergone—as has, in fact, the whole of the material—successive improvements which have referred especially to the details of the mechanism, the first principle of the system not having been modified.

We have seen from preceding articles that the introduction of the Schneider-Canet guns of high power, involving great length of bore, was very much criticised in the first instance. It was the same with this new type of breech. When it first appeared its value was somewhat strongly disputed, especially by those works which had not yet then departed from the ordinary screw breech mechanism, that required three distinct actions for its opening. As soon, however, as the result of trials made with this new breech mechanism were known, the arguments against it lost in intensity, and the principle of opening the breech by one single action of the lever in a horizontal plane, was reproduced and applied by various foreign makers more or less successfully. At the present time the advantages of this type of breech are no longer disputed, and several firms who had criticised it the loudest, use, for every medium-calibre quick-firing gun they build, a breech-closing mechanism that works with a single action of the hand lever.

We shall now proceed to describe briefly a few of the principal examples of this type of mechanism, following, as far as practicable, the chronological order of their adoption in service. We shall describe afterwards the most recent types of breech-pieces to be fitted to quick-firing Schneider-Canet guns now in course of completion for various Governments.

Cylindrical Breech-Screw, with Repeat-Firing Action (Figs. 500 to 504).—This consists principally of the breech-block, the breech-block support, and the firing device.

The breech-block is cylindrical, with four threaded parts and four interruptions; it is arranged for firing with metallic cartridge-cases, and is provided with two claws in front, which form extractors, and which are arranged in such a manner as to take hold of the cartridge-case flange, and withdraw it gradually during the opening of the breech. It is provided in the rear with a toothed sector, in the continuation of which is a longitudinal hollow rack, inside the breech-block itself and in the direction of its main centre line. The breech support carries the whole of the mechanism in the various positions it takes, and pivots round a vertical bolt held in a lug fitted at the side of the gun; it is provided with the double-acting Schneider-Canet latch, already described in a preceding article, and which serves to connect, at the proper moment, the various elements. The hand-lever operates a compound pinion mounted on the pivot of the breech-support, and which consists of an endless screw that engages the toothed wheel of the breech-screw rings and a section of wheel with cylindrical teeth that works the longitudinal rack. When the breech is completely closed, the lever enters a notch in the rear and presses down a tongue spring which secures the system and prevents the accidental opening of the breech. The firing device is repeating, and embodies the general arrangements previously described with the two-motion breech-blocks and also their safety appliances.

To open the breech, it is sufficient to cause the hand-lever to pivot round in a horizontal plane. During the first period, the endless screw arrangement acts on the toothed wheel and causes the breech-block to revolve. In the second period, the cylindrical teeth of the pinion engage the rack and effect the withdrawal of the breech-screw. The continued action of the hand lever brings the whole of the mechanism to the side, leaving the breech of the gun free. To close the breech, the hand lever is brought back.

structure, placing the centre hinge in the bottom chord at panel-point 20, and omitting top chords 19 and 20, thus making the bottom chords carry the greater part of the stress due to the dead load at the time of closure. 3. To change to a two-hinged arch by placing the top chords 19 and 20 in position, and, by means of an hydraulic ram placed at upper panel-point 20, to impart to the top chords the stress they were calculated to bear in a two-hinged arch under existing conditions.

In order to provide for starting the arch correctly, so that lower panel-point 20 would be in its proper position at closure, the movement of this point was calculated, assuming the structure to be completed to panel-point 20, and to be carried as yet by the anchorages. The elongation of the anchorage bars under maximum stress, and the play in the pins connecting them, added to the distortion of the arch under these conditions, were found to cause lower panel-point 20 to move out 5 in. and deflect about 14 in. It was therefore decided to set the toggles 5 in. short, so that the total length from the anchorage pits to panel-point 20 would come to the measured distance when completed to closure. It was for this reason also that no adjustment was provided in the main lines of bars from the top of bent 0 to panel-point 14, as already noted, the setting of the main toggles absolutely fixing the distance.

The necessary clearance required at lower panel-point 20 to enter the bottom chords 19 and 20 at the time of closure, was provided by planing the ends back ¾ in., making an opening of 1½ in. under normal temperature. In case the clearance would not be sufficient, it could be increased by raising the arch slightly with the toggles at the anchorage pits. A 12-in. pin was then to be inserted at lower panel-point 20, to act as a temporary hinge. This pin was not to be removed, but was to finish flush with the webs of the chords, so that plates could be riveted on the outside, giving the appearance of a riveted joint in the finished structure (see Fig. 43).

Assuming the arch to be swung on three hinges, it was found by calculating the position of the ends of the top chords at panel-point 20, that they would, if made of the geometrical length, overlap 2¼ in. Therefore, to give ample clearance for inserting the top-chord sections 19 and 20 after the arch was swung on three hinges, it was decided to plane the end of each chord section back 3 in., making a geometrical opening of 6 in., and an opening or clearance of 3¾ in. under existing conditions at normal temperature. To change the three-hinged arch to a two-hinged arch, the hydraulic rams were then to be put in place. The calculated stress in the top chords 19 and 20 of the two-hinged arch under existing conditions, was calculated to be 370,000 lb. per rib at normal temperature. Therefore, the hydraulic rams should increase the opening of 3¾ in. to 6 in. at a pressure of 370,000 lb., temperature normal (60 deg.). Every 10 deg. increase in temperature above the normal would reduce the pressure 34,000 lb., and *vice versâ*. This opening was then to be filled by means of a cast-steel key, made to conform to the shape of the chord sections, the rams removed, and the joints finished with heavy connecting-plates, completely covering the keys. (See Figs. 43 to 45). The 6-in. keys were to be shipped unfinished to the bridge site, and to be kept at a local machine shop until a measurement of the opening could be obtained, as imperfection in workmanship or errors in measurement might cause the opening to vary from the calculated 6 in. Whatever opening would be obtained at the required stress would determine the size of the keys. The opening could be maintained temporarily by means of small plates acting as temporary packing-pieces, until the permanent keys could be planed to the size required. The rivet-holes in the connection-plates were to be drilled in the field to conform to this opening, and the centre stringers were not to be shipped until the opening was measured, to insure a perfect fitting of all parts of the structure affected by it.

(To be continued.)

MESSRS. SCHNEIDER AND CO.'S WORKS AT CREUSOT.—No. LV.

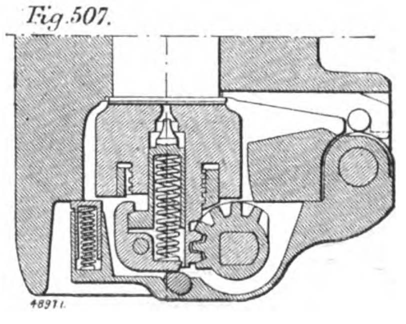
QUICK-FIRING GUNS—(*continued*).

Cylindrical Breech-Block, with Repeat Firing Action (Figs. 505 to 507).—This type contains the same principal elements as the preceding one (on page 611 *ante*); it differs from it, however, in this detail, that during the opening and closing actions, the breech-block is not shifted with relation to the seating, the swinging of the mechanism to the side, taking place immediately after unscrewing.

The block is cylindrical, with two threaded parts and two interruptions; a screwed cylindrical part is cut out centrally in the rear, thus forming a toothed socket for a pivot of equal diameter carried by the breech-screw support, and which effects the connection of the breech-screw and the support. On the right the block is fitted with a toothed wheel arrangement, of the same type as that described for the preceding breech-piece; the female screw is cut in such a way that the block can enter the gun simply by bringing round the hand-lever, no shifting action being necessary.

The breech-block support is in the form of a disc; it completely closes the gun in the rear, and affords, in consequence, full protection for the various parts of the mechanism. It pivots round a vertical hinge fitted to the right of the breech-end, and carries the block through the screwed socket and pivot mentioned above. It carries also on the right the socket for the endless screw, which works the pinion that forms part of the breech-screw, and on which the hand-lever is fitted. This is provided with a jointed handle fitted with a catch, which prevents the accidental opening of the breech. The repeat firing action is of the type already described; it is worked by a horizontal lever placed immediately below the hand-lever, and is fitted with the required safety devices. A double-ended extractor is lodged in the gun, and oscillates freely to eject the empty cartridge-cases; it is worked by the butt-end of the breech-block support, which bears on it when the screw is made to swing completely to

Fig. 507.



the side. A spring-latch, which serves solely to fix the screw on its axis as soon as the swinging to the side has commenced, is provided on the left side of the screw support. When the latter comes in contact with the rear-end of the female screw, this connection ceases.

To open the breech, the hand-lever is brought round from left to right; during the first period the catch leaves the gun, and the lever, on getting away from the breech-block support, works the endless screw, which produces the release of the block. In the second period, the whole of the mechanism, drawn by the hand-lever, pivots round the vertical hinge, until the breech of the gun is completely freed, the latch fixing the block on its axis; when the swinging round is complete, the mechanism bears on the heel of the extractor, which effects the ejection of the empty cartridge-case.

To close the breech the action is repeated inversely. When the breech is closed, it is sufficient to pull the firing-line to fire the gun; the firing device cannot act until the breech is completely closed.

Conical Breech-Block, with Repeat Firing Action (Figs. 508 to 510).—This type is very similar to the preceding one, though the breech-block is conical, and the working mechanism consists of conical pinion gearing.

The block has two threaded parts and two interruptions; swinging to the side takes place immediately after unscrewing, the block not being shifted with regard to the centre line of the gun. It is united to the support by a screwed joint of the type described for the preceding breech-piece. The breech-block support consists of a circular disc, which pivots round a vertical hinge on the right hand of the gun; it carries all the mechanism. In its central plane is the socket for the conical pinion fitted to the hand-lever. The lower part of the breech-block is fitted with a pinion of same shape, the two pinions causing, by acting on the hand-lever, the screwing or unscrewing of the breech-block in its seat.

The hand-lever is provided with a spiral spring, the object of which is to insure the locking of the system when the breech is completely closed. The extractor, latch, firing device, and general working of all the various parts are similar to those described with the preceding breech-piece.

Conical Breech-Block, with Shifting Action (Figs. 511 and 512).—This differs from the preceding one, as the block is slightly shifted in its support; moreover, the working lever is fitted to the lower part of the breech-block. The latter is slightly conical, and has four threaded parts and four interruptions; there is only one clutch ejector, of the type already described. On the rear is a conical toothed arrangement that gears into a pinion worked by the lever; this produces the necessary partial revolution of the breech-screw. On the continuation of the breech-block and on its centre line, is a pivot threaded on its outside circumference on two sectors, there being also two interruptions. When the breech is closed, the block support lodges in a rabbet in the rear-end of the gun.

This support is continued in the rear by a horizontal frame that forms a slide; as will be seen in Fig. 512, which shows the breech mechanism taken apart, the right-hand side of the breech-block support frame is made with a circular groove on its lower surface, the groove ending in a semi-cylindrical bearing.

The mechanism is carried entirely on the supporting frame, and consists of the conical gearing mentioned above, and of the jointed hand-lever. On the first arm of the lever is a slide that carries the pinion centre, and which fits to the breech through a bayonet-joint, of which the breech-block rear pivot forms one of the elements. The second arm ends in a roller which, during the operation, moves in the lower groove of the support above referred to, and, by bearing on the bottom of the groove, insures the removal of the breech-block from the breech and its swinging to the side of the system.

The working lever is fitted with a jointed handle provided with a catch; this, when the breech is completely closed, enters a notch in the rear of the gun tube and prevents accidental opening of the breech. The firing device is repeating and works by percussion; it is similar to the one previously described.

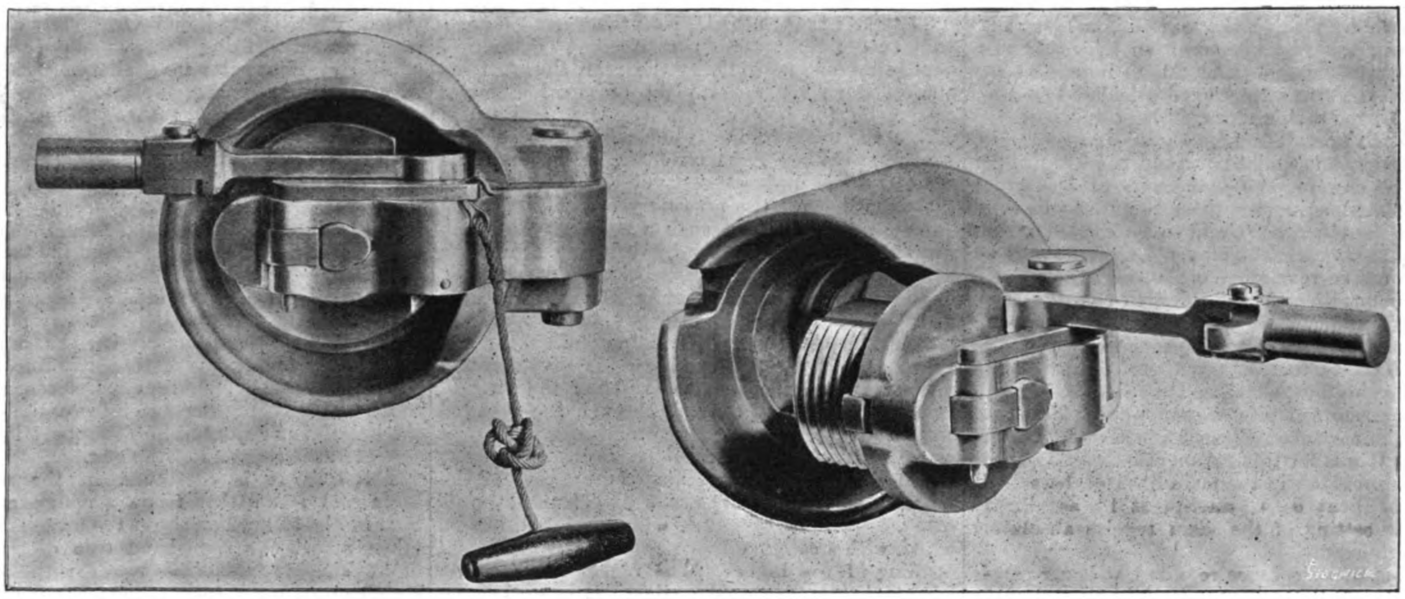
To open the breech it is sufficient to turn round the hand-lever from left to right in a horizontal plane. During the first period the conical pinion effects the unscrewing of the breech-block; during the second, the roller on the smaller arm bearing at the bottom of the groove helps to withdraw the block, which slides on the horizontal frame. The action continues without interruption by the swing to the side of the whole mechanism. To close the breech the hand-lever is turned from right to left.

Cylindrical Breech-Block, with Automatic Trigger-setting Action (Figs. 513 to 515).—In certain cases the method of working by conical pinions or endless screws, described for preceding types, is replaced by a rack, which acts direct on cylindrical toothed gearing in the rear part of the breech-block. A large number of quick-firing Schneider-Canet guns in service at the present time are fitted with this type of breech-closing arrangement. They have given the best results.

The breech-block has two threaded parts and two interruptions. Its shape and dimensions are such that it is not necessary to draw it back to disengage it from the seat; once turned, it is immediately withdrawn by its support. This pivots round a vertical hinge; it contains a holding and guiding gear for the block, and sockets for the various parts of the mechanism and firing device. The working gear proper consists of a hand-lever, a rack, and the toothed part cut in the rear of the breech-block. The lever is in one piece with the hinge-bolt, and is fitted with a pivot that works the rack, and a heel that effects the swinging round of the breech-block support. The rack is guided throughout in the support and engages the teeth of the block; on the other end is a socket in which fits the hand-lever pivot.

The percussion piece is made with two helicoidal curved planes, cut symmetrically one with the other; on opening the breech, these ascend two similar planes cut in the breech-block. The main spring rests on a ribbed tube which butts on the breech-block, and cannot follow the longitudinal action of

SCHNEIDER-CANET BREECH-LOADING MECHANISM FOR QUICK-FIRING GUNS.



FIGS. 505 AND 506. SINGLE-MOTION BREECH MECHANISM FOR QUICK-FIRING GUNS, WITH REPEAT FIRING ACTION.

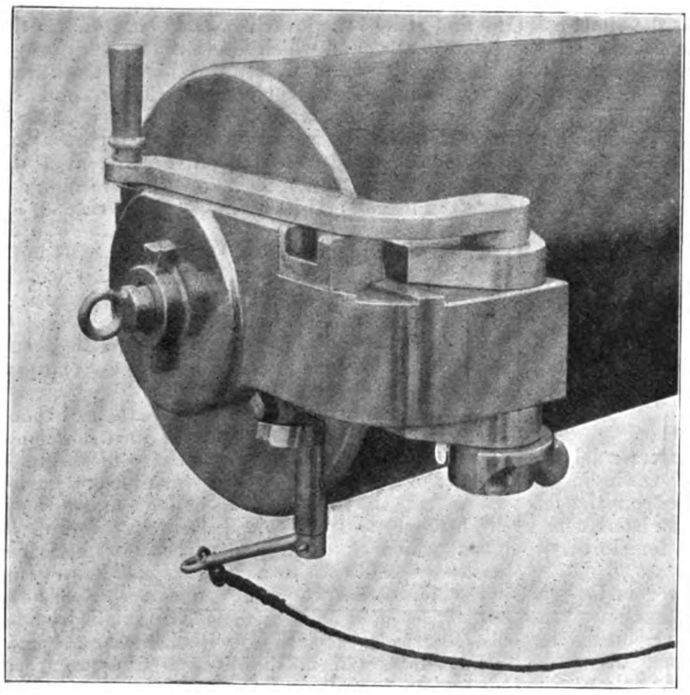


FIG. 513.

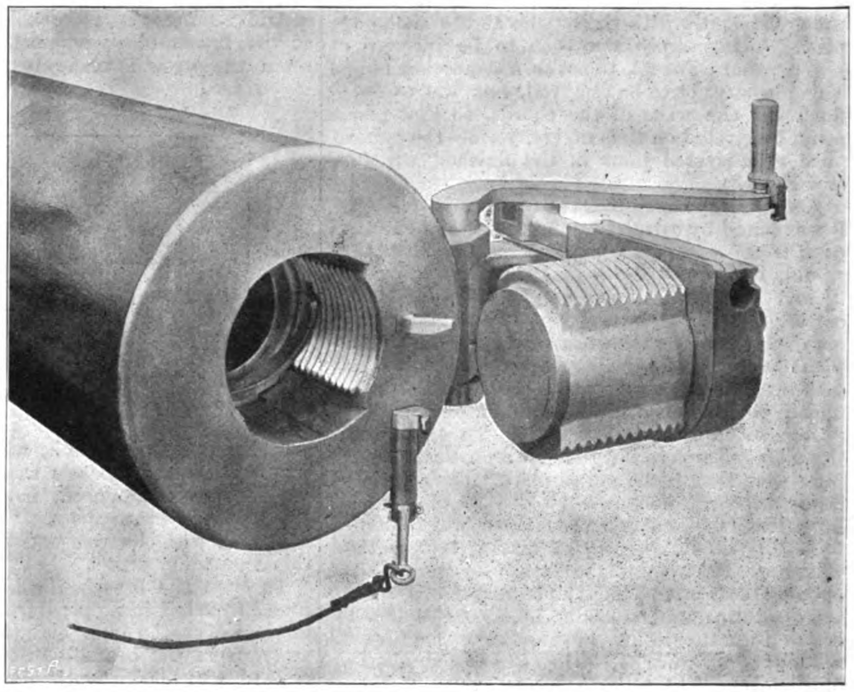


FIG. 514.

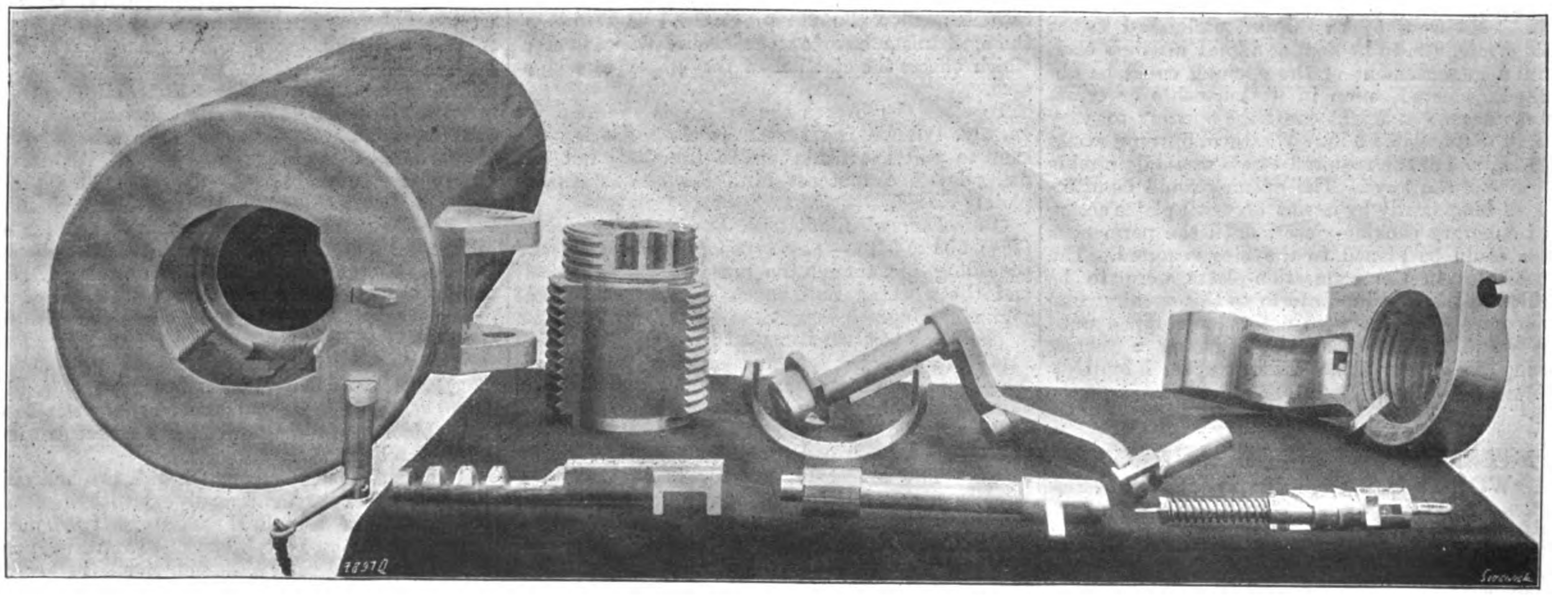
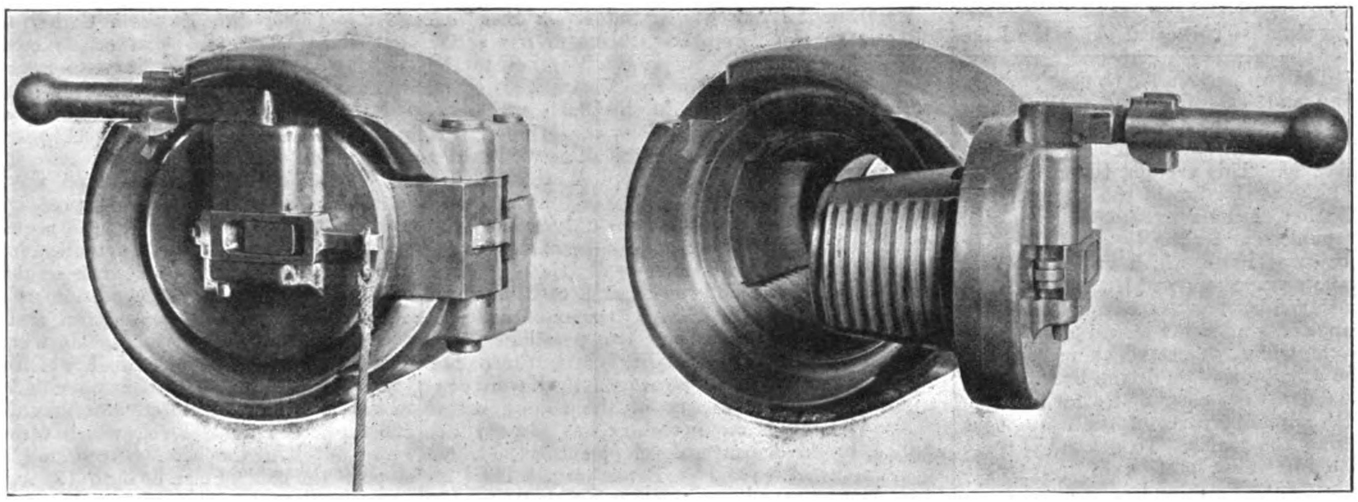


FIG. 515. SINGLE-MOTION BREECH MECHANISM FOR QUICK-FIRING GUNS, WITH CYLINDRICAL BLOCK AND AUTOMATIC FIRING DEVICE.

SCHNEIDER-CANET BREECH-LOADING MECHANISM FOR QUICK-FIRING GUNS.



FIGS. 508 AND 509. SINGLE-MOTION BREECH MECHANISM FOR QUICK-FIRING GUNS, WITH CONICAL BLOCK.

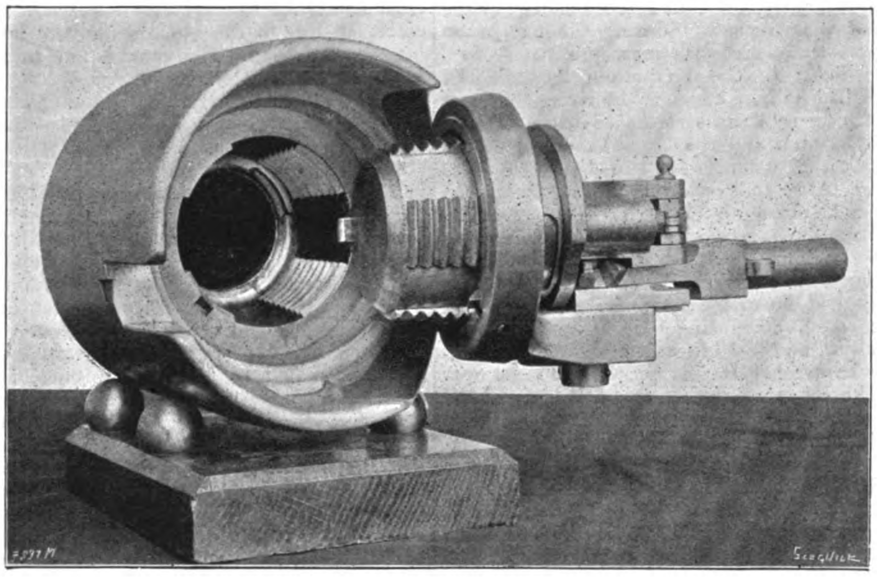


FIG. 511.

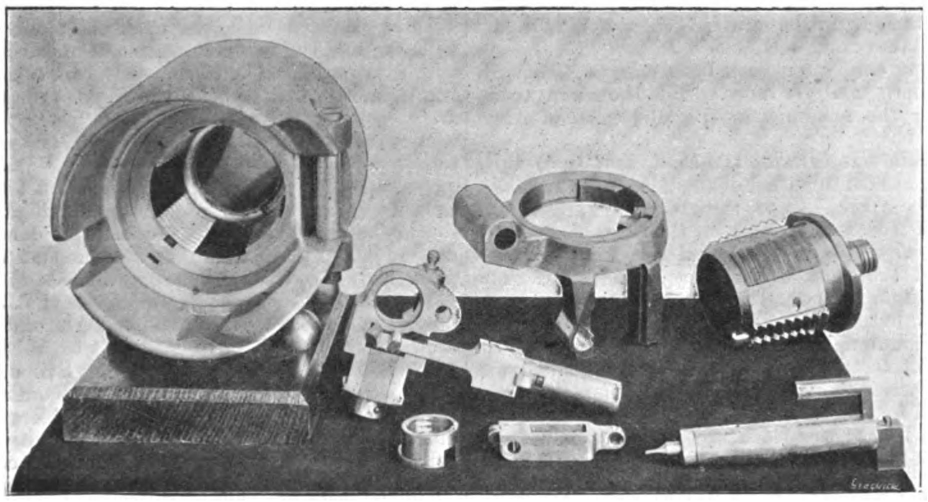


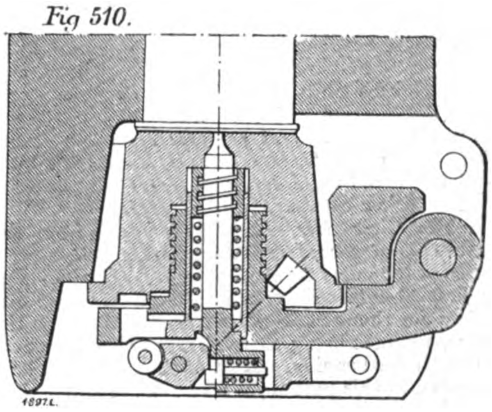
FIG. 512. SINGLE-MOTION BREECH MECHANISM FOR QUICK-FIRING GUNS, WITH CONICAL BLOCK.

the percussion piece. A pin, which runs through the block support and the percussion piece, prevents the latter from turning round, while it permits the cocking of the system on opening the breech. Firing can also be effected by electricity, in replacing the percussion piece by a contact pin.

The electric-firing device has a single pin, which, under the action of a spring, extends slightly beyond the front of the breech-block, and which touches, when the breech is closed, the centre of the electric fuse, screwed in the bottom of the cartridge-case. An insulated wire unites this pin to a switch. The operator fires the gun by closing the circuit. To prevent misfires or delays in firing, all the contacts are covered with silver, and a few seconds before it is required, the battery is worked on a high shunt-resistance.

The extractor is fork-shaped; it disengages the empty cartridge-case and effects its ejection. To

Fig 510.



this end it is fitted on a bolt provided with a stud, on which bears an incline cut in a tube fitted to the hinge bolt. When the breech is completely closed, the hand-lever clutches the block support automatically, and prevents all accidental opening of the breech. The catch being in the breech-screw and the trigger in the breech support, the trigger being, moreover, governed by the end of the firing-lever placed on the rear end of the gun—the gun cannot be fired until the breech is completely closed.

To open the breech, it is sufficient to press on the handle to disengage the clutch at the heel and to bring the lever, in one action, from left to right. In doing this, the lever withdraws the rack, and the breech-block becoming disengaged, pushes back the percussion-piece and sets its spring. When the breech-block is thrown back, the catch engages under a shoulder made on the rear of the percussion-piece, and keeps it cocked. When the block is quite unscrewed, the driving heel bears on the block support, and brings it to the side, while the latch bolt, pushed by its spring, engages in the rack and fixes the block in its support; the extractor then disengages the empty cartridge-case and throws it back. To close the breech, it is sufficient to repeat this action inversely.

AMERICAN NATURAL GAS.—The Carnegie Natural Gas Company, of Pittsburg, has purchased for 8,000*l.* a controlling interest in the Waynesburg Natural Gas Company, of Waynesburg, Pennsylvania.

NEW CENTRAL PASSENGER RAILWAY STATION IN COPENHAGEN.—The present main station in Copenhagen, which is about thirty-five years old, is entirely inadequate for the present traffic, which now comprises the working of eight railway lines. Next year the large new goods central station will be ready, and the authorities have therefore now invited the tendering of plans for a new central passenger station, which must be received not later than November 15, 1899. The committee in question has at its disposal three prizes of respectively 10,000 kr., 6000 kr., and 4000*l.* for the three best plans. The plans must not only deal with matters as they exist at present, but due regard must be shown to the development which is likely to take place. Persons desirous of competing can obtain all necessary papers and information by depositing the sum of 50 kr.

SCHNEIDER-CANET BREECH MECHANISM FOR QUICK-FIRING GUNS.

(*For Description, see Page* 700.)

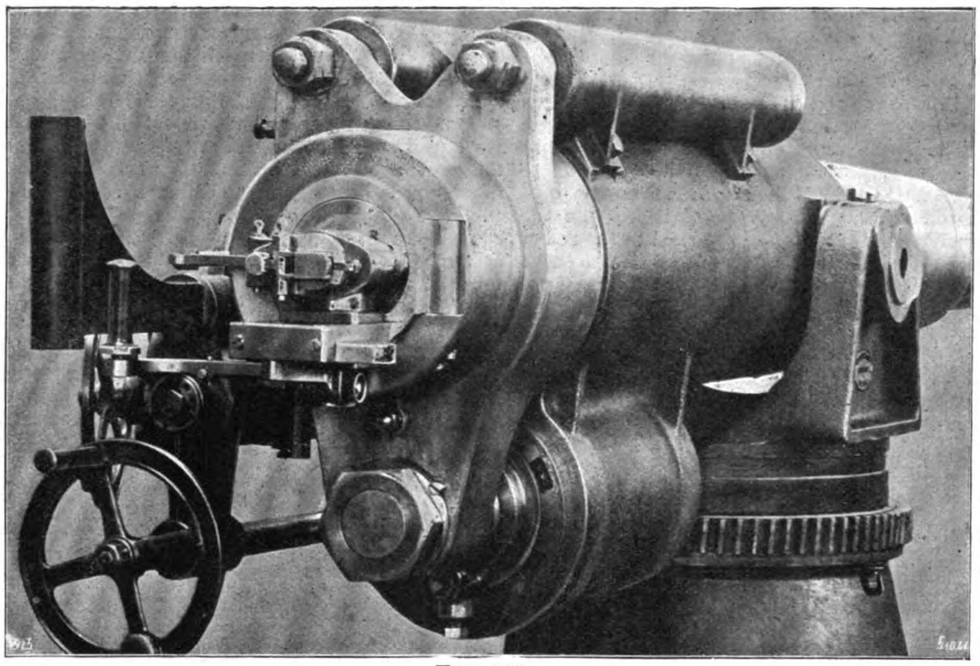
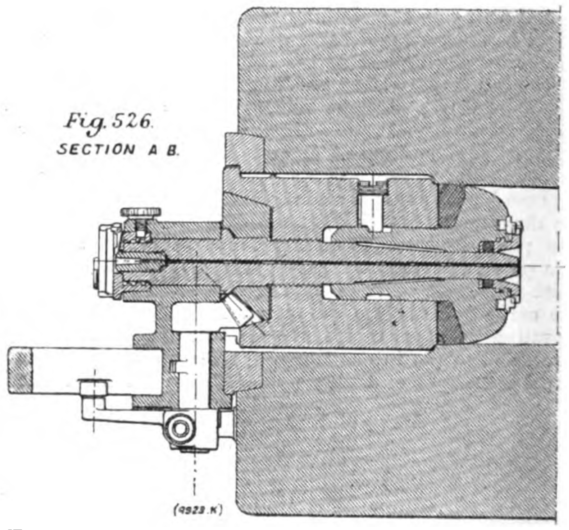


FIG. 529.



FIGS. 526 TO 531. BREECH MECHANISM FOR 24-CENT. (9.449 IN.) QUICK-FIRING GUNS.

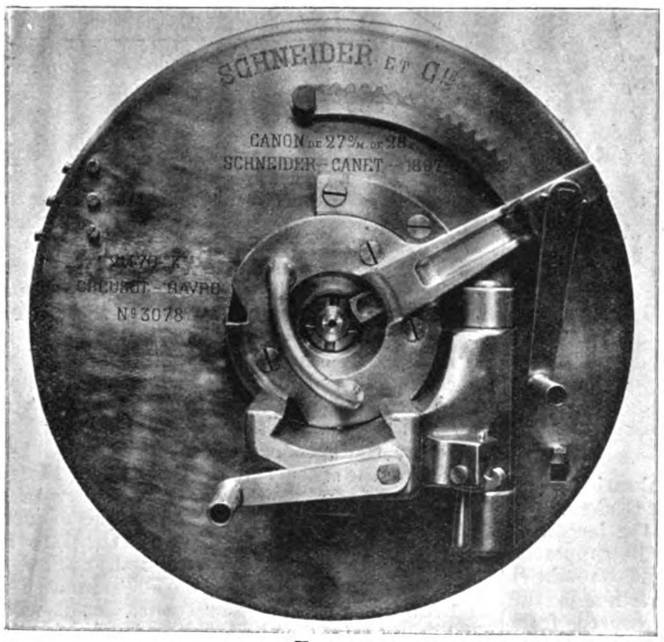
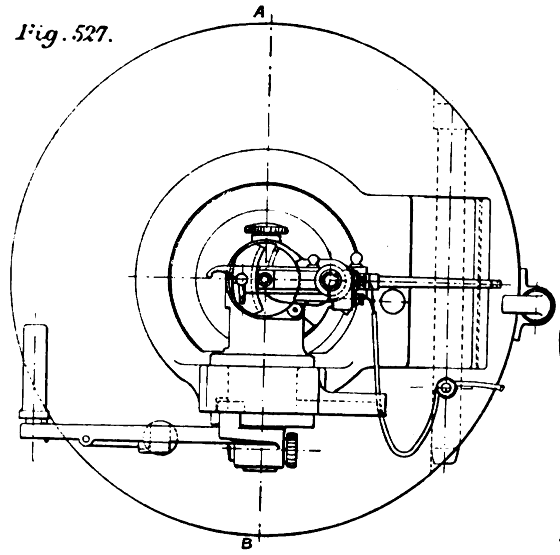
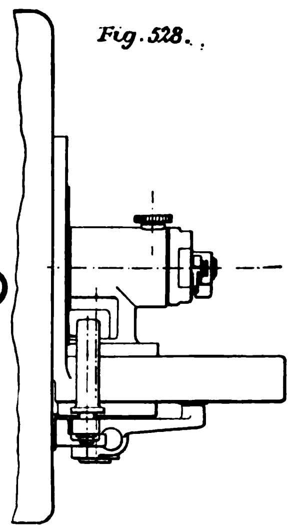
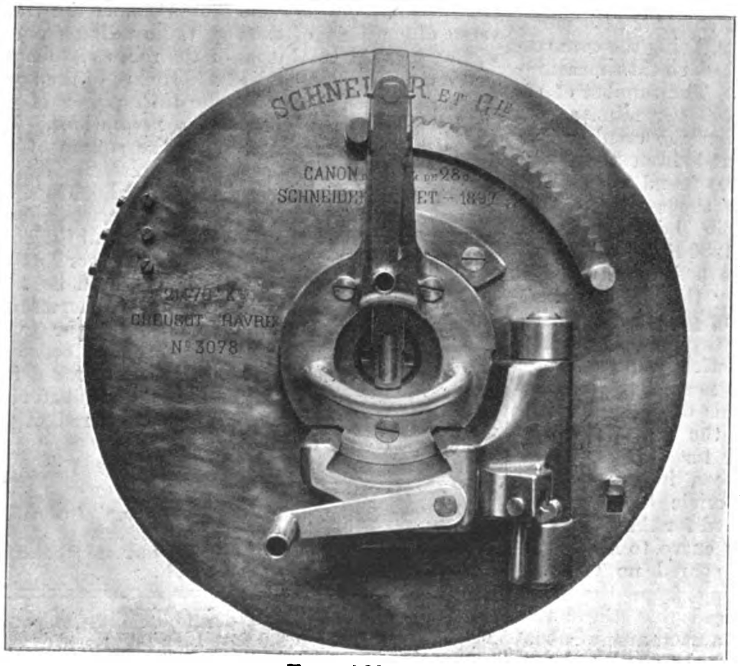
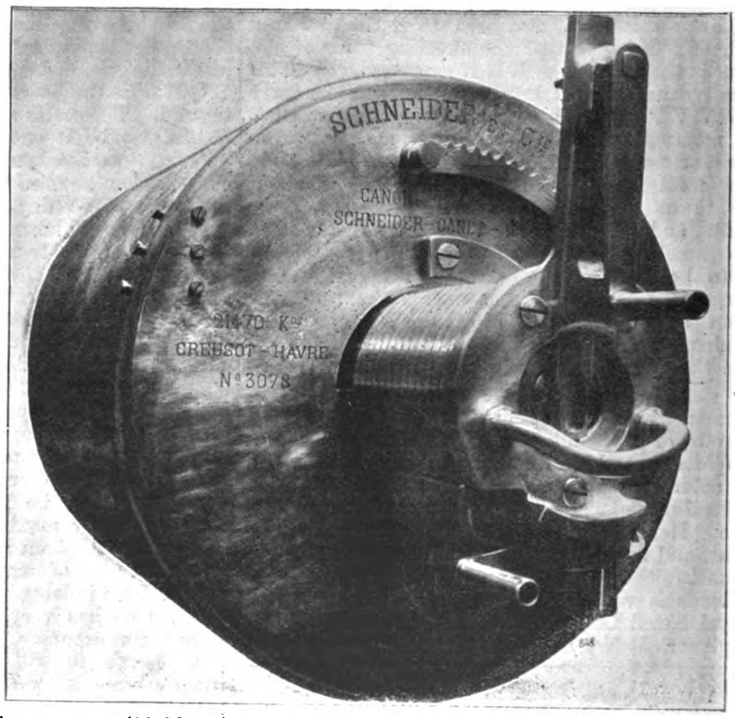


FIG. 532.









FIGS. 532 TO 534. BREECH MECHANISM FOR 28-CENTIMETRE (11.02-IN.) QUICK-FIRING GUNS.

SCHNEIDER-CANET BREECH MECHANISM FOR QUICK-FIRING GUNS.

(*For Description, see Page* 700.)

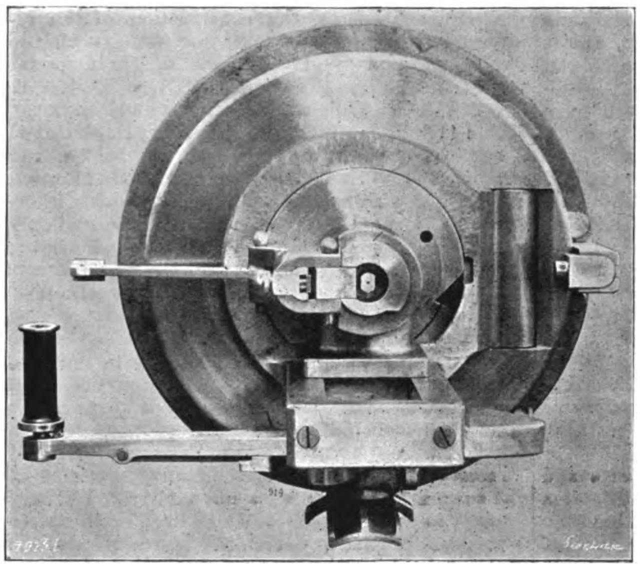


Fig. 530.

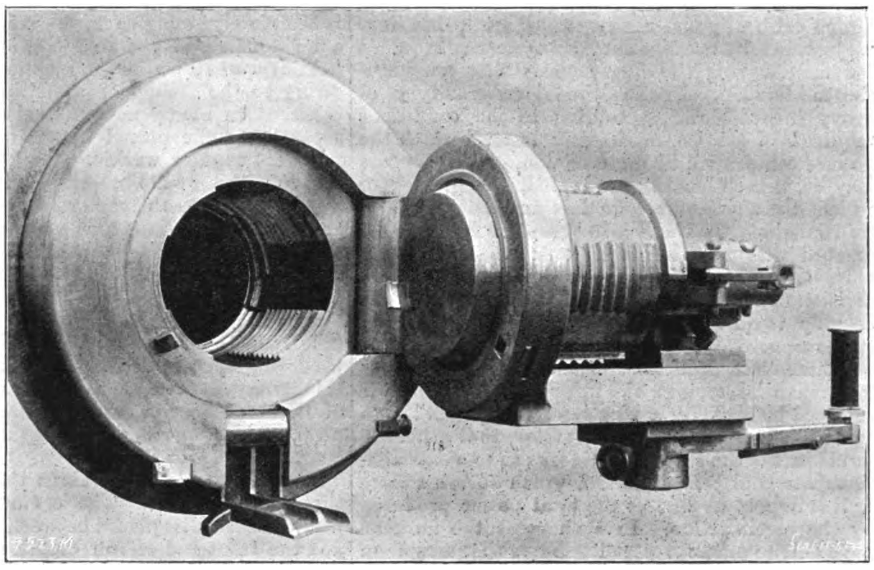


Fig. 531.

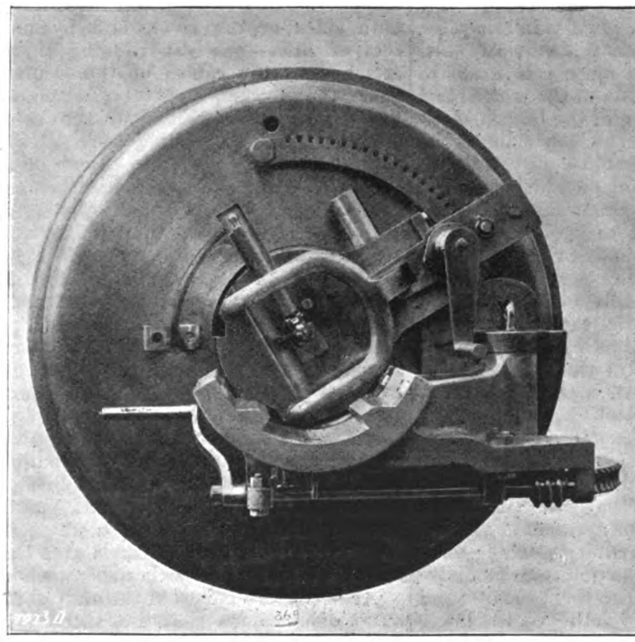


Fig. 535.

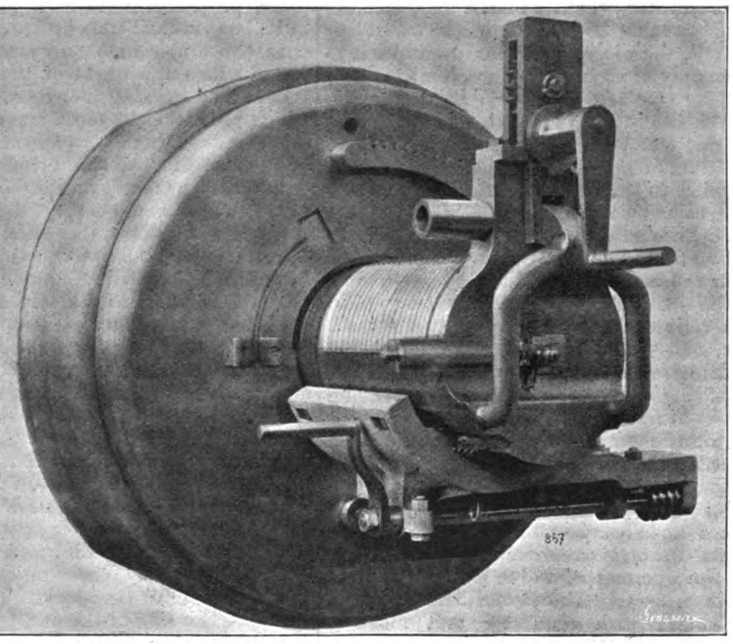
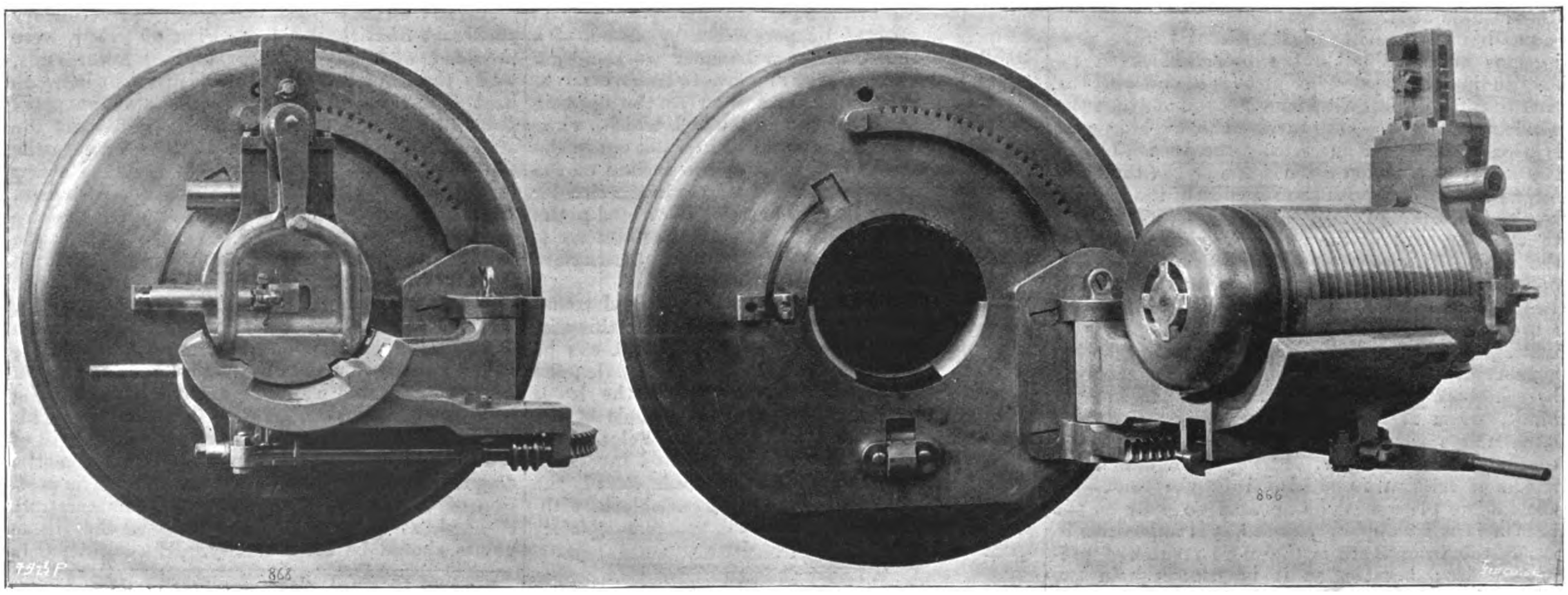


Fig. 536.



535 to 538. Breech Mechanism for Quick-Firing Guns of Large Calibre.

MESSRS. SCHNEIDER AND CO.'S WORKS AT CREUSOT.—No. LVII.

QUICK-FIRING GUNS—(*continued*).

Breech-Blocks for Large-Calibre Guns.—The classification of breech-blocks for rapid-firing large-calibre guns under a separate heading, is justified by the special arrangements required for manœuvring the heavy parts that constitute the mechanism. In the Schneider-Canet types of heavy breech-blocks, according to the conditions required in service, mechanism is used which the gunner can control by direct action, or, as the case may be, breech-blocks are adopted, the gearing of which contains a more or less intricate series of transmissions that serve to keep the effort to be exerted within the limits of work that can reasonably be demanded of the attendants. This subdivision of large-calibre breech-blocks corresponds roughly to quick-firing guns and accelerated firing guns respectively. When the sizes of the parts to be manœuvred make it expedient to have recourse to mechanical motors, the work of the *personnel* is replaced by that of a transmission operated by a steam, hydraulic, or electric motor, that generally forms part of the ship's machinery; in some installations accumulators are used, which absorb a more or less important part of the total power produced by the recoil action. In such cases the gunners have only to manœuvre a distributor that acts upon a set of valves; hand levers are nevertheless provided, to be used for working the breech-block, should the motors fail to act. The following Schneider-Canet breech-blocks may be used with any type of obturator, whether plastic disc, metallic ring or cup, movable bottom or whole cartridge-case; we shall, therefore, limit our description to one specimen only of each kind of mechanism.

Direct-Acting One-Motion Breech-Block for 20, 22, and 24-Centimetre (7.874, 8.661, and 9.449 In.) Schneider-Canet Quick-Firing Guns (Figs. 526 to 531, pages 698 and 699).—The same type of breech-block is applied to the three calibres. It contains generally the same mechanism as the breech-blocks for medium-calibre guns we have already described. The general views and details illustrate the working parts, which are so arranged that by one single action of the hand lever, breech-blocks up to 9.449 in. in calibre are quickly opened or closed. Section Fig. 526 shows the breech-closing device for a 24-centimetre (9.449-in.) 45-calibre Schneider-Canet quick-firing gun. It is designed for firing with a plastic obturator or by electricity. A plate in the rear of the gun, which can be raised and lowered, facilitates charging (see Figs. 530 and 531).

Two-Action Breech-Block, with Firing Device for Friction Fuse (Figs. 532 to 534, page 688).—This illustrates the class of Schneider-Canet breech-blocks, for the opening of which several distinct actions are necessary. The mechanism comprises the breech-block with obturator and movable head, its bracket with the manœuvring apparatus, and the firing device. The breech-block is made with three threaded parts and three interruptions; the obturator consists of a metallic disc centred on the movable head.

The bracket consists of a horizontal plate, projections in which guide the breech-block in its longitudinal travel. This plate is in one with the part that passes over the hinge-bolt round which the whole system is made to turn. The working gear is used specially for unscrewing the breech-block; it consists of a pinion fitted to the end of the lever forged in one piece with the rear disc of the breech-block. This pinion engages in a circular rack fitted to the rear end of the gun. A handle fixed to the pinion axis serves to turn round the lever, operating the breech-block which is thus unscrewed. In the lower part of the lever is a groove in which travels, guided by a spring, a small tongue plate that masks the vent as soon as the opening action is started. A fixed traction handle on the rear breech-block disc serves to withdraw the breech-block, when it is unscrewed. A special double latch unites the bracket to the breech-block and to the gun alternately. Firing is obtained by means of friction fuses placed in the vent. As the tongue plate masks the vent so long as the breech is not completely closed, it is impossible to insert the fuse, there is therefore no risk of premature fire; besides, as it is necessary in the event of a miss-fire, to lower the tongue plate, and, consequently, to previously remove the fuse from the vent, there is no risk of accidental firing.

To open the breech, the tongue plate being lowered, the lever handle is turned until the breech-block has travelled through 60 deg., when the threads being disengaged, the block can be withdrawn and swung to the side by pulling on the fixed traction handle. When the breech-block is completely swung back, the bracket latch engages a hook fitted to the rear end of the gun, and is held firm whatever be the incline taken by the gun owing to the rolling of the ship or to any other cause. An emergency mechanism, operated by a separate handle placed under the bracket, serves to insure regular working should it be found difficult to withdraw the breech-block from the seating. To close the breech, the latch is released by hand and the above actions are repeated inversely.

Figs. 532 to 534 show the breech closed, the breech-block unscrewed, and the block withdrawn from the breech.

Three-Motion Breech-Block with Percussion Firing (Figs. 535 to 538, page 699).—This differs from the preceding type in that the block is swung to the side by means of a special mechanism. It consists of the breech-screw, with obturator and movable head, the supporting bracket, with the working gear, and the firing device.

The breech-block has three threaded parts and three interruptions. The obturator consists of a plastic elastic disc placed between the movable head and the front end of the breech-screw. The vent goes through the movable head-bar, the rear end being fitted with a brass bush, in which the fuse is placed.

The supporting bracket consists of a curved plate, projections on which guide the breech-screw in its longitudinal travel. This plate is in one piece with the hinge that surrounds the vertical bolt, round which the whole of the system is made to turn. The working gear consists of the mechanism which produces the unscrewing of the breech-block and the swinging of the system to the side of the gun. The disc of the breech-block is extended, and forms a lever, at the end of which is fitted a set of toothed gearing working a pinion that engages a circular rack fitted to the rear end of the gun. The mechanism is operated by a handle keyed to the small pinion axle. A spring latch at the end of the lever blocks the mechanism, and holds the gearing fast as long as the breech-screw is not driven completely home; this is to prevent any accidental displacement of the breech-screw during the manœuvres which follow the unscrewing.

To withdraw the breech-block when it is unscrewed, the gunner acts on the jointed hand-lever by raising its two arms. In so doing a cam at the top part of the lever bears on the rear end of the breech, and facilitates the release of the obturator, then by pulling the whole of the system to the rear, the breech-block is withdrawn from the seat; anti-friction rollers are placed on the guides to facilitate the movement of the block. The bracket is turned round to the side of the gun by acting on the lower handle, which works a spindle passing under the bracket, the spindle being fitted with an endless screw that engages a helicoidal sector fixed to the gun. A swinging latch unites the bracket to the breech-block and to the gun alternately.

Firing is effected by percussion by means of a latch bolt; this contains a hammer worked by a spring, and which moves in a groove transversal to the breech-block disc. As soon as the opening motion is started, the end of the bolt which, when the breech is closed is situated in a slot cut in the rear surface of the gun, rises up the incline on the left-hand side of the slot and travels in the circular groove with which the slot is connected; the hammer spring is thus set and the hammer is brought out of the centre of the vent. Premature firing is thus rendered impossible.

To open the breech the block is turned round 60 deg. by working the upper handle; this disengages the threads, and the breech-block can be withdrawn by acting on the jointed handle; the obturator being previously released, the lower handle is then turned to cause the whole of the system to swing round to the side. For closing the breech, the above actions are repeated inversely. Figs. 535 to 538 show the breech closed, the breech-block unscrewed, the breech-block withdrawn from the seating, and the breech completely open.

BEIRA RAILWAY.—A contract for widening the gauge of the Beira and Umtali line has been signed in England. Work is to be commenced at once.

THE NEW BRIDGE OVER THE NIAGARA RIVER.

(*Concluded from page 635*)

Progress of Work.—The installation of the contractors' plant, the erection of the false works for the approach spaces, the construction of the reinforcing chord of the stiffening trusses of the old bridge, and other work of a similar character was carried on from September, 1897, until winter.

Considerable time was lost in an endeavour, on the part of the contractors, to have the arch flattened about 6 ft., so as to clear the old bridge, and simplify the work of erection. This modification was desirable on account of the unlooked-for interference of the old bridge, which was discovered only during the preliminary work; the proposal, however, did not receive the sanction of the chief engineer.*

At the approach of winter the work was temporarily suspended, as the contractors did not wish to expose the workmen to dangers incident to the erection of a structure of this character in extreme cold weather. For this reason it was not until February, 28, 1898, that the work of erection was actively prosecuted. The heaviest pieces to be handled were the shoes of the arch, which weighed 16 tons each. The floor system and suspenders of the suspension bridge were not considered strong enough to carry the concentrated load, neither were travellers designed to handle it. The erection of the shoes, for this reason, was carried out as follows: Those for the Canadian end of the arch were transferred to the Canadian side of the gorge *viâ* the Niagara Railway arch, two miles north. The shoes were all landed close to the edge of the gorge on both sides of the river, and by means of two sets of lines—one set running through sheaves attached to the cables of the suspension bridge near the towers, and the other set running through sheaves attached to the cables near the centre of the bridge—they were successfuly landed at the bottom of the gorge. Their erection in final position on the skewbacks was then comparatively simple, great care, however, being taken to set them exactly to the required line and elevation. To secure an even bearing on the masonry, the shoes rest on a ¾-in. rust joint. Fig. 70, page 703, is engraved from a photograph of a shoe with pin and cast bearing in place. The end panels of the arch at the springing were then erected in place, supported by timber false work. Bents 0 were set up complete, braced at intervals by means of timber struts attached to the false work of the approach spans, and were connected at the top with the main anchorage. Then the arch was built out to panel point 2 Fig. 49†, and the first line of secondary anchor bars A attached; bents No. 2 were then erected and the towers completed. After that the arch was built out two panels at a time, and the successive lines on anchor rods attached.

After the two halves of the arch were built out a short distance, so that the anchorages were subjected to considerable strain, the main toggles at the anchorage pits were set to the proper lengths, that is to say, 5 in. short, in order to bring panel point 20 to the proper position at closure.

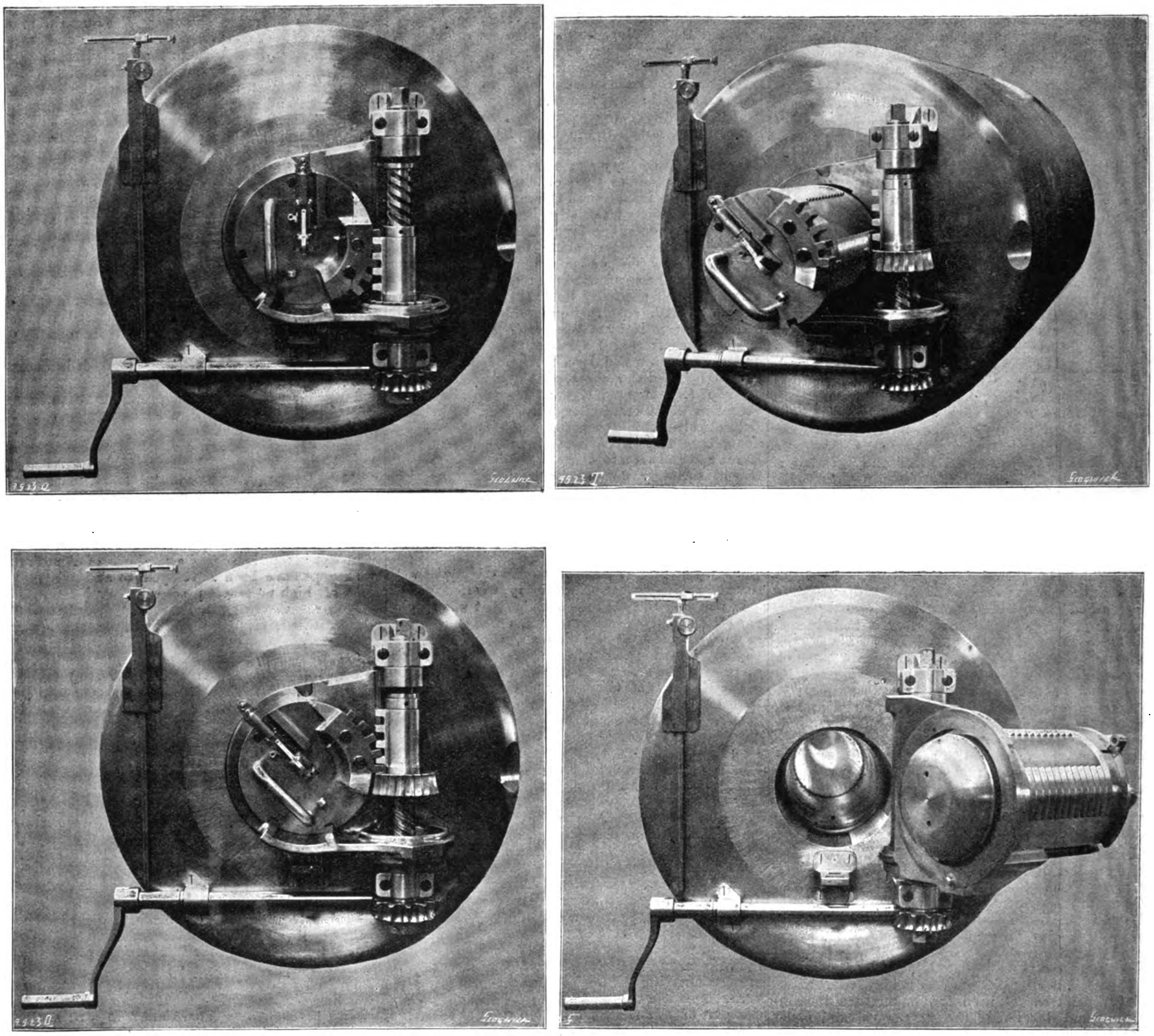
As has already been noted, all the secondary anchorage lines from A to E, Figs. 49 to 52†, were provided with adjustments at their lower ends, while the main line G had no adjustment between bent 0 and its attachment to the arch at panel point 14. It was, therefore, necessary to start the arch a trifle high so that the distance between the top of bent 0 and panel point 14 would be a few inches shorter than the actual geometrical distances, to provide the necessary "slack" required to drive the last pin in this line of bars. As soon as the arch and the towers were complete to panel points 2, the secondary anchorage lines A were screwed up sufficiently to bring panel points 2 about ⅞ in. above their normal positions. This elevation would bring panel points 14 about 6 in. too high, and would shorten the distance between the top of bent 0 and panel point 14 about 3½ in., causing bent 0 to bend slightly toward the river. This bending was made uniform over the full length of the bent by means of the adjustments in the diagonal rods between bents 0 and 2. The position of the arch at panel points 2 was carefully checked, as it was absolutely essential that these points should be set correctly. The adjustments

* It will be noted that the curves of influence (see Figs. 36 to 40 of the two-page plate in our issue of May 19) are worked out for such an arch.

† See two-page plate, ENGINEERING, May 19.

SCHNEIDER-CANET BREECH MECHANISM FOR LARGE-CALIBRE GUNS.

(*For Description, see opposite Page.*)



FIGS. 539 TO 542.

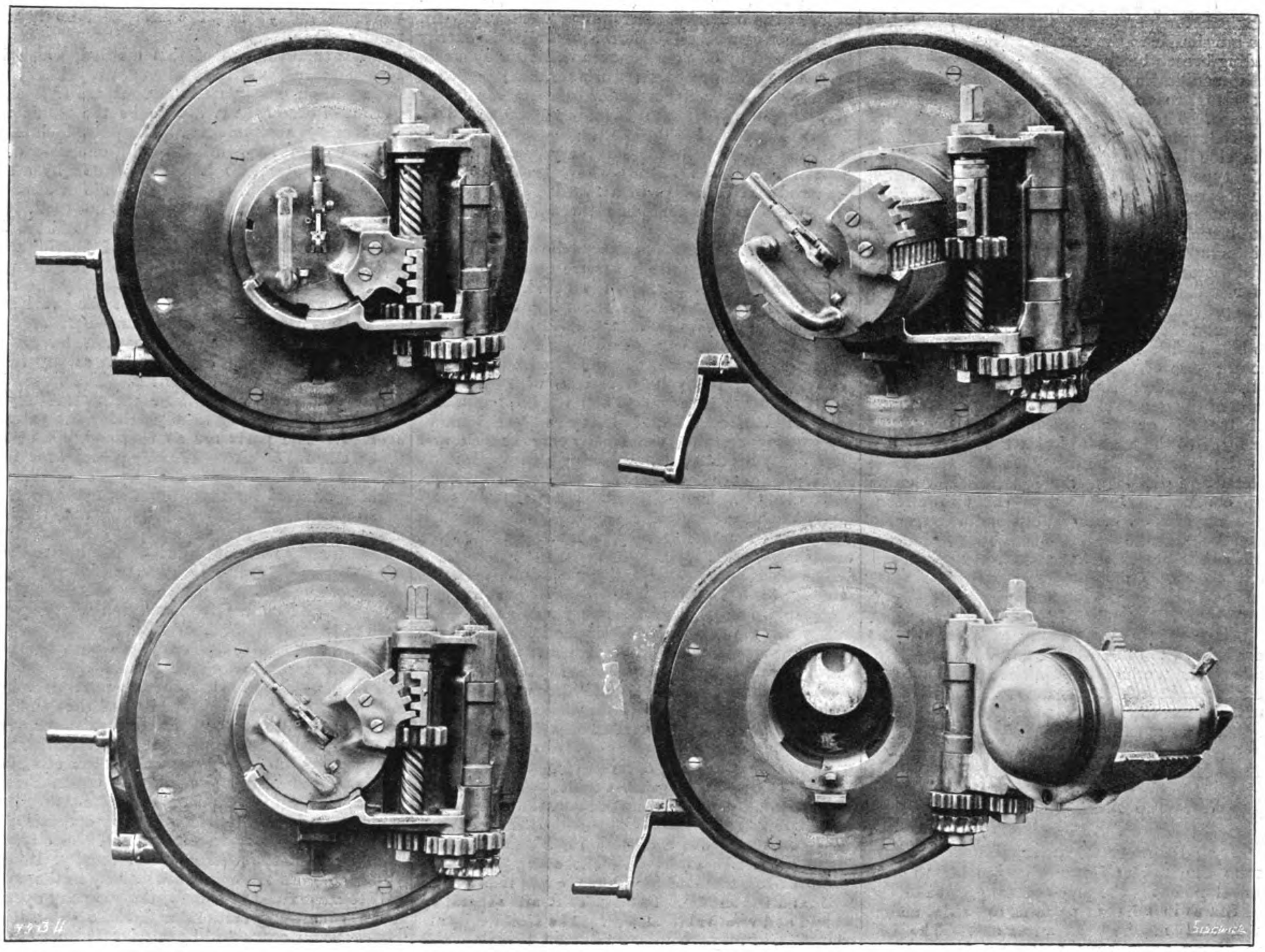
vened, and the orders had to go to Baldwin's, of Philadelphia. . . . The Director of Railways, Bimbashi Girouard, is a Canadian, presumably of French derivation. In early life he built a section of the Canadian Pacific Railway. He came out to Egypt for the Dongola campaign, one of three subalterns specially chosen from the railway department of the Royal Engineers. The Soudan killed the other two out of hand, but Bimbashi Girouard goes on building and running railways. The Dongola line runs as far as Kerma, above the Third Cataract. The desert line must wait at the Atbara River for a bridge before it can be extended to Khartoum. But already here is something over 500 miles of rail laid in a savage desert—a record to make the reputation of any engineer in the world, standing to the credit of a subaltern of sappers."

The Atbara River, 550 miles south of Halfa, barred the way of the railroad till the bridge could be erected. At the crossing the width is about a 1000 ft., and as the bed of the river offered no physical difficulties (it is chiefly a dry sandy bed except at flood times) to the sinking of cylinders for piers, small spans, which meant light weight for transport, were obviously desirable. For this reason spans of 150 ft. were decided upon, and English contractors sent representives to Cairo to obtain information and submit tenders. The best of these offers thus made did not accord at all with the methods of the Sirdar, and accordingly the Egyptian War Office was requested to ascertain whether the United States could not provide more prompt delivery. With this object telegrams were sent to the Pencoyd Iron Works (the directors of which had not sought to compete) asking if they would undertake the work.

The following paragraphs show the complete history of the bridge, from the date of the first cablegram from Cairo to the completion of the shipment at Philadelphia:

1. Cablegram inquiring for price and delivery was dated at Cairo January 7, 1899.
2. Cablegram answering same was sent from Pencoyd same date, January 7, 1899.
3. Specifications were received at Pencoyd, January 24, 1899.
4. Received order to proceed January 24, 1899.
5. Dates on which drawings were commenced in the drawing office: Strain sheets, January 27, 1899. General drawings, January 28, 1899. Shop drawings, January 31, 1899.
6. All drawings completed February 10, 1899.
7. Plates were ordered from the plate mills from February 1 to 8; other material ordered from the rolling mills, February 2 to 11.
8. Material was received from the mills from February 3 to 21.
9. Work was commenced in the templet shops, February 5, 1899.
10. Work was commenced in bridge shop, February 6, 1899.
11. Material loaded complete on cars ready for shipment, March 7, 1899.
12. One half of the bridge left New York on steamer March 22, 1899, and the balance on March 30, 1899. The material could have all gone

SCHNEIDER-CANET BREECH MECHANISM FOR LARGE-CALIBRE GUNS.



FIGS. 543 TO 546.

on the first steamer if loading had not been interfered with, which necessitated the holding of the remaining half of the bridge for another week.

13. March 2, 1899, order was received for main portion of erection plant; and on March 30 and April 15, orders were received for additional plant.

14. Bridge shop was not running from February 13 to 18 inclusive (six days) on account of the severe blizzard, which closed the works down completely, on account of the railroads being blocked with snow, which cut off the coal supply.

15. Steel mill and rolling mills closed down from February 13 to 20 inclusive (eight days), also on account of the blizzard interfering with the coal supply.

16. Of the material entering into the bridge, 1,126,000 lb. were rolled at Pencoyd.

17. Of the material, in the shape of plates, 286,000 lb. were rolled at Harrisburg, a distance of 100 miles from Pencoyd.

18. Number of men employed at Pencoyd, 3000.

19. Total weight of steel in the finished structure, 1,258,313 lb.

20. Total weight of cast-iron pier caps, 133,586 lb.

21. Length of each span, 147 ft., centre to centre of pins.

22. Number of spans in all, seven.

23. Total length of bridge, 1052 ft., between end piers.

(*To be continued.*)

SEWERS AT MEXICO.—Before the close of this month 15,000 men will be at work upon the sewer system of Mexico. Four great collectors or mains are being constructed across the city.

MESSRS. SCHNEIDER AND CO.'S WORKS AT CREUSOT.—No. LVIII.

QUICK-FIRING GUNS—(*continued*).

Breech - Screw with Percussion Firing (Figs. 539 to 541).—This example has been chosen to illustrate the types of Schneider - Canet breech - blocks, the closing and opening of which are effected mechanically throughout, by turning the crank handle always in one direction. The mechanism comprises the breech-block, its plastic obturator, and movable head, the bracket with the working gear, and the firing device. The breech-block is made with four threaded parts and four interruptions. The obturator consists of a plastic elastic composite disc, specially shaped and placed between the movable head and the front end of the breech-screw. On the rear end of the latter is fixed the toothed sector by which the block is turned.

The bracket consists of the support and the breech mechanism. The support carries the breech-block as it is displaced, and is made to turn round a vertical hinge bolt. The breech mechanism comprises the crank that works the horizontal spindle of the driving screw; the latter engages direct with a toothed wheel fitted to the vertical hinge bolt, and effects all the opening motions. The hinge bolt consists of an endless screw mounted in two bearings on the rear end of the gun, and on which travels a rack made to slide, in the rear, in two vertical slots which prevent it from turning round. The rack is fitted at its lower part with a pinion which, when the breech-block is unscrewed, engages the threads of one of the toothed sectors, and effects the withdrawal of the breech-block from the seating.

Firing is effected by percussion, by means of a latch-bolt which consists mainly of a hammer worked by a spring. When the opening action is started, the tenon fitted to the bolt, and which, when the breech is closed, lodges in a notch cut in the support, rises up the inclined plane to the left; this sets the firing spring, and removes the hammer from the vent. At the same time, the safety key engages in its slot, and, driven by its spring, becomes fixed in a socket provided for it in the bolt. When the breech is closed the rim of the breech-block comes in contact with the support, the bolt key engages in its slot and leaves the bolt free to slide in its groove. As the hammer cannot be set free, and as the striker is not opposite the vent, so long as the breech is not completely closed, all risk of accidental firing is avoided.

To open the breech by turning the crank, the vertical endless screw is set in motion, the rack rises and engages the toothed sector fitted to the rear of the breech-block, the latter becoming unscrewed. When the rack is at the top of the endless screw it is made to revolve, the pinion with which it is fitted engages the threads of the breech-block and brings this back until the bracket guides cause it to stop. On continuing to turn the crank the whole system swings to the side of the gun. To close the breech the crank is turned round inversely. A special latch, governed by a spring, joins alternately the support to the breech-block and to the gun. Figs. 539 to 541 show the breech closed, the block unscrewed, withdrawn, and the breech opened.

Figs. 543 to 546 illustrate another type of Schneider-Canet breech-blocks for large-calibre guns; the general arrangement is similar to that just described, but besides the endless screw and the rack gear for turning the breech-block, there is a separate bolt which forms a hinge for swinging it to the side. A set of gearing placed under the bracket puts the endless screw in motion and insures the opening and closing of the breech. The mechanism for percussion firing and the safety device are similar to the corresponding parts of the preceding breech-block.

In a modification, the continuous action of a crank also produces the opening and closing of the breech. The opening action consists of turning, withdrawing, and swinging the breech-block to the side by means of pinions and racks, but in this type all the toothed wheels are covered, which insures greater safety in service and gives to the system a simple and robust appearance.

The breech-block has four threaded parts and four interruptions; it is fitted at the back with a toothed sector for turning and with a longitudinal rack for withdrawing the block. It is guided in a bracket provided with a closing disc, and which can turn round a hinge supported on steel lugs. The hinge bolt is fitted with two pinions of different diameter; one of these engages a double-toothed rack that can slide horizontally in a groove on the rear end of the gun to effect the turning; the second set of teeth is arranged to engage the toothed sector fitted to the breech-block; the other pinion works the longitudinal rack when the turning is completed and withdraws the breech. The action of the crank is transferred to the two pinions through an endless screw and a suitably geared wheel. A double-latch bolt fitted in the bracket fixes it to the breech and the block to the bracket, so that the three motions of unscrewing, withdrawal, and swinging to the side, always follow in the required succession. A small cam on the hinge-bolt fixes the unscrewing rack during the withdrawal of the breech-block and its swinging to the side. The teeth of the pinions and rack are so shaped that the breech-block is never abandoned when one action ceases to give place to another. The firing device is the same as that previously described.

THE WESTINGHOUSE ELECTRIC WORKS AT PITTSBURG.

*(Continued from page 613.)**

RAILWAY GENERATORS.

AMONG the leading features of nineteenth century development is the phenomenal growth of the United States in all that pertains to trade, manufactures, and material advancement. The last ten or fifteen years have witnessed a growth of population and prosperity beyond any recorded in history, and facilities for transit in, and around, cities have given a great impetus to the advance of American industries. Crowded and congested tenement houses have been abandoned for more healthful surroundings in suburban districts. The bone and sinew of factories, reared in country air instead of fetid city dwellings, have been enabled to put their strength and vitality into American products.

Cheaper transit and increased facilities for travel are mainly due to the introduction of electric railroads. They have wrought a drastic change for the better in social conditions, and in the home life of the people.

The Westinghouse electrical engineers were among the first to grasp the problem of electric railway work. Their designs for motors, and for other apparatus, have been almost universally adopted. For inventive genius and practical utility these designs have been unexcelled. It is well known that the remarkable growth of electric railways, which has been so great a stimulus to prosperity, is largely due to Westinghouse enterprise and inventiveness.

There is hardly a town in the United States of over 10,000 inhabitants that does not possess a well-organised electric traction system. Take the New England States, with their dense population, where but a few miles intervene between large cities. There one finds such a perfect network of electric roads that it is possible to travel more than 200 miles by transfer from one car to another. The same conditions prevail in all the more densely-populated States. Frequency of car service economises the traveller's time, and wherever electric roads are installed, traffic is developed, for country life does not fail to attract town dwellers.

* By an oversight the article we published on page 612 was marked "concluded" instead of "continued."

The history of applied electricity is a record of improved devices and of constantly changing apparatus. The ideal is to combine economy with high efficiency. Necessarily the electric force required for an extensive traction system is very considerable, as the ordinary car requires 30 horse-power, and larger cars reach 150 horse-power. This energy is produced by electric generators driven by steam or gas engines, or by water turbines. A number of railway generator fields under construction in the Westinghouse Works are shown in Fig. 30, page 734.

The success of the Westinghouse slow-speed "engine-type" generators is very marked. The department of the factory where these machines are produced is always in a crowded state. Some of the orders call for generators up to 1800 kilowatt capacity.

Among belt-driven generators the six-pole type, built especially for railway service by the Westinghouse Company, is perhaps the best known. The design embraces the best features which have been discovered by years of expert experience. These generators are over-compounded for a rise of 10 per cent., the voltage increasing with the load. Where, with no load, the voltage is 500, with full load the potential is increased to 550 volts. The armature winding consists of heavy copper bars of rectangular section, the coils being shaped and thoroughly insulated before being put in place on the armature core. Each coil is continuous throughout its length. The simplicity, strength, and symmetry of this method of winding, and the thorough ventilation secured thereby, will be apparent upon examination of Fig. 31.

The direct-connected railway generators range in speed from 75 to 275 revolutions per minute, according to size. The customary voltage for railway work is 550. The Westinghouse engine-type generator consists of a circular yoke, carrying inwardly projecting pole-pieces of laminated soft steel. The field castings are divided vertically and set upon a guide-plate. This vertical division of the fields affords excellent facilities for immediate inspection, or removal of armature or field coils, without the necessity of removing the outboard bearing or dismantling the engine. The opening of the fields upon ways in a horizontal direction is a great convenience where head-room is limited, and where cranes or other devices for handling heavy castings are not available. These generators are also over-compounded for 10 per cent. rise at full load, and the shunt and series coils are separately wound and removable at will. The series coils are composed of forged copper conductors of rectangular section.

The armature core consists of punched sheets of carefully annealed steel (Fig. 32), held together by cast-steel end-plates. This core is built upon an iron spider, which also carries the commutator. This spider is pressed and keyed upon the engine-shaft, and may be drawn off at will, should that ever be necessary, without in any way interfering with the perfect arrangement of the commutator and windings. Ventilating spaces through the spider and armature core are so arranged as to allow a constant circulation of air through the commutator and windings when the machine is running.

The periphery of the armature is slotted. The armature windings are made from bars of drawn copper, forged into proper shape on cast-iron formers. After being thus shaped, the bars are thoroughly insulated with mica and prepared fuller board, and baked to remove all moisture. The coils are held in the slot by means of retaining wedges of hard fibre, driven into notches near the top of the slots, longitudinally with the armature. These fibre wedges may be pressed out at will, should it become necessary to remove any armature coil.

The commutators are constructed from the best obtainable grade of hard-drawn copper, the segments being spaced by prepared mica of such corresponding hardness that an extremely even-wearing surface is presented to the brushes.

The brush-holder mechanism is carried by brackets projecting from a ring concentric with, and supported by, the field. A hand-wheel rocker arrangement accomplishes adjustment of all the brushes simultaneously. The brackets carrying the brush-holder rods lie close to the fields, and do not project over the commutator. The commutator and brushes are, therefore, clear of obstructions, and may easily be inspected at any point. Carbon brushes are used in connection with all of these machines.

A feature of great importance in the Westinghouse railway generators is that all the brushes of the same polarity are maintained at precisely the same potential. By the use of the Westinghouse balancing method the armature could be considerably out of centre, and no injurious results occur.

Another advantage of this method, which is of especial value, is that it prevents any heavy magnetic pull on one side of the armature if it should get out of centre, as is apt to be the result when the bearings become worn. The pull which may be exerted on a large armature by one side of the field, if the armature is out of centre by a small fraction of an inch, may become as high as several tons, if this method of balancing is not used. Such an increased pull on the armature would result in the heating and rapid wearing of bearings. By the method of balancing now used, the induction under all poles is maintained practically the same, which causes the magnetic pull to be equal at all poles, thus preventing an unbalanced pull.

The Westinghouse railway generators have several special features which mark them as superior to those of any other construction. The losses incident to this class of machine are so carefully distributed, that heating to any deleterious extent is avoided. The parts are so thoroughly ventilated that a current of air continually passes over them, and the design of the generators is such that it is nothing unusual for them to be run at an overload of 50 per cent. for several hours, and they will momentarily carry even 100 per cent. over their rated capacity without injurious heating or sparking. When these machines are erected the brushes are placed in position and never require shifting, however the load or other condition may vary from time to time.

A marked tendency during the past few years has been towards discarding the high-speed belt-driven generators for the direct-connected at lower speed, the number of revolutions of the generators being adapted to those of the driving power.

Among the large number of electric roads equipped by the Westinghouse Electric and Manufacturing Company is that of the Union Traction Company, of Philadelphia. The main power house is shown in Fig. 33. This company operates about 450 miles of track in and around the city, and its receipts are about 2,200,000*l*. annually. It is said to be the largest single street railway in the world. On account of the wide area, the company operates seven generating stations and three sub-stations. These are all connected by special tie-lines of large capacity, and any deficiency of power in one can be obtained from others of the system.

(To be continued.)

THE INSTITUTION OF CIVIL ENGINEERS' CONFERENCE.

THE second Conference of the Institution of Civil Engineers is being held this week in London. As our readers will remember, the first of these biennial Conferences was held the year before last, when there was a large attendance of members and others. In accordance with the precedent set at the first conference, the proceedings were divided into several sections, of which the following is a list:

Section I., related to Railways; Section II., to Harbours, Docks and Canals; Section III., Machinery; Section IV., Mining and Metallurgy; Section V., Shipbuilding; Section VI., Water Works, Sewerage and Gas Works; Section VII., Applications of Electricity.

The proceedings were opened by the President, Sir W. H. Preece, K.C.B.—whom we congratulate on his well-earned title—delivering a short address to all sections in the theatre of the Institution. This address we print in full on another page, and need not therefore make further reference to it here, beyond saying that a vote of thanks was proposed by Sir J. Wolfe Barry, and was seconded by Sir Edward Carbutt.

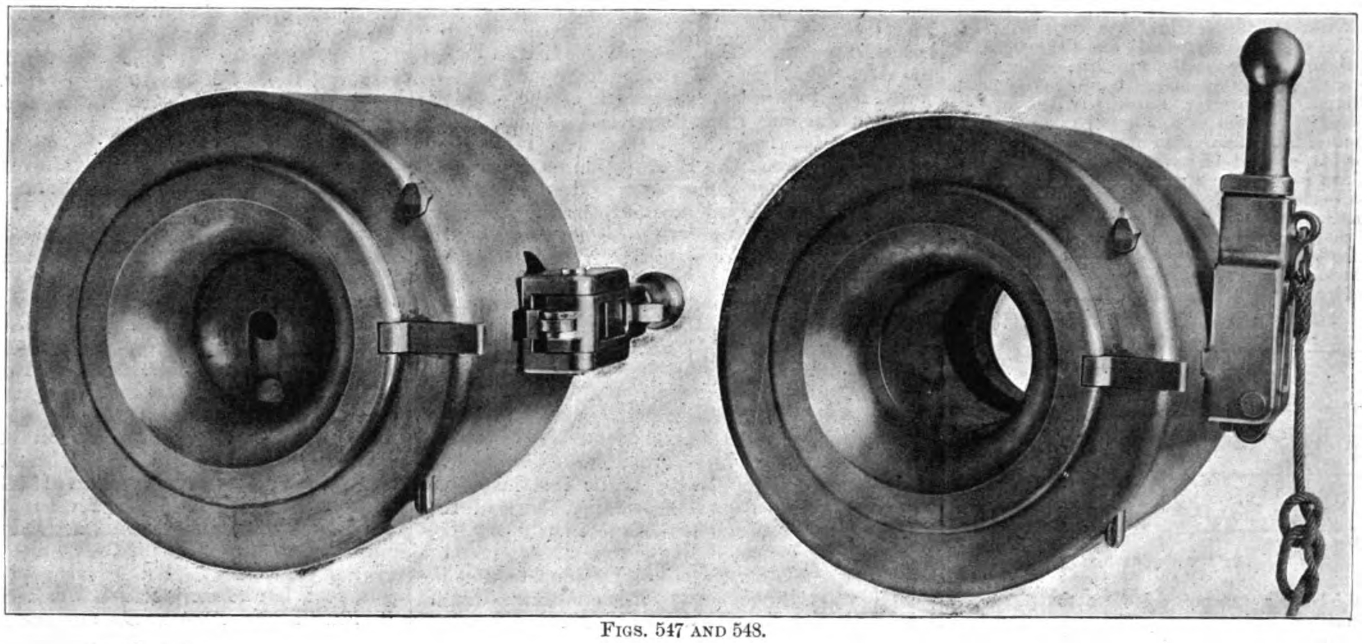
At the conclusion of the reading of the address, the members separated to assemble in the rooms assigned to them for the various sections of the meeting.

SECTION I.—RAILWAYS.

The Railway Section of the Conference met at 11 A.M. in the meeting-room of the Surveyors' Institute, the chair being occupied by Sir Douglas Fox, who, in opening the proceedings, requested speakers in the discussion to be as brief as possible,

CONCENTRIC SCREW BREECHLOADING MECHANISM FOR QUICK-FIRING GUNS.

(*For Description, see Page* 811.)



Figs. 547 and 548.

Fig. 549.

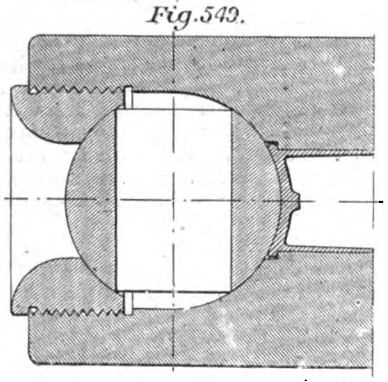


Fig. 550.

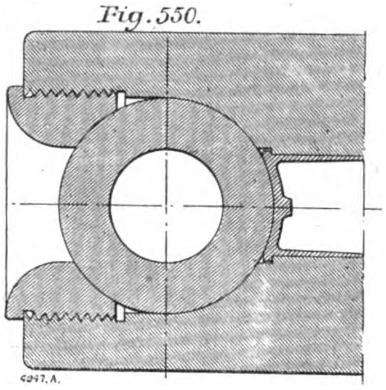
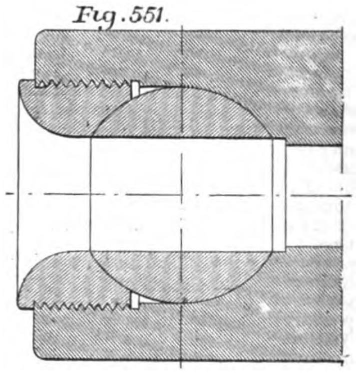
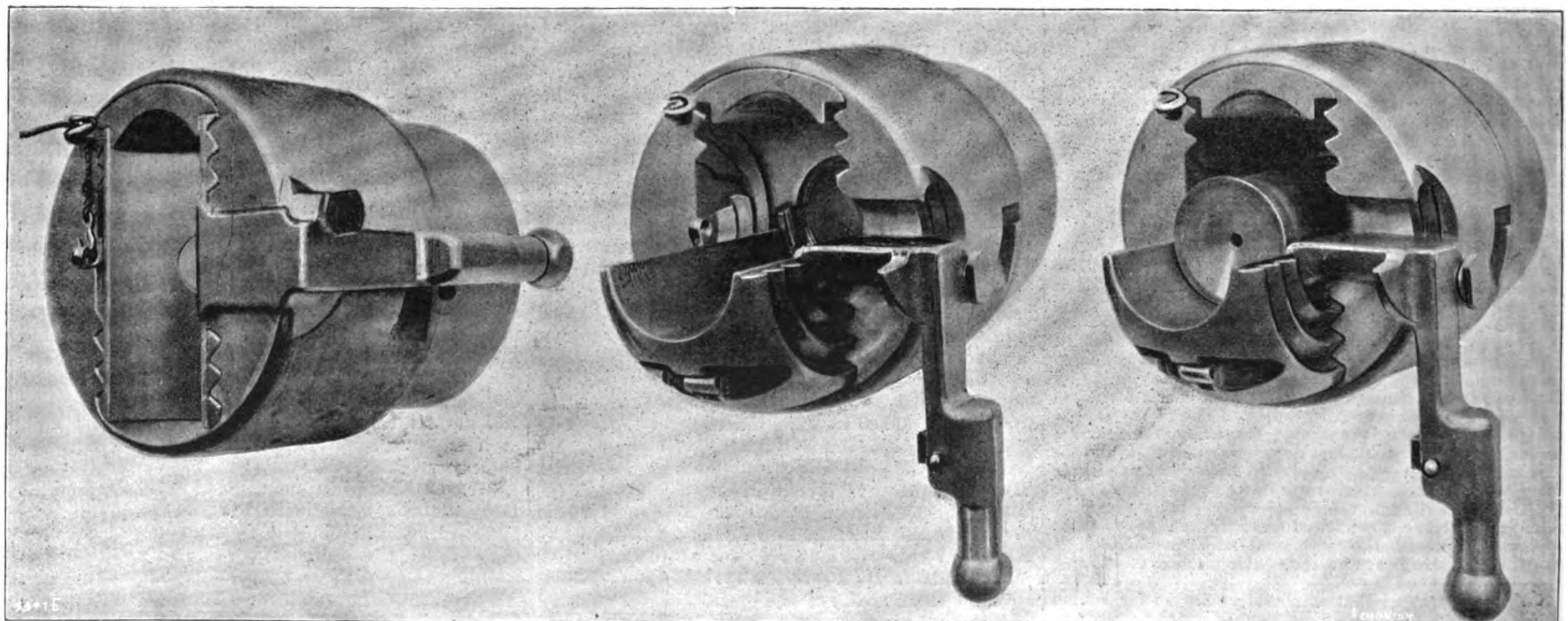


Fig. 551.





Figs. 552 to 554.

Fig. 555.

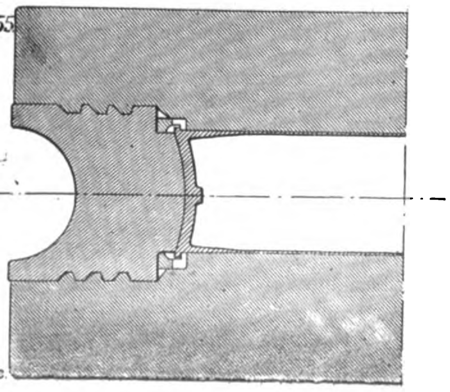


Fig. 556.

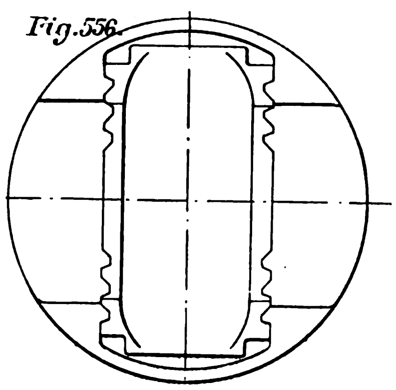
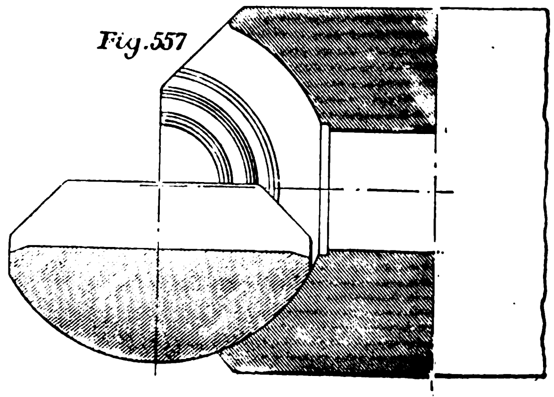


Fig. 557.



CONCENTRIC SCREW BREECHLOADING MECHANISM FOR QUICK-FIRING GUNS.

(*For Description, see Page* 811.)

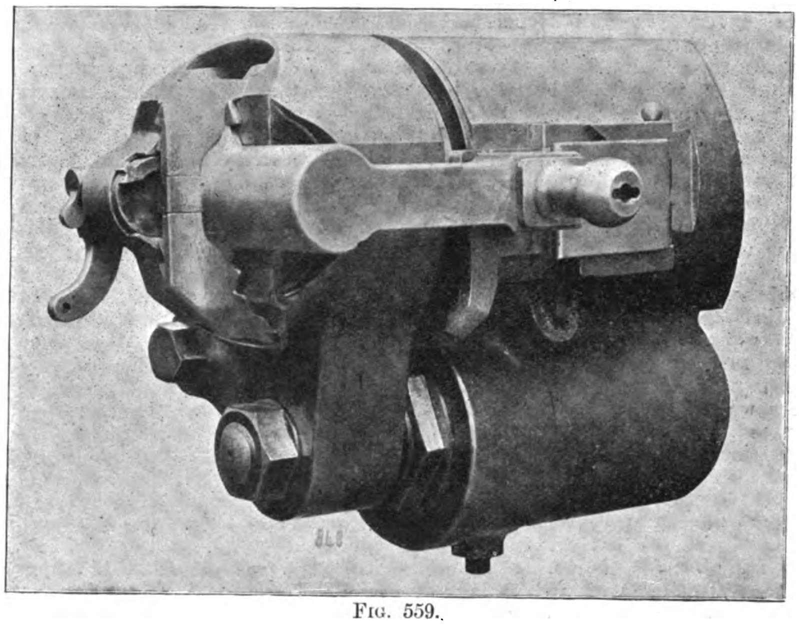


FIG. 559.

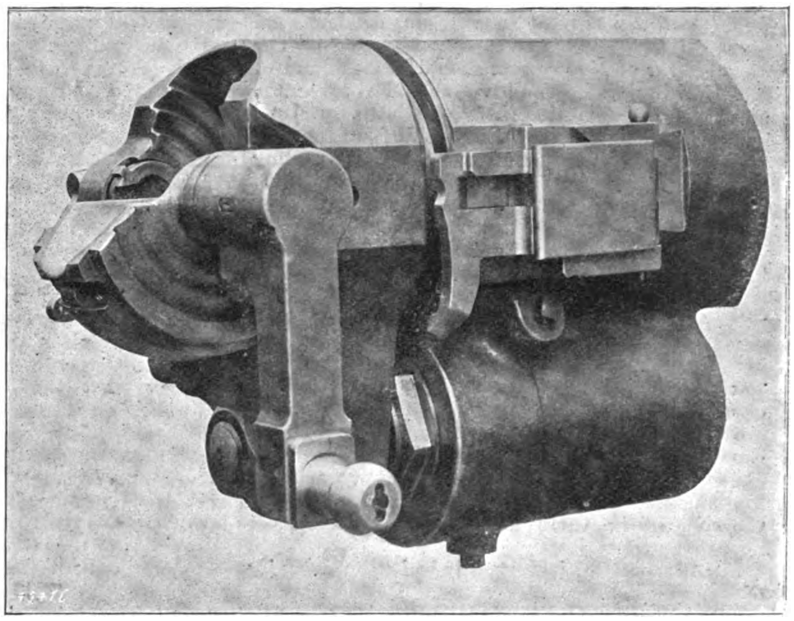


FIG. 560.

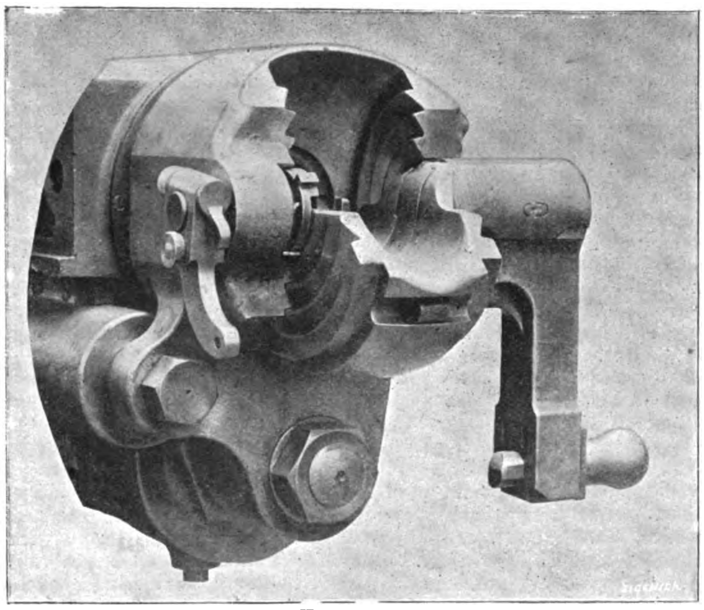


FIG. 561.

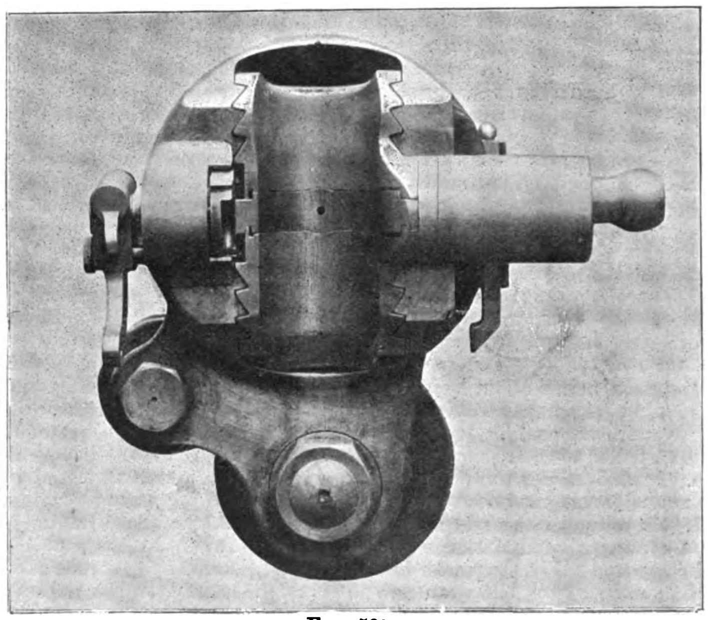


FIG. 562.

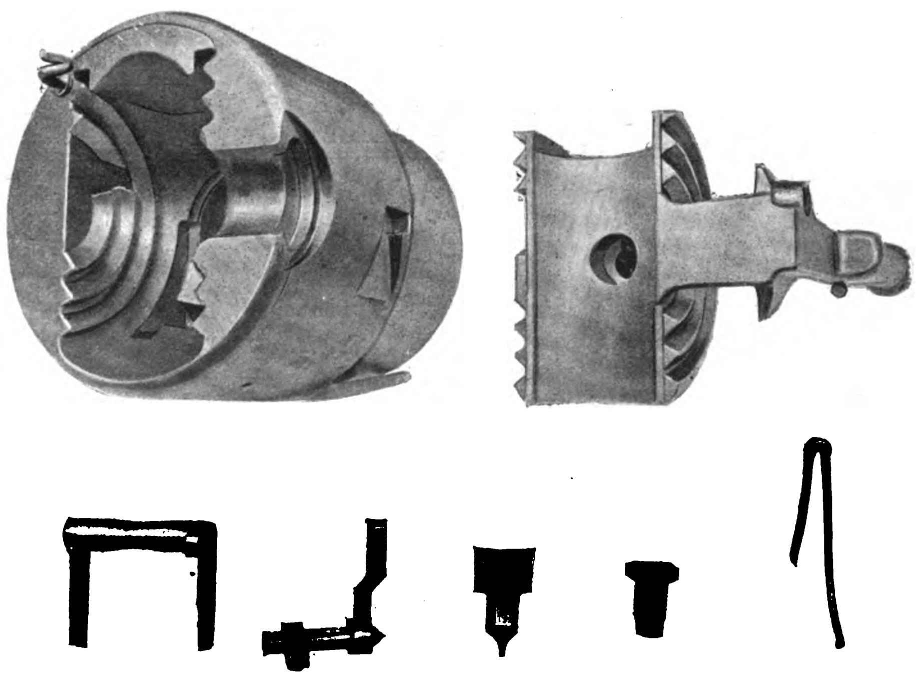


FIG. 558.

Livesey's views did not appear to him to be cor mercial, and he had his misgivings also as to ta we were already in the habit of burning tar, not bring it on the market. He had, during the la few years, experimented on the recovery of cyanoge at first with but little success, but he seemed n to be on the right track. He would like to h whether a high or a low temperature was m suitable for cyanogen; his own experiments w rather contradictory, and he had also noticed t the percentage of cyanogen recovered, var strongly. He had obtained from 1 lb. to 7 l his average figure would be about 3 lb. against Foulis' 4 lb. He had found the use of lime inst of soda, advantageous. He started with lime afterwards added soda to convert the ferro-cya of calcium into the sodium compound, thus re ing the cost by one-half. There was an additi advantage in the use of lime; it absorbed the bonic acid, which otherwise gave trouble. T iron oxide was obtained from copperas and galv ing pickle, neutralised with scrap. On a fo occasion Mr. Foulis had stated that he evapo the cyanides in open pans. Mr. Hack had fou impossible to do that as the pans become a nuis and he used now closed pans into which he adm exhaust steam.

Mr. Ashton Hill—not the Chairman—reg that gas manufacturers were not scientists.

question of outside or inside producers could not be decided in so general a fashion; for moderate-size works, one producer was certainly inconvenient.

Mr. Herbert Humphrey, who read a paper on the Mond producers before the Institution of Civil Engineers in 1897, stated that in Northwich the Mond gas was applied in vast quantities for all purposes, for cooking and steel furnaces even. The gas used for heating retorts should be clean and of high heating value, and we should recover the ammonia. They heated their coke ovens by Mond gas, and they recovered the ammonia from the coke gas; but they did not sacrifice the heat by cooling down in order to recover the ammonia, as Mr. Hunt had said. For by their method of condensation hey regained all the heat.

Mr. H. E. Jones remarked that it was possible to keep the ammonia in the purified gas down to one grain; that amount could not longer be detected by analysis. He had the latest London averages; they were $\frac{3}{4}$ grain, and occasionally as low as 0.2 grain. This was due to efficient scrubbing. The Continental gas works made large profits out of cyanogen, but the spent iron oxide contained greatly varying quantities of ferro-cyanide. He concurred in what Mr. Livesey had said concerning ammonia; agriculture would always want ammonia. The purification should, in the gas works begin at the condenser; there would be no trouble from naphthalin then.

Mr. Brackenbury had recently had an opportunity of studying Continental practice. He would warn against going too far in improving the works chiefly for the sake of certain by-products. He knew of one manufacturer who modified his gas producer in order to obtain graphite. That meant losing sight of the *raison d'être* of gas making. The sulphate of ammonium production had fallen off last year; tar was only sold by very large works. The recovery of cyanogen was general on the Continent, where iron oxide mixed with 10 per cent. of slaked lime was the favourite—and often the only—purifying agent applied. The oxides were three times washed with water, and the cyanide obtained by direct crystallation or by subsequent redistillation; the residual paste was also utilised. It was possible to absorb all the cyanogen by carbonate of iron in washer scrubbers, but it was a costly method.

Mr. Foulis remarked, in his reply, that Mr. Hunt's criticisms had already been answered. If the gas could not be carried through the flues of central producers without losing heat, there would, anyhow, be sufficient heat in the settings to raise the temperature again. It was true that different coals varied as to their percentages of nitrogen; his 4 lb. of cyanogen per ton of coal were derived from the annual averages, however, of twenty kinds of coal. He did not know whether the time had come for a cyanogen combination, such as Mr. Livesey had suggested. Mr. Carpenter had mentioned that sloping retorts gave less cyanogen; that might be because the gas passed over more incandescent material. He advised the extraction of the cyanogen after the removal of the ammonia and of the tar. A high temperature favoured the formation of cyanogen. His other replies to Mr. Hack were all in the negative. He had not noticed the strong variations in the yield of cyanogen; no complaint had been made concerning his open evaporating pans, and he did not understand the advantages of starting with ferro-cyanide of lime.

LABOUR-SAVING APPLIANCES IN GAS WORKS.

A paper with this title was next read by Mr. C. C. Carpenter, who gave some very striking figures in his communication, which we print in full on page 832. If there had been complaints about want of definite statements in other sections, no such charge could be brought in this instance, and the debate at once became interesting.

In opening the discussion, Mr. Hunt said that we could see now, how the South Metropolitan Company attained its reputation for cheap gas. The paper contained interesting information about the practice of that company, but he thought other methods ought also to have been touched upon. No mention was made, for instance, of West's mechanical stokers, although we were all grateful to him, and it should not be forgotten that labour-saving machinery had been in use for over twenty years—in Manchester, *e.g.*, he added, in response to a question put by the chairman, Mr. H. E. Jones. Entering into details then, Mr. Hunt inquired why two shifts (of 10 hours) had been put down for stoking in inclined retorts and three shifts (of 8 hours) for ordinary stoking. Apparently hand-worked retorts were to last longer than machine-worked retorts; that was not his experience, however. Mr. Carpenter's method of handling the coke by means of narrow-gauge locomotives had its advantages; but why leave conveyors out of question altogether? In Mr. Hunt's works the coal was received in hopper wagons, shot into breakers, taken up by conveyors, and separated and sorted into sacks without any manual labour. Mr. Hunt further asked whether the author had found the gas from inclined retorts somewhat deficient in quantity and quality.

Mr. H. Hack also commented upon several cost items of the paper. The hand-stoking came to 24.4d.; his own works at Saltley paid 17.5d. He missed any estimate for firemen's wages, and in the figures relating to hydraulic power stoking, all mention of engine attendance, and he did not know how to understand the increase of the duty of the retort plant in the proportion of 3 to $3\frac{1}{2}$, of which Mr. Carpenter had spoken. He also wished to know what the 3200*l*. installation included, and whether the retorts were whole or segmental. Mr. Carpenter's retorts attained a very remarkable age, 2400 days (hand stoked) or 2000 days with Arrol-Foulis hydraulic stokers, whilst he could not work them for more than 1440 (segmental) or 720 days. On this point, Mr. Hack evidently expressed the opinion of the section; but we shall see that Mr. Carpenter took full responsibility for his figures. Mr. Hack also avoided manual labour as far as possible, and emphatically asserted that the men should in any case be relieved of the hand work, wherever machinery was available. In handling the coal and coke, he employed a large crane, conveyors, and hoppers, the crane lifting the hoppers on screens across the water, &c. His first experience with conveyors had not been altogether satisfactory; it should not be neglected to have the conveyors made exceedingly strong, for the coke acted like emery, the action being very different from that of the soft coal. As regards stoking, he had saved 6d. per ton of coal by adopting West's compressed air machinery.

Mr. W. King thought that the advantages of machine stoking, both of the Arrol and Foulis, and the West systems were acknowledged. Could we settle the question of inclined *versus* horizontal retorts? Did the former really yield less gas of impaired illuminating power? Mr. Foulis had no doubt that machinery was still much needed in gas works. With regard to the transport of coal and coke, by conveyors or on rail, he favoured small locomotives, as the wagons could be sent anywhere.

Mr. Brackenbury considered the title of the paper as misleading. It should have been "Labour-Saving in Retort Houses," since there was nothing on loading, purifiers, clinkers, refuse, &c. [The chairman reminded the speaker that the length of conference papers was strictly limited, apparently without convincing him.] Mr. Carpenter had characterised hydraulic machinery as indispensable to gas works; the same claim might be made for electric apparatus. Like Mr. Hack, he did not understand how the adoption of stoking machines could raise the capacity of the retorts. He had, on the contrary, found a diminution; but the stoking saved half the labour and therefore money. That applied to inclined retorts too; their life was not shorter than that of ordinary retorts; he was satisfied with 1000 days, however. The erection of inclined retorts was a very important matter, as he knew from experience on the Continent. The creeping of the coal had been referred to; he had never heard any complaints in that respect, although the new works about which he could speak used all sorts of Durham coal. The coal was generally very fine, however, because it arrived in that state in foreign ports.

Mr. A. F. Wilson, who spoke next, was pleased to hear of the success of inclined retorts, because he had taken a patent on such retorts twenty-four years ago. That patent had come before the Courts in a recent litigation of angle of pose. He did not see why the yield of gas should be inferior in inclined retorts; for in the horizontal retorts the gas also passed over heated coke; he could not speak from experience, however.

Mr. Carpenter had nothing to modify in answering his critics. The life of the hand-worked retorts stated was the actual figure, 2400 days of 24 hours, based on observations made in the retort-house, at Vauxhall, which was pulled down this year; it was no doubt a very high average. The two or three shifts had entered into this paper because they represented the working conditions of the respective works; the men at the 144 inclined retorts at Bankside were not on three shifts. The smaller yield in gas seemed established, but much depended upon the condition of the coal; some coal would not do at all. There was no doubt, however, that the coke handling was much more economical with inclined retorts. In reply to Mr. Hack, he stated that the coal-breaking expenses were not included in any of his figures; the hydraulic plant was already at disposal. In the old works of the company conveyors would certainly have been out of place.

In summing up the discussion on this valuable paper, Mr. H. E. Jones remarked that the reputation of the South Metropolitan Company was firmly established, but the Wandsworth Company now produced gas at equally low costs. He added a few plain facts from experience. It was not much good to calculate the coal saving on 300 days, when the season meant 200 or 180 days. The saving of sixpence mentioned by Mr. Hack would, perhaps, not outweigh the capital buried. Conveyors and fixed elevators were limited in their utility; accidental advantages of position counted for nothing, as one could frequently observe. His own experience confirmed the pretty generally expressed opinion concerning the loss of gas and of illuminating power in inclined retorts. A vote of thanks to the authors of the two papers concluded the proceedings of this section, with which we end our report on this year's Engineering Conference.

THE WESTINGHOUSE ELECTRIC WORKS AT PITTSBURG.

(*Continued from page* 732.)

IN some instances, in the United States, electric power for street railroads is not generated locally, but is obtained from a distant power plant. One of the most notable instances of this nature is the transmission of electric current from the Niagara Falls Power House to the City of Buffalo, 26 miles distant, where it is applied to the street railway service, to lighting, and to manufacturing purposes. At Niagara there are eight Westinghouse generators in operation. They were specially designed for the Niagara installation. They are direct-connected to turbines, and each generator has a capacity of 5000 horse-power.

The prevailing tendency is to utilise Nature's forces for mechanical energy in operating generators. The mighty power of the Niagara Falls having been successfully harnessed to man's service, similar enterprises have been undertaken in various parts of the American Continent. Prominent among those who have aided in these important works, the name of Westinghouse stands *facile princeps*. Improved materials, and larger apparatus more perfect in detail, have marked a substantial advance in engineering projects. So many great undertakings have been carried to a successful issue by the Westinghouse Company, that whenever any new project of great difficulty is proposed, their aid and advice are sought by the projectors.

The electric railroad industry has had a remarkable development within a very short period. The first commercial road was installed in Richmond, Va., in 1888. Since that date the present network of 15,500 miles of electric roads has sprung into existence in the United States; these roads use 33,500 motor cars. The illustrations which accompany this article (see pages 804 and 805) show a few types of different power installations.

One of the model railway power installations in the United States is that of the South Side Elevated Railroad Company of Chicago. The electricity employed on the lines of this company is obtained entirely from Westinghouse standard generators, of which there are four, each being of 800-kilowatt capacity, and each direct-connected to a 1200 horse-power compound Allis engine. Fig. 34 gives a good idea of the power station and group of four generators, and Fig. 35 shows one separate and the engine to which it is connected.

At the main station of the Union Traction Company, Philadelphia (see page 735 *ante*) are four Westinghouse 1500-kilowatt "engine-type" generators (Fig. 36), direct-connected to engines running at 80 revolutions per minute at full load. Each generator carries 2730 amperes at 550 volts, but is capable of carrying an overload up to 4000 amperes. The approximate weight of each generator is 100 tons, and the height above bedplate 17 ft. $5\frac{3}{4}$ in.

In the other power stations of the same company there are two Westinghouse generators of 1500 kilowatts each, three of 500 horse-power each, Westinghouse four-pole "Kodak-type," also five of 750 horse-power Westinghouse "engine-type." Practically, the entire distribution system is carried underground, there being only a few short sections in the outlying districts where the feeder wires are on poles. Nearly a thousand miles of lead-covered insulated cable are carried in the company's conduits.

Fig. 37 shows a Westinghouse engine generator with a rated capacity of 400 kilowatts direct-connected to a 650 horse-power gas engine. This is the Westinghouse engine which is already famous as the largest gas engine in the world. The generator, although rated at 400 kilowatts, is capable of carrying 30 per cent. overload. It runs at 150 revolutions and 550 volts. It is, indeed, a remarkable fact that a railway generator can be direct-connected to a gas engine and produce perfectly satisfactory results. But this is what takes place in the Westinghouse electric works at Pittsburg, where the engine and generator shown in Fig. 37 are used not only for supplying current to the line of railway on which the Westinghouse experiments are worked out, but also on the lines of rail which extend through the shops and yards for the convenience of loading and unloading freights. The Laconia-street Railroad Company, of New Hampshire, is, by the way, about to adopt Westinghouse gas engines for driving the electric generators in its power-house.

An electric railway, which presents some unique features as a model inter-urban road, is that running between Detroit, Ypsilanti, and Ann Arbor, in the State of Michigan. It passes through several thriving towns. The road, a little over forty miles in length, was entirely equipped by the Westinghouse Company. The electric current is supplied from two power-houses, about twenty miles apart, each station delivering power for ten miles on either side. The generating plant in each station consists of two 450 horse-power Westinghouse compound engines, direct-connected by means of flexible spring couplings, to 225-kilowatt Westinghouse railway generators. The current to the distant portions of the line is conducted through feeders, in which there is normally a very considerable drop in pressure at the time of maximum load. To compensate for this, the feeders are equipped with Westinghouse apparatus, by which the voltage to the feeder circuit is increased in proportion to the increase of load, thus insuring a practically constant pressure at the trolley line. This method was far more economical than increasing the weight of copper-wire conductors. The service of this road, having a comparatively small number of heavy cars to be run at a high speed, necessitates a widely fluctuating load upon the stationary automatic engines. Roney automatic stokers, mechanical draught, and other devices of Westinghouse make, were introduced in connection with the boilers and engines, to effect economies under these varying conditions, the result having proved very successful.

(To be continued.)

MESSRS. SCHNEIDER AND CO.'S WORKS AT CREUSOT.—No. LIX.

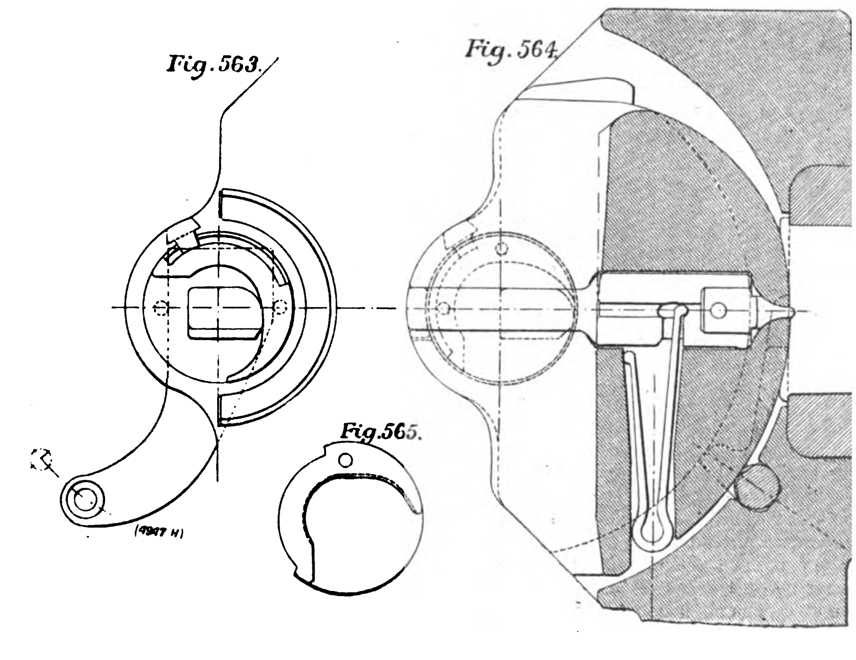
QUICK-FIRING GUNS—(*concluded*).

Concentric Threaded Breech-Blocks.—In a distinctive class of breech mechanism adapted to the Schneider-Canet quick-firing guns, the block is made with concentric threads. A series of this type has now to be noticed.

The main feature of this new type consists in the adaptation to the gun of a block with a spherically-shaped face, the two sides having parallel plane surfaces, with the rear hollowed out. The block thus formed fits in a suitable socket cut in the rear of the gun. By this arrangement it will be seen that a rotary motion opens or closes the bore by a single action; in this respect the arrangement fulfils in the simplest manner the conditions required of breech mechanism. The displacement of the breech-block is effected round a centre line, which may be set at any desired angle. A series of concentric threads, of equal section, cut in the breech-block cheeks, fit into corresponding grooves made in the seating, and insure the close connection of the breech-block with the gun in the various positions the former is required to take. Figs. 547 and 548 show the principle of this class of breech-blocks, page 808.

Besides the principal characteristic of this type there are special points connected with the particular arrangements adopted for its manipulation, firing, &c. We shall review in the following descriptions the various types that have been put into service, those for small and medium-calibre guns and those for large guns, first giving a description of the Schneider-Canet spherical breech-block, from which the concentric-threaded type has been evolved.

Schneider-Canet Spherical Breech-Block for Quick-Firing Guns (Figs. 549 to 551).—This type consists of a complete sphere made to turn in a spherical seat in the enlarged rear of the gun. It is held in position by a screwed ring at the back of the block and the arrangement is completed by special mechanism for firing and extraction. In the centre of the sphere a hole is drilled, of the same diameter as the bore of the gun, so that the charge can be easily introduced. When the breech is open, the bore in the sphere corresponds exactly with that of the gun, while to close the breech it is sufficient to turn the block through 90 deg., that is to say, in a vertical position (see Fig. 549).



The device consists mainly of the following parts: (*a*) The breech-block, with threaded ring in the rear; (*b*, *b*) The working lever, in which part of the firing mechanism is fitted; (*c*) The extractor.

The ring, which bears against the back of the block, is of hardened steel, and is screwed into the rear end of the gun, the threads on the ring being either continuous or interrupted, as in ordinary breech-blocks. The spherical block is maintained in position by the smaller arm of the working lever, which contains a cylindrical extension forming a trunnion. When the lever is fitted in the breech-block, the latter can only turn round the axis of this trunnion, the rotary travel being limited by a stop provided in the swell of the gun, and by the smaller branch of the extractor, which the block meets when the opening motion is complete. The working lever is the only mechanism visible when the breech is fitted up ready for service, either when the breech is open or closed (see Figs. 547 and 548).

Firing is obtained by a striker that acts direct on the fuse; it is worked by a two-armed lever that oscillates in the body of the spherical block. One of the arms of this lever is governed by a hammer and a spring fitted in a cylinder placed in the centre line of the smaller arm of the working lever which is grooved out to receive it. When the hammer is drawn back, the firing spring is pressed down by a cam trigger of the same type as that described for the one-motion breech-blocks for 6-in. quick-firing guns. The trigger is fitted completely in the thickness of the working lever. To cause the fuse to act, it is sufficient to pull, by means of the firing line, on the lever fitted with the cam, until the latter escapes the corresponding tooth fitted to the hammer; when the hammer is freed, it returns with a shock and acts on the two-armed lever that drives the striker against the fuse.

The extractor consists of a round h
guided in a groove cut in the bore, a
are jointed two clutches that act on t
case flange. The case is ejected wh
zontal rod is driven forward by the sp
as the opening action is completed;
works as a lever, and the clutches are
wards and draw out the case, the extra
its position on the introduction of a fr
case. Its operation is insured by a st
the head of a spring fitted in the thi
block, and which comes in contact w
zontal rod, thus shifting it when
motion is completed and clearing it
afterwards. To prevent accidental o
breech, the working lever is provided
able handle fitted with a spring,
continuation of which is a lateral
the breech is closed and the gunner
handle the catch is driven into a pro
gun, and the breech-block is thus hel
Until the breech is completely close
which moves with the spherical b
opposite the fuse, so that all acci
is rendered impossible; in additio
ing lever is fitted with a second
holds the trigger cam fast during t
opening, releasing it only when t
completely locked. To open the breec
presses on the working lever handle
the catch, and turns the lever thro
backward in one action. When a fr
case is introduced the extractor is br
its normal position, and to close the
sufficient to turn the working lever for
90 deg. If the cartridge-case has not
quite home by hand it is driven int
position by the spherical block owing
inclined planes with which the latter is
the purpose.

Concentric-Threaded Breech-Blocks f
Medium-Calibre Guns (Figs. 552 to 55
breech-block of this type designed a
tured by Messrs. Schneider and Co. w
75-millimetre (2.952-in.) quick-firing g
readily be seen, this arrangement is a
velopment of the spherical block ju
The working lever for opening and
breech is on the right-hand side of the
joined to the breech-block by a se
arm forming a trunnion that rests in
similar section cut in the rear of th
lever is provided with a movable
with a projection which, when th
closed, engages in a recess cut in the
the metal at the breech end of the gun
spring presses the projection to the
socket, and fixes the block when t
closed.

The firing device consists of three
closed within the breech-block (see Fi
catch, formed of a working arm and
together by a round pin, acts on the m
fitted to the striker and on the smalle

MESSRS. SCHNEIDER AND CO.'S WORKS AT CREUSOT.—No. XLVIII.

EARLIER TYPES OF NAVAL GUNS.

WE have seen that the manufacture of ordnance was recommenced at Creusot, after an interval of three-quarters of a century—about 1870—and that five years after it had passed from an experimental stage to a departmental industry. The guns made at that comparatively recent period—and, indeed, during the ten years following—belong to types not, indeed, obsolete to-day, but antiquated, and not adapted to the conditions of modern warfare. The wonderful display of naval and other guns made by Mr. Canet at the Paris Exhibition of 1889 was one of the first, and certainly the best, illustrations of the great change in gun design and construction that had been inaugurated four or five years before, and which has been continued on the same lines since that time.

The most important result has been the development of the quick-firing gun, which, at first made only of small calibres, has been now increased to the rank of an armour-piercing weapon, and occupies a first place in naval armament. With this change came the necessity for longer range and flatter trajectory of projectile—demands that could be met only by modifications in design and greatly increased length of bore, together with the use of a more suitable explosive than the black or brown powders in all their great varieties. The modern naval gun is therefore a very different weapon to-day to that of fifteen years ago, and we shall in due course give examples of the different types made by Messrs. Schneider and Co. on the most recent lines. But it will be convenient first to describe briefly

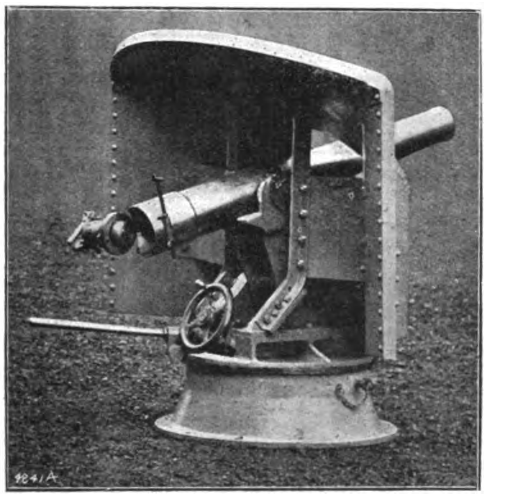


FIG. 430. 75-MILLIMETRE GUN AND BOAT CARRIAGE.

some of the more important earlier types, which are still being manufactured by Messrs. Schneider to fill orders they receive from various Governments who continue to use such guns, either for the sake of economy or to maintain uniformity in their armament. These descriptions and illustrations will indicate to a large extent the progress made in the construction of naval guns, not of quick-firing natures.

The charges for naval guns of the earlier kinds were of black or brown powder and of the various qualities to be described hereafter; projectiles of all the different types may be fired from them. The projectiles fired from such guns consisted generally of the following classes:

Steel armour-piercing shell.
Cast-iron common shell.
Shrapnel.

Steel shrapnel were not usually included, but for attacking batteries in action, shells containing cast-iron rings or shot, were used. The guns were generally fired with 9 millimetres (.354 in.) percussion tubes.

75-MILLIMETRE (2.952-IN.) GUN, ON BOAT MOUNTING. TYPE 1886. (FIG. 430.)

Guns of this type have been delivered to the Portuguese Government for the gunboats Cacongo and Massabi.

Weight of gun	100 kilogs.	(220 lb.)
„ mounting ...	400 „	(880 „)
„ shield	110 „	(242 „)
„ projectile ...	4.6 „	(10.2 „)
Weight of charge (black powder)	.45 kilogs.	(.99 lb.)
Muzzle velocity	260 m.	(853 ft.)
Firing pressure	990 kilogs.	(5.8 tons per sq. in.)

The breech mechanism consists of the breech-piece, the obturator, and the striker.

The breech-block is made with an interrupted screw, having three threaded parts and three interruptions; it is carried by a hinged cover. The obturation consists of a plastic ring placed between the movable head of the breech-block and the front end of the breech-screw. The gun is fired by a percussion bolt, the striker acting only when the breech is completely closed, so that danger of premature fire is entirely done away with. The breech is opened or closed by means of a lever fitted with a cam; when the gun is ready for firing the cam enters a mortice so as to prevent all accidental opening of the breech-piece. The mounting consists of a bolster, a traversing platform, and a gun-carrying frame. The bolster carries the roller path, and is fixed to the ship's deck. The traversing platform is fitted to the bolster, and rests on the roller path. The frame consists of two cheeks which carry the gun and pivot round a centre on the platform; on these cheeks are fixed the recoil brake and the cylinder-rod for replacing the gun in position.

The gun is elevated by means of a handwheel, the movement of which raises and lowers the carriage. The training of the gun is effected by means of a lever, by raising which the action of the brake friction slide on the edge of the bolster is momentarily stopped. The gunner can then move this lever in the direction in which he wants to train the gun. The hydraulic brake consists of a cylinder, with piston and spring recuperator. When the gun recoils, the frame in pivoting round its centre displaces the piston in the cylinder, and causes compression of the springs. When the recoil is spent the springs relax and relay the gun. The liquid in the brake cylinder flows slowly through small openings in the piston, and moderates the speed at which the gun is automatically relaid.

10-CENTIMETRE (3.937-IN.) GUN. TYPE 1892. (FIGS. 431 AND 432, PAGE 376.)

Guns of this type have been supplied to the Haytian Government for arming the gunboats Petion and Capois la Mort.

Weight of gun	1430 kilogs.	(3146 lb.)
„ mounting ...	1591 „	(3500 „)
„ shield	475 „	(1045 „)
„ projectile (armour piercing shell)	12.5 „	(27.5 „)
Weight of charge (prismatic brown powder)	5.8 „	(12.76 „)
Muzzle velocity	520 m.	(1705 ft.)
Angles of elevation	25 deg. — 10 deg.	

The breech-block of this gun is cylindrical, with three threaded sectors; it is worked by means of a lever, the head of which acts as a cam and prevents any accidental opening of the breech-piece after the charge is inserted. The breech-block is carried by a bracket, that turns round a vertical bolt attached to the back of the gun.

Obturation is insured by a plastic ring placed between the front end of the screw and the movable head.

The gun is fired by means of a percussion bolt that moves between two slides on opening the breech, thus immediately closing the vent. The percussion tube can only be inserted and the trigger worked when the breech is completely closed.

The central pivot mounting consists of three main parts—the bolster, the slide, and the gun-carriage. The bolster is fixed to the deck, and is fitted with a roller path and central pivot; the slide rests on the roller path, and consists of two cheeks provided with cross-stays; it comprises also a plate disc into which is fitted the bolster pivot; the gun-carriage is made movable in the inclined planes of the slide, and is fitted with the trunnion plate, the front stay carrying the pivots of the recoil piston-rod crosshead.

For elevating, a handwheel is provided, which works a toothed sector fixed to the gun by means of a helicoidal screw and pinion.

The gun is trained by means of a pinion gearing in the toothed ring that surrounds the bolster. The pinion itself is worked by a helicoidal wheel upon which acts a plate chain set in motion by a crank.

The recoil cylinder placed between the cheeks of the slide, is fixed; the piston is worked by the action of the recoil, and the liquid in the cylinder passes through lateral ports and an annular space between the edges of the piston and central rod. The sections of this rod are made to vary, so as to maintain a practically uniform pressure in the cylinder. Buffers regulate the travel of the gun-carriage during its automatic return.

12-CENTIMETRE (4.724-IN.) GUN. TYPE 1885. (FIG. 433, PAGE 376.)

Guns of this type have been supplied to the Haytian Government for armament of the despatch boat Toussaint Louverture.

Weight of gun	2000 kilogs.	(4400 lb.)
Weight of mounting ...	3500 „	(7700 „)
„ projectile (armour piercing shell)	21 „	(46.2 „)
Weight of charge (black powder)	8.4 „	(18.5 „)
Muzzle velocity	565 m.	(1853 ft.)
Pressure	2400 kilogs.	(15.24 tons per sq. in.)
Angles of elevation	28 deg.—10 deg.	

The breech-block is cylindrical with interrupted screw threads, and slides to and fro in guides at the rear of the gun. The opening and closing mechanism is operated by a lever and cam, and a safety device prevents accidental opening of the breech. A plastic obturator is placed between the front end of the breech-block and the movable head. The firing mechanism comprises a percussion bolt, the striker of which can only act on the percussion tube when the breech is completely closed.

The mounting of this gun consists of three main parts, the bolster, the slide, and the gun-carriage proper. On the bolster are attached the roller path and the central pivot, around which the slide turns, on conical rollers. The carriage is fitted with recoil cylinders and elevating gear, and it rests on the inclined slides of the frame, guide-blocks being introduced as indicated in the illustration.

A pinion gearing with the toothed sector fixed to the gun, regulates the elevating movement; this pinion is worked by a helicoidal screw from a handwheel. The gun is trained by means of a pinion and toothed ring attached to the bolster, the pinion being actuated by a handwheel, a system of gearing, and a chain and helicoidal screw.

The hydraulic recoil cylinders, which form part of the gun-carriage, are provided with rods fixed to the front of the slide. They are in communication with each other by means of two pipes.

12-CENTIMETRE (4.724-IN.) GUN. TYPE 1890. (FIGS. 435 AND 436, PAGE 377.)

Guns of this type have been delivered to the Mexican Government for the armament of the training ship Zaragoza; they have included two series, of different lengths, as shown below:

	26 Calibres Long.	43 Calibres Long.
Weight of gun	2888 kilogs. (6353 lb.)	3428 kilogs. (7541 lb.)
„ mounting ...	2290 kilogs. (5038 lb.)	2290 kilogs. (5038 lb.)
„ shield	625 kilogs. (1375 lb.)	625 kilogs. (1375 lb.)
„ projectile (armour piercing shell)	21 kilogs. (46.2 lb.)	21 kilogs. (46.2 lb.)
Weight of charge (prismatic brown powder)	12 kilogs. (26.4 lb.)	12 kilogs. (26.4 lb.)
Pressure	2400 kilogs. (15.24 tons per sq. in.)	2400 kilogs.
Muzzle velocity	660 m. (2165 ft.)	710 m. (2329 ft.)
Angles of elevation	25 deg. —8 deg.	22 deg. — 8 deg.

The breech mechanism is the same for both guns; it consists of the breech-block with interrupted screw, carried by a slide bracket with pivots on a vertical hinge at the back of the gun. The block is operated by a lever provided with a cam that enters a mortice only when the breech is completely closed, thus acting as a safety block. This cam serves also, in case of need, to disengage the obturator from the walls of the gun chamber, when the lever is brought down after having disengaged the threads of the breech-screw.

The obturator consists of a special-shaped plastic disc placed between the movable ring and the front end of the breech-screw. A bolt contains the

MESSRS. SCHNEIDER AND CO.; TYPES OF EARLY GUNS.

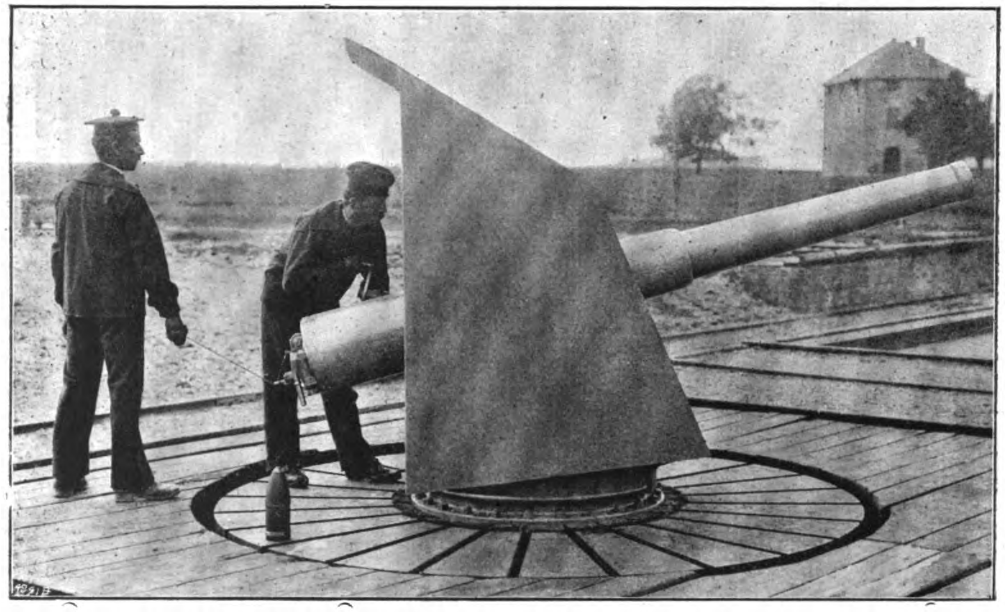


Fig. 431. 10-Centimetre Gun, Mounting and Shield; Side View; Model, 1892.

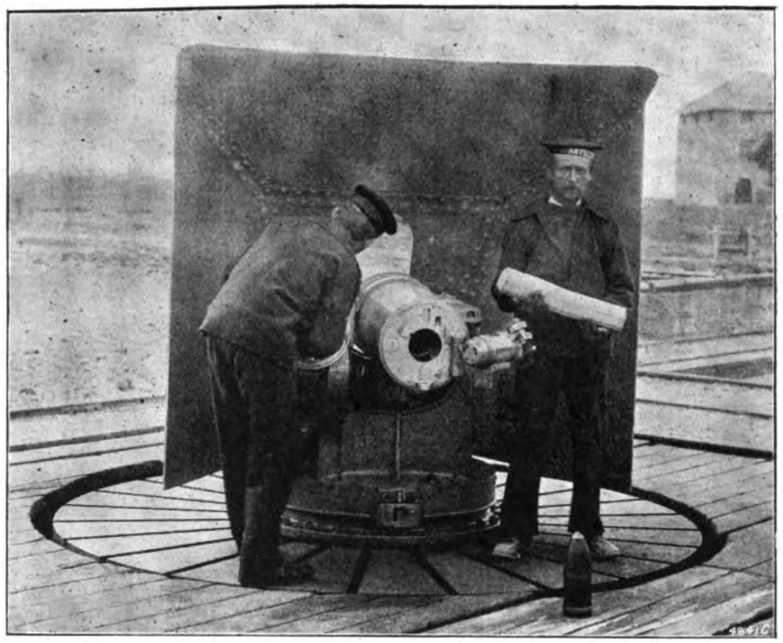


Fig. 432. 10-Centimetre Gun, Mounting and Shield; End View.

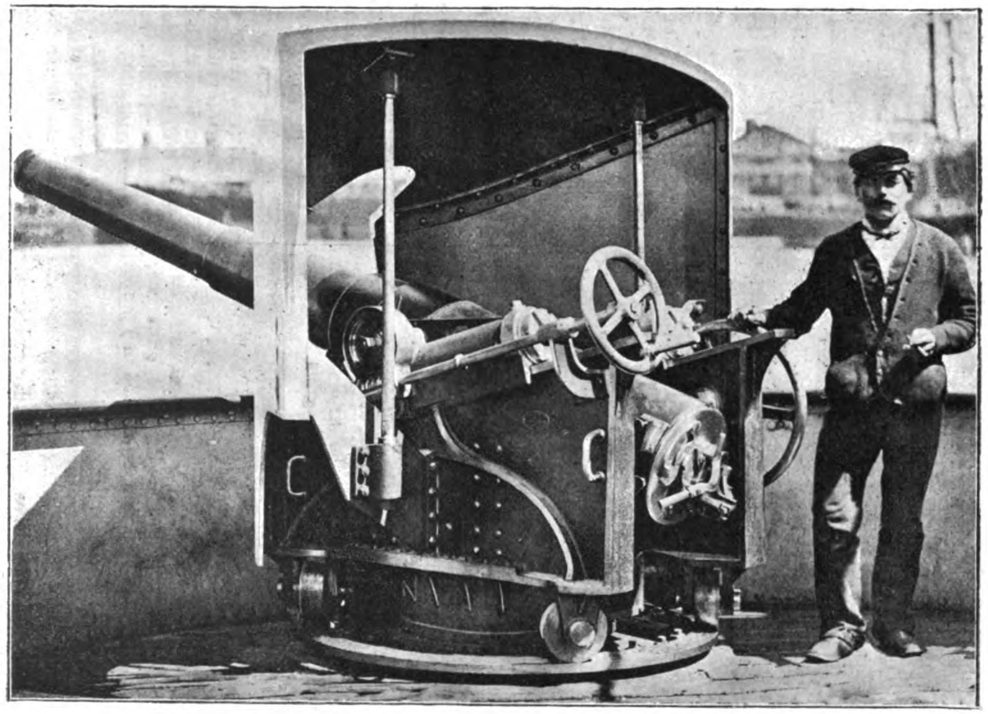


Fig. 433. 12-Centimetre Gun and Mounting; Model, 1885.

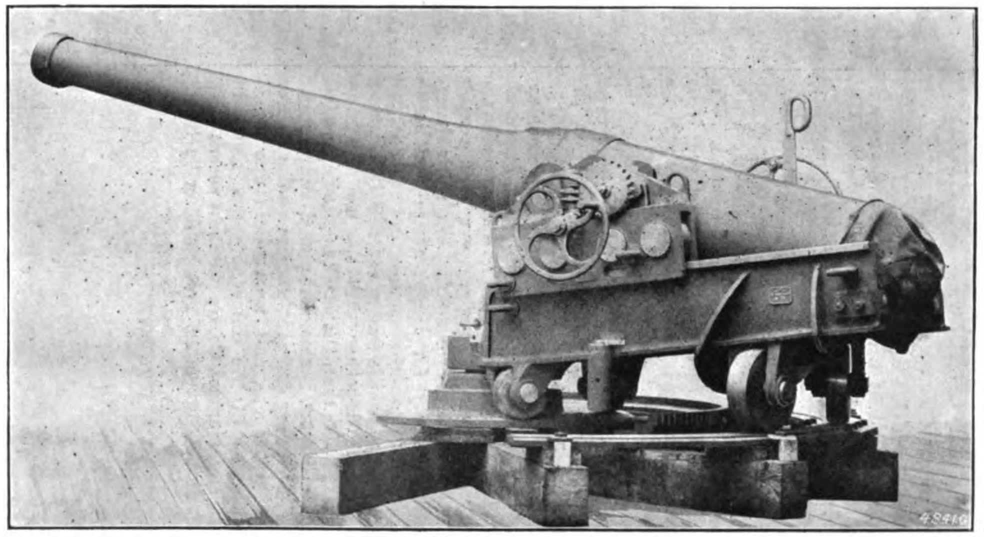


Fig. 434. 138.6-Millimetre Gun and Muzzle Pivot Mounting.

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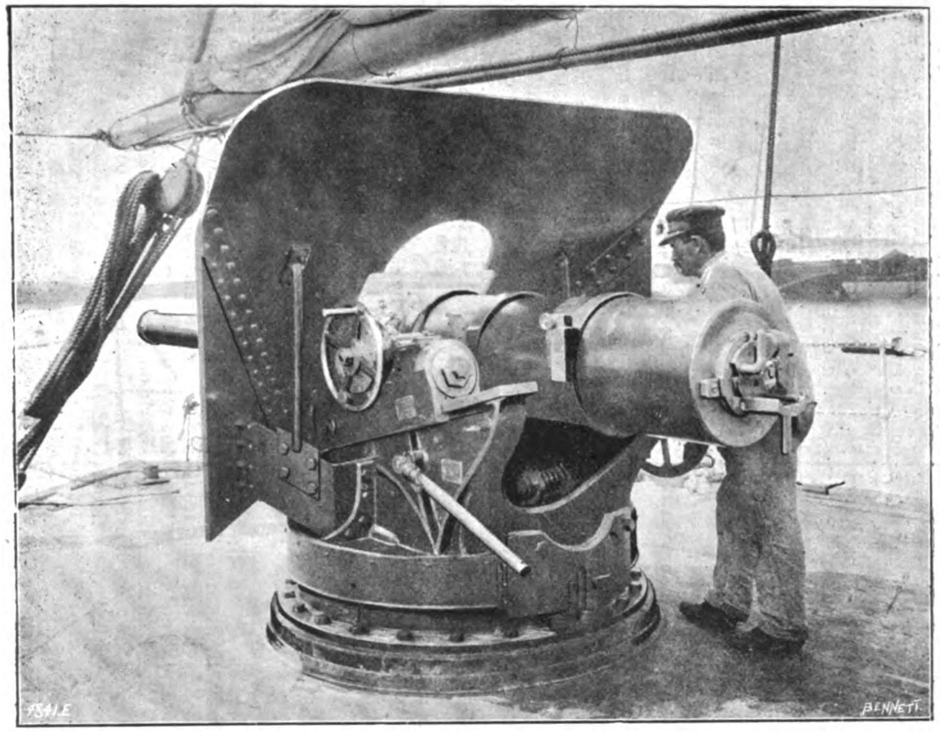


Fig. 435. 12-Centimetre Gun and Mounting (26 Calibre); Model, 1890.

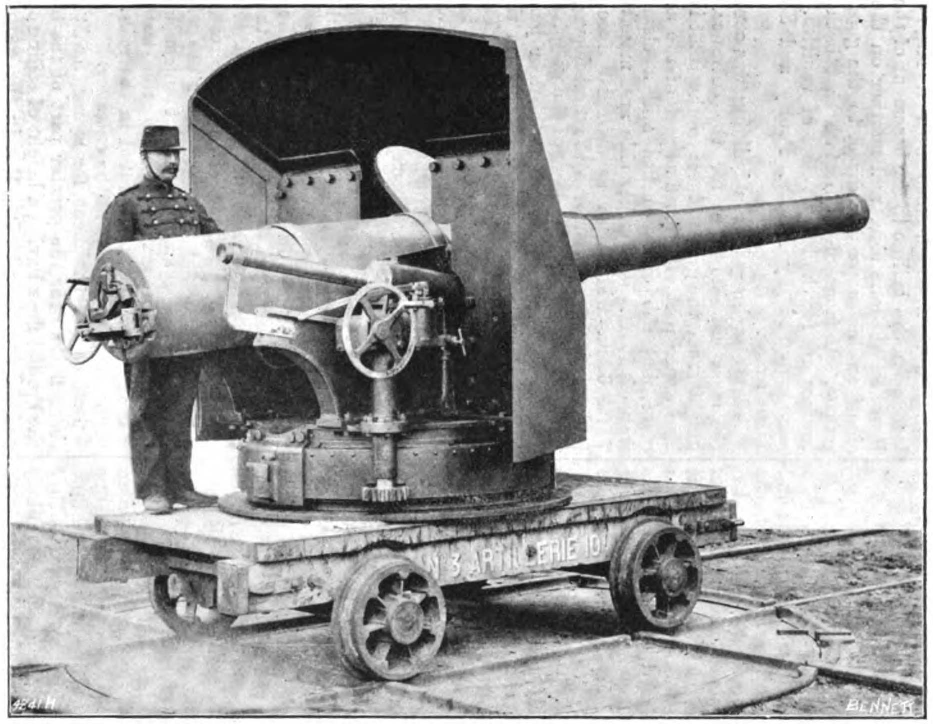


Fig. 437. 14-Centimetre Gun and Central Pivot Mounting.

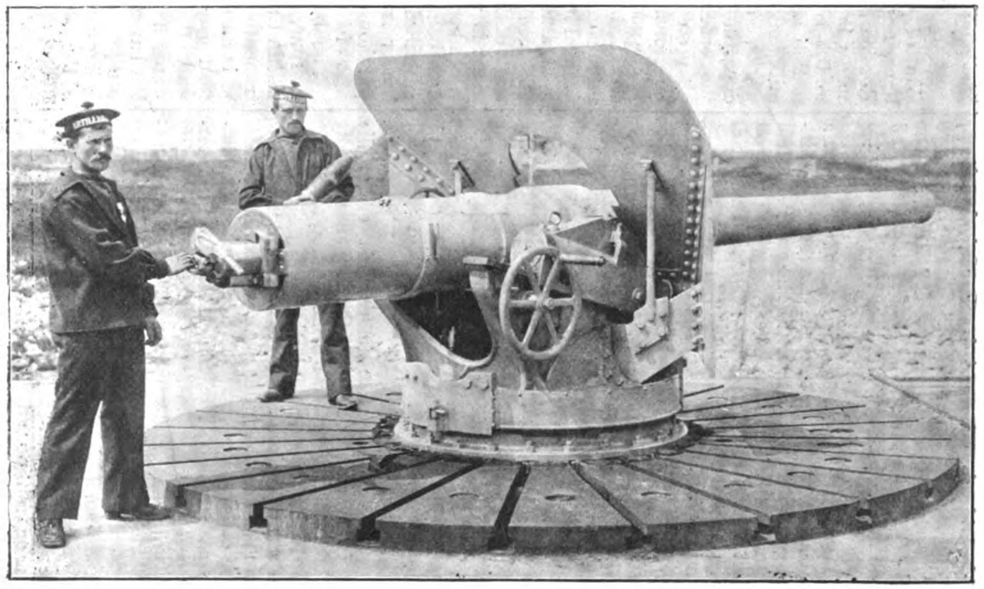


Fig. 436. 12-Centimetre Gun and Mounting (43 Calibre); Model, 1890.

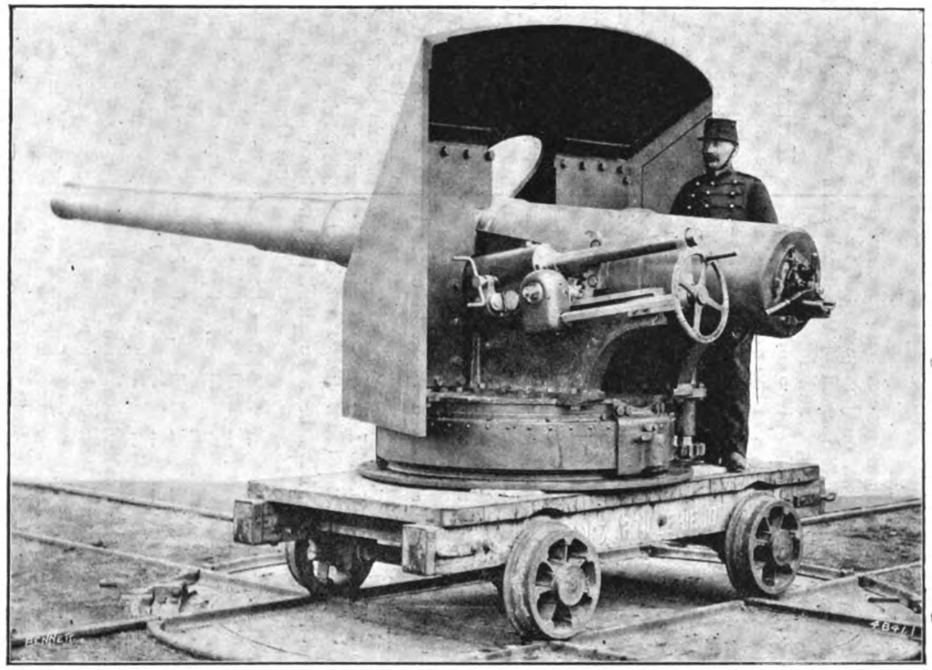


Fig. 438. 14-Centimetre Gun and Central Pivot Mounting.

firing device, which works by percussion. The vent remains closed as long as the breech is not locked, thus preventing premature firing as the percussion tube cannot be placed in the vent until the closing of the breech is complete. The striker is worked by a trigger and a line.

The central pivot mounting consists of a circular bolster fixed to the deck, on the top part of which is the roller path; a slide formed of two brackets is connected by cross-stays, and forms a central platform that surrounds the pivot and bolster; the gun-carriage proper consists of the usual slides and two recoil cylinders that communicate with each other through a pipe and slide on the brackets.

To elevate the gun, a differential device, worked by a handwheel, is provided; it acts through a friction cone on a pinion that gears in a toothed sector fitted to the left of the gun. The gun is trained by another handwheel and a pinion which gears in a circular rack fitted to the bolster.

The recoil cylinders are of the Schneider-Canet type, with central counter-rods. Both the pistons and rods remain fixed during recoil. Each piston is provided with valves that remain open only under the action of the recoil on the liquid contained in the cylinders. Automatic return of the gun takes place with reduced speed in order to reduce shocks.

138.6-MILLIMETRE (5.456-IN.) GUN ON MUZZLE-PIVOTING MOUNTING. (FIG. 434, PAGE 376.)

Guns of this type have been supplied to the French Navy.

Weight of gun	3250 kilogs.	(7150 lb.)
,, mounting ...	2870 ,,	(6314 ,,)
,, projectile ...	30 ,,	(66 ,,)
,, charge (prismatic brown powder)	12.3 ,,	(27 ,,)
Muzzle velocity	590 m.	(1935 ft.)
Angles of elevation	28 deg. – 12 deg.	

The breech-screw is cylindrical with interrupted thread, and slides in a bracket which turns round a vertical hinge; it is worked by a jointed lever. A plastic obturator is placed between the bulb of the movable head and the front end of the screw. The striker can only act when the breech is completely closed.

The mounting consists of the bolster, the slide, and the carriage. To the bolster are connected the muzzle pivot, and concentric roller paths bolted to the deck. The inclined slide is formed of two parallel guide beams carried on conical rollers, which run on the roller paths. The gun-carriage proper rests, through cylindrical rollers, on the inclined girders of the slide. Under these is placed the hydraulic recoil cylinder that checks the recoil of the system.

A pinion with helical gearing that works on a toothed sector, fitted to the gun, serves for obtaining the required elevation, while the gun is trained by a handwheel and toothed gearing which acts on a circular rack fitted to the bolster. The recoil cylinder is on the hydraulic system, with constant volume and loaded valves. The force of the recoil is utilised to bring the gun back into battery.

14-CENTIMETRE (5.511-IN.) GUN ON CENTRAL PIVOTING MOUNTING. (FIGS. 437 AND 438, PAGE 377.)

Guns of this type have been supplied to the Spanish Navy:

Weight of gun	4200 kilogs.	(9240 lb.)
,, mounting ...	3680 ,,	(3680 ,,)
,, shield	1870 ,,	(4111 ,,)
,, projectile ...	40 ,,	(88 ,,)
,, charge (prismatic brown powder)	20 ,,	(44 ,,)
Muzzle velocity	630 m.	(2066 ft.)
Angles of elevation	25 deg. – 10 deg.	

The breech-closing mechanism is essentially similar in its various parts to that of guns already described, and the systems of obturation and firing are also similar.

The mounting consists of a bolster fixed to the deck and the usual roller path; an inclined slide, formed of two brackets bolted on a circular platform, rests on the bolster, conical rollers being interposed and clips preventing the slides from being displaced. The gun-carriage with two brake cylinders runs freely under the action of recoil on two sets of cylindrical rollers up the two inclined planes of the slide.

For elevating the gun, a handwheel operates a pinion that gears into a toothed sector fitted to the gun. For training, another handwheel is provided that works a pinion acting on a circular rack around the bolster.

The recoil cylinder is hydraulic with constant volume; the piston-rods are fixed to the front of the slide, and are supported at the back by angle-shaped standards. When the recoil has ceased, the gun returns automatically into position by its own weight.

GREAT CENTRAL RAILWAY.

(*Continued from page* 341.)

HAVING completed our series of illustrations and the description of the passenger station at the London terminus, we turn now to the provision made for goods and minerals at Marylebone, and it may be said at the outset that the present arrangements suggest that the company anticipate a much more extensive traffic in these departments than in passengers, while the engineering features are quite as interesting, and in some respects more novel.

The extent of the goods station will be appreciated when it is stated that the area of ground embraced in the various departments is 36 acres, and the length of railway in sidings, warehouse, dépôts, &c., exceeds 10 miles. This is not after all surprising, for the ratio of goods receipts to the total revenue of the Great Central is only a trifle less than three-fourths, and their later returns show that they have dealt with minerals and with goods which have brought a revenue of 902,664*l*. per annum. Much of this traffic, as we have already explained, was for transit to London and the south, and the company have now laid themselves out not only for retaining, but for considerably developing this traffic, while at the same time offering substantial inducements in the way of comforts to passengers.

Within the area of 36 acres given over for dealing with goods and mineral traffic, there are the following departments: A three-storey building, admirably arranged for the management and clerical staff; a goods warehouse with a total floor area of 11½ acres, surrounded by a yard with a light roof; an open yard for goods not likely to be affected by weather, supplied by an electric goliath crane to lift 25 tons and several jib cranes; an extensive coal yard; a wharf arranged for the transhipment of goods to and from barges on the Regent's Canal, with an interesting umbrella roof, and a 30-ton hydraulic gantry crane; and close by a well-equipped hydraulic and electric power station.

These departments are situated on the east side of Grove-road and west of the passenger lines, and are bounded on the south by the new Rossmore-road—from which and from Grove-road access is provided—while they stretch northwards to the canal. On the east side of the passenger station again there are the special sidings for the milk and fish traffic, with a carriage shed, oil gas works, and other accessories. These several departments we shall describe pretty much in the order mentioned. A glance at the general plan on page 168 *ante* will show their relative positions.

The goods offices are conveniently situated, and extend 226 ft. along Grove-road and 176 ft. up Rossmore road, the plan being in the form of an L, the vertical line forming the north wing along Grove-road, and the horizontal the eastern portion. The entrance to the goods yard is constructed at the angle of the building: the advantage of this arrangement is self-evident. It is very ample, too, the width being 40 ft. and the headroom 17 ft., the first floor being continued over the gateway, as will be described later. From this entrance also direct access is provided to the basement of the goods warehouse, which occupies a central position to the east of the offices.

The basement just mentioned has an extensive area, exceeding that of Trafalgar-square, within the balustrade, and the provision of an entrance to this floor involved an interesting problem, which has been admirably solved. From the Grove-road gateway, and immediately within the front wall of the goods yard, there extends to the eastwards a decline on a gradient of 1 in 28 right into the basement. This ramp takes the place of part of the ground floor of the building, the upper floors being carried on girders, while in the front wall of the building and in the boundary wall beyond, light and ventilation is provided. The great width of the entrance, and the fact that it is at an angle to the line of the main building and of this inclined access, makes it easy for vehicles to curve inwards to this passage. The nett width of the incline is 27 ft., while the building is 50 ft. deep, so that there are various offices between the incline and the back wall of the building. That nearest the entrance is a weigh-office with a large weigh-bridge on the incline to the basement of the warehouse on the one side, and another on the other side for vehicles passing direct to the goods yard proper. It is needless to state that both weigh-bridges are for the largest class of vehicles. They were supplied by Messrs. Pooley and Sons, of Manchester.

A large archway in the building was considered the most suitable form for the entrance. The height from the ground level to the soffit is 38 ft. The upper part is utilised as part of the accounts office, but the entrance has still a clear head-way of 17 ft. On either side are massive piers 7 ft. 6 in. wide with semicircular face, developing into hexagons above the first-floor girders. These girders, 4 ft. 6 in. deep, of the webplate type, carry the cross walls as well as the floor joists over the entrance, and several of these form the floor over the inclined way to the basement. The front of the arch above the first-floor girders is neatly framed and utilised as windows for the offices situated on this part of the first floor.

A somewhat novel feature is the way this entrance is closed. The difficulties in the way of swing or rolling gates with 40-ft. width need only be indicated. A satisfactory solution was found in the adoption of a curvilinear steel lath revolving shutter divided into two widths with a movable pilaster in the middle, so that the whole of the opening is clear for traffic. Another matter of minor importance, but of some interest, is that instead of a wicket in the gate for use when the latter is closed, an independent entrance in the wall has been made close to the watchman's "box," which is incorporated in the main pillars supporting the girders at the entrance.

Besides the basement for stores, &c., there are three floors over the greater part of the building, the ground floor having a height of ceiling of 19 ft., and the first floor 20 ft. But in the central part, for the accounts department, there is no second floor, the height being about 30 ft. This department has an area of 8000 square feet, and includes the part over the entrance. The shipping department has a width of 54 ft. by 50 ft., and the delivery department about the same. The only other office which need be mentioned is the carting department, and the mess-rooms for inside and outside employés, with complete culinary establishment. The cloak-rooms, lavatories, &c., for each floor are in a separate wing projecting out from, and connected by, covered passages with the back of the building. In the basement there are installed heating and ventilating appliances for use in connection with hot-water pipes, &c.

As a continuation of the goods offices eastward along Rossmore-road, there is a fine boundary wall extending to the bridge carrying the road over the passenger lines. This wall is 38 ft. in height and is built of red and blue brick. At the eastern end there is a double entrance to the covered goods yard, each opening being 31 ft. in width by 18 ft. 9 in. in height, provided, as in the case of the gate through the goods office to the open yard, with revolving shutters. These shutters were supplied by Messrs. Francis and Co., of Gray's Inn-road, so were also those to the 40-ft. entrance previously described. The jambs of these gateways are formed of massive cast-iron pillars, which serve the double purpose of protecting the brick wall from abrasion by the carts, and of supporting the girder carrying the wall above. These are shown to the right of the elevation on our two-page plate this week (Fig. 183).

The boundary wall is 2 ft. 3 in. thick to a height of 5 ft. above the road level, and then it is panelled out. The wall is pierced with large openings for lighting and ventilating the decline into the basement, and the upper part is built in the form of a series of gable ends to conform to the principals of the roof over the goods yard within. This wall is shown on the plan on page 380, which shows part of the basement floor and part of the ground floor (Figs. 174 and 175). The basement covers the area not only of the immense warehouse, but extends also in the form of a series of arches under the south end of the goods yard, as shown in the sections, Figs. 178 and 179, on page 380. These arches provide a serviceable system of vaults, well ventilated by 6-ft. wide openings on the walls foot. The size of the concrete base in the case of the heavier columns with which we are now dealing is 16 ft. 6 in. square, and the depth of the foundation below the basement level is 6 ft. 6 in. This foundation is shown in Figs. 202 and 203. The concrete is composed of Portland cement, Thames ballast, and broken brick, in the proportion of one of cement to six parts of Thames ballast and broken brick in equal proportions, which forms a solid homogeneous mass. The weight upon the concrete is transmitted from the base of the column itself through the medium of a mass of blue brick set in cement in the form of a truncated pyramid. The weight upon the upper side of the brick, as already stated, is 706 tons, or 15.4 tons per square foot, while the load upon the concrete, due to the combined weight of the brickwork and the column, is equal to 7.13 tons per square foot.

In order to provide for this enormous load, the columns are of very special design, and the detail drawings we reproduce on page 403 will be studied with interest. It is only necessary to direct attention to one or two particular features. The baseplate of each column (Figs. 188 and 189) is of such a character that the load is uniformly distributed throughout its entire area and is not, as is often the case, liable to depression in the centre, owing to weakness at the extremities. It is 6 ft. 9 in. square, composed of seven steel joists 8 in. by 6 in. by 35 lb. per foot by 6 ft. 6 in. long, riveted through both top and bottom flanges to plates ½ in. in thickness. This base distributes the load in a direction transverse to the axis of the warehouse, whilst the load in the longitudinal direction is taken up by the column which is spread out at the foot, as shown by Fig. 189, so as to cover the whole length of the base. As a further means of solidifying the base, the interstices between the joists and the upper and lower plates are filled with strong cement concrete. This also excludes atmospheric action and precludes corrosion of the metal.

The shaft of the column is practically in one continuous piece for its full height of 77 ft. The structure is composed of steel joists and plates strongly riveted together and of diminishing sectional area, as the loads are reduced at each successive floor. The ends of the plates and joists, where they abut, are all machined so as to make perfect joints. A special feature also is that the joint between the upper side of the baseplate and the shaft of the column is machined all over, so that the whole section of the plates and joists are in contact with the upper surface of the baseplate. This insures that the base is perfectly square with the axis of the column. It was contemplated that the columns would be delivered on the site, with the brackets riveted on in one piece, with the exception of the base and the portion above the third-floor level, but this was found impracticable owing to the great length. A joint had consequently to be inserted above the first-floor level, made good later by means of cover plates. As an indication of the attention paid to details, it may be said that since the erection of the columns took many months, provision was made for draining the interior of rain water until such time as it was filled up with fine cement concrete, in the proportion of 7 parts of sand to 1 of Portland cement. Riveting was done, as far as possible, at the makers' works—the Teeside Bridge and Engineering Company, Limited—and by hydraulic pressure, while great care was taken in the case of hand-work done on the site to insure the accuracy of the holes, and that the rivets completely filled them. The method of erecting the columns by sheerlegs and guys is shown in the engraving on page 381 *ante*.

The ground floor girders are arranged in transverse lines which stretch from wall to wall of the building. The ends which abut on the columns rest upon steel brackets riveted thereto, as shown on the cross-section, Fig. 193. The brackets are short in the horizontal direction, but have considerable depth vertically, in order to provide an ample number of rivets to give the necessary shearing area to carry the vertical weight. A space of ⅜ in. is left behind the end of the girder and the face of the column, in view of any slight amount of expansion that may take place and to give a little freedom in erection. The girder ends are then bolted right through the columns, the bolts being tightened up. The ground-floor girders occur only at the columns, and are thus at 24-ft. centres. The space between is bridged by Hobson's system of arched flooring as already incidentally mentioned. The method of attachment is shown in the elevation and plan of a typical ground-floor girder illustrated on page 418, Figs. 198 to 201. The flooring consists of arched plates ⅜ in. thick and T's 6 in. by 4 in. by ½ in., the total depth of the floor over all being 15 in. Each end of the flooring plates and T's rests upon vertical T stiffeners riveted to the webs of the main girders. The flooring is further riveted to the webs of the girders by means of the curved end angles, which make a very rigid and satisfactory connection. This method of flooring, as will be understood from the drawing reproduced, has the advantage of reducing the dead load to a minimum, the shape of the section being such as to displace the solid material usually necessary for bringing the floor to a level surface.

Although the question of watertightness within such a building may appear to be unimportant, it is not really so, for goods wagons come in during wet weather with considerable quantities of water in the tarpaulin covers, which, on being removed, shed the water over the floor. Careful precaution has therefore been taken to make the floor waterproof. This is done by means of ashphalte and concrete in the manner described in our article on the Rossmore-road bridge. The whole of the floor in the railway and cartways in the building is paved with Jarrahdale Jarrah-wood blocks, as shown in the cross-section, Fig. 193. A slight curvature is given to the surface of the blocks to shed the water towards each side, where gutters are provided (Figs. 196 and 197). These gutters are connected by down pipes conveying the water into the drains in the basement.

Fig 202

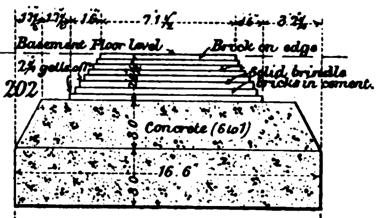
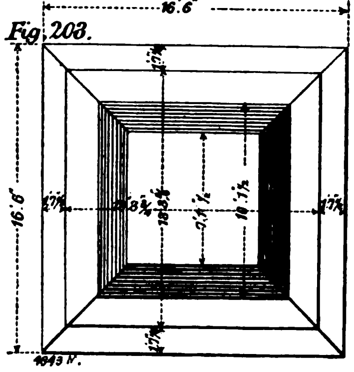


Fig 203.



The platforms are carried upon longitudinal girders resting upon the main transverse girders. There are four to the width of the platforms. They are a plate type, braced together at short intervals, as shown by Fig. 193. The surface of the platforms is of timber, and special provision is made at the edge nearest the cart road to resist the blows of the heavy drays (Fig. 195), and there is also a fender at the foot to prevent contact between the cart wheels and the girders (Fig. 196). On the railway side of the platform a special beechwood coping is fixed to resist the abrasion caused by the fastenings and ironwork of the side doors of the wagons being left in contact with the platform when the wagon is moved about—a not unusual contingency.

The upper storeys of the building—floored with wooden planks—are dealt with in a different manner. Instead of the transverse girders being 24 ft. apart—the distance between the columns—the spacing is 12 ft., intermediate girders being fitted, and to carry these a series of longitudinal girders are introduced along the lines of the columns at right angles to the main transverse girders. The depth of the girders throughout is practically uniform, being 2 ft. 9 in., and is governed by the longest span, which is 43 ft. 9 in. centres—that for the centre cartway in the building. The depth for this span is comparatively shallow; for others it is ample, and in some cases more than ample; but there are distinct advantages in uniformity. The 11 in. by 3 in. joists are 24 ft. in length, while the girders upon which they rest are at 12-ft. centres, so that each joist spans two openings, and the joints of the joists are on alternate girders, and thus overlap. They are stiffened at the points of support and at intermediate points by solid wooden blocks placed between them. The floor timbers are 7 in. by 2½ in. deals, tongued and grooved with iron tongues as already mentioned.

The wells or openings in the upper floors are of a uniform width of 24 ft., corresponding with the centres of the columns, and the length of the well in the other direction is 43 ft., which again corresponds with the centres of the columns in that direction. Each well is surrounded by a strong iron railing with an opening having a chain barrier, so situated as to be convenient for the landing of goods by the crane fixed close to the well on the top floor.

The roof is of the ridge and furrow type, the ridges running transversely with the gables at the east and west sides of the building. The principals and purlins are made of wood, of the simplest possible character, with ordinary sections and such as can be most readily obtained. The timber is used as it comes from the saw mill, the span being very moderate—24 ft. This type of construction is of the most economical character. The upper part of the northern slope of each division is glazed. The remainder is covered with closed boarding and slates. The gutters, which are of great importance, owing to their great length—261 ft.—are 26 in. wide by 12 in. deep, of cast iron ⅜ in. thick, and weigh in all some 110 tons. They are laid in two divisions, with a convenient slope from the centre towards each side to carry the water to the down pipes.

The weight of the steel in the columns, girders, and floor of the building is about 6900 tons.

The whole building is protected from fire by a complete installation of Grinnell automatic sprinklers by Messrs. Dowson, Taylor, and Co., Limited, of Westminster, the water for which is supplied under pressure from two tanks, in towers at the north and south ends of the building. These towers are also utilised for providing fireproof stairways between the top and bottom of the building. The ceiling of each floor is fitted with pipes and Grinnell sprinklers, the latter spaced at distances apart each way of 10 ft. The total number of sprinklers in the building is thus no less than 5000. Should the temperature rise above 150 deg. Fahr. any one of these would open and quench an incipient outbreak. The danger of a pipe freezing in cold weather is obviated by an arrangement, known as the "dry pipe system," whereby the water, in the winter time, is displaced in the pipes by air under pressure, on the release of which, from any cause, the active flow of the water follows.

The sprinkler system is divided into four separate installations, each having its own controlling valve and automatic alarm. The latter is operated by the flow of water in the pipes, so that shortly after the opening of a sprinkler a loud alarm is rung on a gong situate on the outside wall of the building.

In order to supplement the supply of water from the tanks above mentioned, an hydraulic injector apparatus has been laid down, which consists of two injectors delivering into a discharge pipe leading to the sprinklers. The injectors draw water from an underground tank kept filled by a connection from the ordinary service mains; and a loaded accumulator in communication with the supply pipe to the sprinklers, by its rise and fall operates a valve controlling the supply of high-pressure water to the apparatus. Should a sprinkler open, the accumulator falls slowly to a point of its stroke, where it causes the valve to open sufficiently on the high-pressure supply to allow of a full discharge through the injectors, thus giving a continuous supply of water to the sprinklers in operation at a high pressure.

(To be continued.)

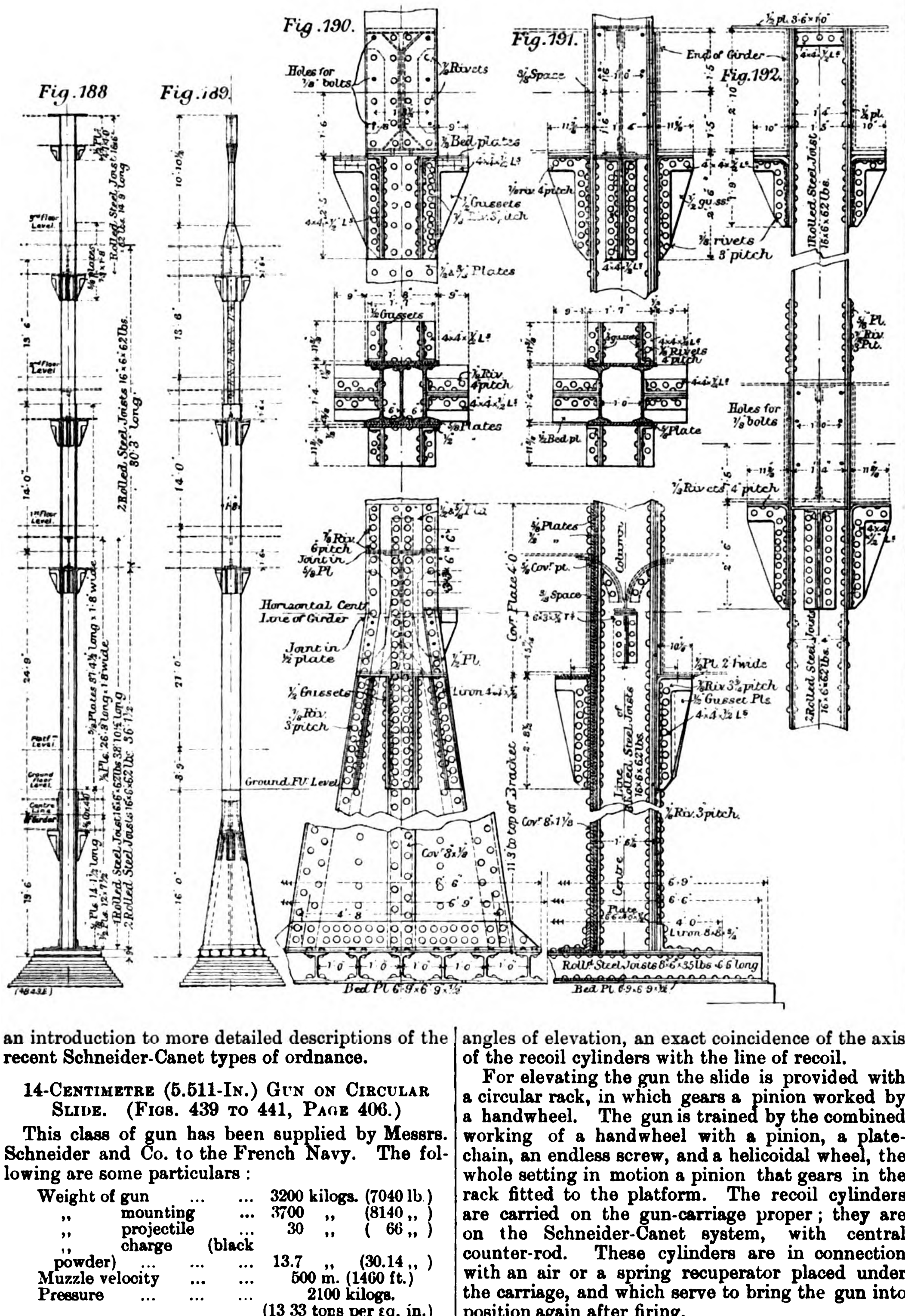
MESSRS. SCHNEIDER AND CO.'S WORKS AT CREUSOT.—No. XLIX.

EARLY TYPES OF NAVAL GUNS—(*continued*).

IN the present article, we continue our rapid summary of the earlier types of guns manufactured by Messrs. Schneider and Co. As already stated, this review is chiefly historical, but is necessary as

GREAT CENTRAL RAILWAY: DETAILS OF WAREHOUSE.

(*For Description, see Page* 401.)



an introduction to more detailed descriptions of the recent Schneider-Canet types of ordnance.

14-CENTIMETRE (5.511-IN.) GUN ON CIRCULAR SLIDE. (FIGS. 439 TO 441, PAGE 406.)

This class of gun has been supplied by Messrs. Schneider and Co. to the French Navy. The following are some particulars:

Weight of gun	3200 kilogs.	(7040 lb.)
,, mounting ...	3700 ,,	(8140 ,,)
,, projectile ...	30 ,,	(66 ,,)
,, charge (black powder)	13.7 ,,	(30.14 ,,)
Muzzle velocity	500 m.	(1460 ft.)
Pressure	2100 kilogs.	(13 33 tons per sq. in.)

The breech mechanism consists of a cylindrical breech-block sliding in a bracket which turns horizontally on a vertical hinge, and is worked by a lever. A plastic obturator, specially shaped, is placed between the front end of the screw and the movable head. The bolt for firing acts by percussion, all the necessary means being taken against premature firing.

The mounting consists of the four following main parts: (1) A bolster which rests on a fixed platform, the top of which serves as roller path for the training of the gun. (2) A fixed slide, consisting of two vertical brackets stayed together, rests on the series of rollers on the roller path; the top part being shaped into two circular slide paths, the centres of which coincide with the gun trunnions. (3) An oscillating slide, also consisting of two vertical stayed brackets, the bottom part of which forms slide-blocks of the same shape as the slide-paths; the two latter brackets serve also as slides for the gun-carriage proper. The object of this special type of mounting is to maintain, with all angles of elevation, an exact coincidence of the axis of the recoil cylinders with the line of recoil.

For elevating the gun the slide is provided with a circular rack, in which gears a pinion worked by a handwheel. The gun is trained by the combined working of a handwheel with a pinion, a plate-chain, an endless screw, and a helicoidal wheel, the whole setting in motion a pinion that gears in the rack fitted to the platform. The recoil cylinders are carried on the gun-carriage proper; they are on the Schneider-Canet system, with central counter-rod. These cylinders are in connection with an air or a spring recuperator placed under the carriage, and which serve to bring the gun into position again after firing.

15-CENTIMETRE (5.905-IN.) GUN ON MUZZLE PIVOTING AND CENTRAL PIVOTING MOUNTING (FIGS. 442 TO 445, PAGE 407.)

Such guns have been supplied to the Greek Admiralty for armament of the battleships Hydra, Spetzai, and Psara.

Weight of gun	7750 kilogs.	(17,050 lb.)
,, mounting (muzzle pivoting)	3175 ,,	(6,985 ,,)
Weight of mounting (central pivoting	3630 ,,	(7,986 ,,)
Weight of shield	895 ,,	(1,969 ,,)
,, projectile (armour piercing shell)	42 ,,	(92.4 ,,)
Weight of charge (prism, brown powder)	22.85 ,,	(50.27 ,,)
Muzzle velocity	650 m.	(2183 ft.)
Pressure	2400 kilogs.	(15.24 tons per sq. in.)
Angles of elevation ...	+ 22 deg. – 3 deg.	

The breech mechanism consists of three main parts, a breech-screw with movable head and bracket, an obturator and a firing device. The breech-screw is cylindrical with interrupted thread, and is carried by the bracket; it is worked by a cam lever which effectually locks the breech when closed; the lever serves, besides, to disengage the obturator on starting the opening motion. The obturator consists of a plastic disc of special shape, placed between the movable head and the front end of the breech. Firing is effected by percussion, the device being so arranged that until the breech is completely closed, the tube cannot be placed home in the vent and the striker armed. The striker is worked by a trigger and a line. Each of the two types of mountings consists of the following main parts: Bolster, slide, and carriage.

In the muzzle pivoting mounting the bolster is fixed to the deck and is connected with two roller paths, between which is the circular rack for training the gun. The slide is built of two brackets firmly stayed together and finished with sliding paths on the upper surface; below it bears on cylindrical rollers, the roller paths being held in position by clips. On the left-hand bracket is a glycerine hand pump and tank by which the gun can be run in. The carriage consists of a frame carrying the trunnion bearings and two recoil cylinders of the ordinary kind. In the central pivoting mounting the bolster is fitted to the deck, its bottom part forming the roller path. The slide rests on the bolster and carries a platform that surrounds the bolster pivot. The gun-carriage proper is similar to the preceding one. A flat-surfaced shield protects the men serving the gun. A handwheel works through a differential acting device, the setting arrangement placed on the left of the gun, and gives the required elevation. For training, a set of gearing worked by a handwheel acts upon a pinion that engages in the circular rack fitted to the bolster.

The recoil cylinders are on the Schneider-Canet system, with central counter-rod, arranged so as to allow automatic running-in under the action of gravity.

THE INSTITUTION OF NAVAL ARCHITECTS.

IN our last issue we gave an account of the proceedings on the opening day, Wednesday, the 22nd inst., of the recent meeting of the Institution of Naval Architects, and we now resume our report. On members assembling on Thursday morning, the 23rd inst., Lord Hopetoun again occupied the chair.

DISTRIBUTION OF POWER IN WARSHIPS.

The first paper taken was a contribution by Commodore G. Melville, Engineer-in-Chief of the United States Navy, who is an honorary member of the Institution, the title being "The Logical Arrangement of Motive Power of Warships." Of this paper we commence the publication in full in our present issue. It was read by Lieutenant Harold P. Norton, an engineer in the United States Navy, at present on duty in this country in connection with work being done for the American Government at Newcastle-on-Tyne.

The discussion was opened by the secretary, Mr. Holmes, reading a letter which he had received from Mr. Magnus Sandison, who was much interested in the figures given in the paper as to the power absorbed by the drag of an uncoupled propeller. The writer in proposing three screws had arranged that the small engine should be used for cruising, the shafts of the twin screws being uncoupled, and he would place the single engine in a separate compartment. The writer thought the auxiliary propeller might be of the feathering type.

Mr. A. E. Seaton said that the paper was one of great value and interest. Commodore Melville had stated his case most ably, but in Mr. Seaton's opinion he had stretched it a little further than was necessary. He had given fullest value to the advantages that followed the use of triple screws, but it might be questioned whether he had not shown a tendency to minimise the disadvantages. As a matter of interest, Mr. Seaton might state that forty or more years ago triple screws were tried in the British Navy, and the system was given what might be called an accidental trial. It took place at the time of the Russian War. One of the floating batteries showed a very poor speed. It had a single screw, and it was thought that the blade area was not sufficient. Two wing screws were therefore added, and were driven by gearing from the main engine; the result was not satisfactory, due, no doubt, to any advantage that might have been derived from the three screws being eaten up by the gearing. The speaker could not help saying that the paper would have been more satisfactory if the author had stated the data upon which he arrived at many of his conclusions. Mr. Seaton did not agree with him as to the great superiority of the triple screw for ramming purposes. The author had stated that a glancing blow from either forward or aft would certainly take off a twin screw if it projected beyond the counter, or, with ships rubbing against each other, the side screw might be broken. Mr. Seaton thought that a foot of projection more or less would not matter if it came to such close quarters as this. In regard to the advantage from the reduction of racing, it had been found by experience that trouble from this cause arose more from pitching than from rolling. The single propeller was apt to come out of the water with a fore and aft running sea, but vessels were not expected to roll to the extent of bringing twin screws above the surface. The single propeller being placed further aft, was, therefore, more likely to cause racing than twin screws, and experience bore this out. The Commodore had dealt very lightly, Mr. Seaton thought, with the nuisance that arose from engines not in use. The speaker failed to grasp the arrangement of engines described by the author, who stated that it had been thought advisable, in the latest fast ships of the United States Navy, to use quadruple-expansion engines throughout, the three main engines having in all thirteen cylinders. It would be interesting to know what the arrangement was; probably the idea was to have two four-cylinder quadruple-expansion engines for the wing screws and a five-cylinder quadruple for the centre set of engines. Later on the author had said "that the increase in the number of working parts due to the use of triple screws, is only apparent, as ordinarily there would not be more than eight cylinders on our triple-screw ships against ten cylinders that would necessarily be used in the proposed five-cylinder quadruple-expansion engines for our twin-screw ships." Commodore Melville had also stated that the increase in engine-room force required was not excessive, being twelve men at the most. He considered this was not a disadvantage for warships, as the added staff consists entirely of skilled mechanics, and these men are especially useful in making repairs while under way. This might be very true, but it was well to remember that if there were more men to make repairs, there were more engines to be repaired. The details the Commodore had given in his paper as to the steam needed for driving auxiliary machinery were very interesting. It emphasised the need for introducing a system of electrical distribution of power on warships. Electric motors were simpler and less likely to go wrong than steam engines, whilst the power can be generated by large and highly efficient engines. Mr. Seaton considered electricity a safer means of distributing power than the hydraulic method. It would be understood that in the criticisms the speaker had passed he did not intend to throw cold water on the suggestions of the paper. Those parts that he agreed with naturally did not need comment at his hands, and this, perhaps, appeared to give his speech a character which it was far from his intention it should have. If three engines were to be fitted; the centre screw should have more power than the wing screws, but he would suggest that the centre propeller should be two-bladed, so that it should be shielded by the stern-post when not in use and the drag would be less. In conclusion, he would say that the paper would form a most valuable addition to the Transactions, for the author had put the various points relating to triple-screw propulsion in a light that perhaps few had seen it before.

Professor Biles said that all were pleased so eminent an authority as Commodore Melville had contributed a paper to the Transactions. It might be of interest to add that the Commodore was not only eminent as an engineer, but that he had won fame also as an Arctic explorer, and his book on the Lena Delta, which many present might have read, formed a most thrilling narrative of an heroic expedition. In 1891 the speaker had read a paper before the Institution on "Recent American Warship Designs." At that time the Columbia and Minneapolis were only on paper. They were known at Washington as "the pirates," and great things were expected of them in the matter of preying on the commerce of an enemy should they ever be called upon to act. Since then they had been built, and had taken part in a war under the more dignified guise of armed cruisers, giving good results. The paper, Mr. Biles thought, was open to the criticism that the author had tried to prove a little too much, but that was due to his generous and enthusiastic nature which was also the cause of so much of his success in life. His triple-screw ships might be looked on in this way. He had taken a twin-screw ship and divided one set of engines into two parts. There were, however, twin-screw ships both in our own and in the American Navy which had two distinct sets of engines on each line of shafting, and it might be said, therefore, that the Commodore had taken a four engine twin-screw ship and knocked two of the engines into one. In any case the advantages claimed for the bigger engine did not all apply to the whole of the machinery, but only to 50 per cent. of it. It was easier, however, to get in three propellers than two on a given draught. The author had said that with three screws a better performance was obtained at sea in bad weather than if two were used. What the meeting would like to have had would have been the facts on which this statement was based. In the author's former paper on the Columbia and Minneapolis, read before the American Society of Naval Architects and Marine Engineers, the method used to determine efficiency was to assume a certain net resistance of the hull. Professor Biles thought that it was not possible to assume a resistance until tank experiments had been made, and if the Commodore's data were, therefore, open to question, it was equally open to question whether the efficiency was as much higher as he claimed. If the Admiralty constant were used in analysing the performance of the Columbia and the Minneapolis, the result did not appear to be anything very wonderful. The speaker's experience was that the highest propeller efficiency was obtained by the use of the single screw, and he thought that any superiority that there might be with triple screws would be due to the position of the central screw being similar to that of the single screw. The author had said that it was unquestionable that when more than 10,000 horse-power is to be transmitted through a single shaft under present conditions of speed and displacement the number of revolutions will be limited by the propeller. The speaker did not agree with this. The fact, that though there was a larger engine-room staff, there was more work for them to do, had already been referred to by Mr. Seaton. [We may, perhaps, point out with advantage that Commodore Melville specially referred to making repairs while under way, and it is not very probable that three engines will all require attention of this nature at one time, so that the "skilled mechanics" might, on emergency, be drawn from one engine-room to another.] Professor Biles thought that the point of greater safety with three screws was apt to be over-estimated. With a single-screw ship, if an engine broke down the vessel was helpless; with a twin-screw ship, if an engine broke down she could still proceed at a very fair pace, therefore the distance between single screws and twin screws in regard to the margin of safety was very great, but in going from twin-screws to triple-screws the advance was less.

Sir William White said that the subject of the paper was one in which he had taken the keenest interest throughout his professional career, and he hailed with gladness any opportunity of getting fresh information on the question. Some members might remember that twenty-one years previously he had read a paper in which he strongly recommended twin screws, not only for the purpose of affording a shallow-draught design of vessel, but also for ships of deep draught. At that period the suggestion was not a popular one, but time had justified it. His excuse for recalling this earlier paper of his own was that it showed he had an open mind on the subject of multiple screws, and it would form a fitting preface to what he had then to say. There was a good deal of difficulty in dealing with a paper such as Commodore Melville had presented, because it was full of opinions, of speculations, and of arguments, but contained very few facts. When he heard the paper was coming he was delighted, and said, "Now, at last we are going to have from the best authority the facts about the Columbia and Minneapolis." If, however, experiments had been made with these vessels, their details were not recorded in the paper, and there was, therefore, insufficient data for fortifying opinion. In an analysis of the performance of a steamship, to arrive at her efficiency, there was wanted a very great deal more than the author had given. Commodore Melville had said that 200 ships had been tried, but the speaker would like to know how many of these were triple-screw ships. He thought that he had a fair knowledge of what trials had been made with vessels of that class and, so far as he knew, they were comparatively few. He was afraid that the deductions contained in the paper were built up on a very slender basis. Sir William continuing, said he appeared before the meeting in an unusual position. He knew more than he was able to say, that was not a usual condition, but it arose sometimes. He had knowledge of experiments, but he could not furnish the facts, as they were given him as personal information only. The paper said that three screws led to economy. Sir William knew of no facts supporting this statement. The paper also recommended a third arrangement of triple screws in which there would be small wing engines with the large engine in the centre. In Russia the three-screw ships, however, had large screws at the sides. There was material information in the paper in regard to the waste work of revolving an idle screw. The author had taken a vessel of 12,000 tons, 23,000 horse-power, and 22 knots speed. Now, it was evident that was not an American ship, and it would be interesting to know what vessel it represented. Again, triple screws were recommended by the author as a necessity on account of a 24-ft. draught, but Sir William would undertake to produce a most effective twin-screw vessel of the character indicated upon that draught. Speaking generally, the Director of Naval Construction said that it must not be understood he altogether condemned triple screws, but he was of opinion that the conditions laid down in the paper did not bear out that they were yet demanded. From what had been said, he was under the impression that Commodore Melville had not introduced in his analysis the results of model experiments. Naval architects were, however, under the greatest obligation to such sources of information, and found they were constantly borne out by actual trials which they had foreshadowed, and in working out results they had found it of advantage to come back to the model screws. In regard to the utilisation of the frictional wake, upon which the paper dwelt, he would point out that it was quite possible to speak of tendencies, but what was really wanted was the actual aggregate result. For instance, the late Mr. Froude had at one time favoured putting the single screw far aft, to reduce the augment of resistance, reasoning on tendencies he had observed; but on experiment it was found that the balance of advantages was in favour of the ordinary arrangement. As a matter of detail, he would have liked to have seen a more exact statement as to the space occupied, not only by the engine compartments in a triple-screw ship, but by the shaft passages. The stowage of ammunition was a problem that had to be solved in the design of all warships in the Royal Navy. For well-defined reasons they distributed the ammunition as equally as possible between two ends of the ship, but with the three-shaft passages difficulty might arise. It was a detail which showed that one cannot discuss warship machinery from the point of view of efficiency alone. Sir William trusted that what he had said would not appear to overlook the obligation the Institution was under to Commodore Melville for the paper he had contributed, and if there were further information at his—the author's—disposal, and if he were at liberty to give it, it would be a most desirable thing that it should be included in the Transactions of the Institution. The speaker had always thought that if we go on progressing as we have done in the design of engines and propellers, and if they remain based on the same general principle upon which they are now designed—if there were no radical changes thrusting existing practice on one side—then we might come to triple or other multiple screws. But as matters stood he did not think that the Commodore had made out his case.

Mr. George Quick, Chief Engineer, R.N., said that he looked on the engine of a warship as part of a fighting machine, and not as a piece of mechanism the great object of which was to give out the largest amount of work from the smallest amount of coal. This point of view, he thought, bore on the arrangement of triple screws for the fighting ship of the future. If a twin-screw vessel were to be disabled in one engine she could not go into battle with an odd propeller, but with a triple-screw ship, if one engine were disabled, there would still be half the power left for propulsion, according to Commodore Melville's arrangement of the big central engine. In regard to the absence of detail in the paper, it might be explained by the fact that Commodore Melville was a very busy man, as the head of an important department of the United States Navy. He had, however, a comparatively small staff, and the speaker knew that he had not been well of late.

Mr. Harold F. Norton, on being called on by the chairman to reply, said that there were one or two points in the discussion to which he might make reference. But he would not undertake to answer on the author's behalf upon all the details brought forward. He had been detached from the Bureau of Steam Engineering before the paper was written, otherwise he might have been better informed as to its details. He had, however, the Commodore's authority for stating that all that was contained in the paper could be supported by evidence; and he knew that the author would, in a written reply to the discussion, refer to all the important points raised. What Mr. Quick had pointed out had a very real bearing on warlike operations. The utility of arrangements of machinery for fighting purposes was not always apparent until they were put to the test. At Santiago, during the late war, the fastest American ships watching for the Spanish Fleet, had double sets of engines, and when the enemy came out they could not stop to couple up, so that they had to proceed at moderate speed. The advantage of the triple screw arrangement arose from the fact that there was needed for a cruiser a ship that would be economical with her fuel at ordinary cruising speeds of 16 or 17 knots, but which would also have a high speed of, say, 23 or 24 knots; but if they could get the latter speeds, they did not care what they paid for it in coal. Designs were being brought forward in America that would embody this principle. He knew that a great many trials of the Columbia and the Minneapolis had been made, and he was sure the Commodore would be glad to supply the details for the Transactions. In regard to what had been said about electrical machinery for the transmission of power on board ships, he would state that the system had been tried with the machinery of the Brooklyn, but the difficulty had arisen that if anything occurred to the leads they might hunt all day to find out where the defect existed, and by the time they had found it, in war, they would be "out of the deal." He had been asked whether it was possible to couple up an idle screw with the vessel under way. There was no difficulty in this, they had a powerful friction brake which would hold the screw still whilst the vessel was going 17 or 18 knots. As to the suggestion of a two-bladed screw, he would remind the speaker that these screws were intended to run idle, being revolved by the passage of the ship through the water. He concluded that whether a screw had two or three blades, approximately the same area would be needed, so that the friction of the water passing the blades would be the same; the other points he would refer to the author for reply.

The President next proposed a hearty vote of thanks to Commodore Melville for his valuable contributions to the Transactions the motion being carried with acclamation.

STRUCTURAL STRENGTH OF SHIPS.

The next paper read was a contribution by Mr. J. Bruhn, of Lloyd's Registry, entitled "The Stresses at the Discontinuities in a Ship's Structure." This we print in full on page 429 of the present issue.

Mr. Martell was the first speaker on this paper. He took the point of view that it was one of the most valuable papers ever read at a meeting of the Institution. As regarded general construction, there was no difficulty found with ships of ordinary framing and plating, but a great deal of difficulty arose from the discontinuity of structure owing to various erections. The trouble in meeting stresses, however, had to be overcome, and it was for this reason that Mr. Bruhn's paper was so valuable. Again, there was a continual extension of great hatchways. The shipowners did not recognise how this affected the structural strength, they were often told at Lloyd's that that ought to allow a diminution in scantling, because there were two steel decks in a ship, but it was frequently found that the big hatchways cut the greater part of the deck away. The paper before the meeting gave a scientific expression to determine the value of this feature. It had often been said that science was only of use in supporting practice. However that might be, they found the scientific data given in the paper borne out by practice, and a way was shown by which science might lead to the saving of large sums of money that would otherwise be expended in elucidating problems practically. He intended to recommend that Lloyd's Committee should send round copies of the paper to shipbuilders in order that it might be shown that points which had been insisted upon hitherto, not without considerable opposition, were in effect warranted.

Professor Biles wished to endorse what Mr. Martell had said in regard to the value of the paper. The question of stresses due to discontinuous structure had been a worry to believers of the girder theory. There were two ways of treating the subject: the first was the method of avoidance, or to have no discontinuity. The other way was to strengthen up the structure to compensate for the discontinuity. He was not sure that the author had really avoided the avoidance principle by continuing the construction of deck-houses, &c. The usual way to treat any part of a ship that is found to be weak is to add more material, but it was a question as to the difference in the quantity of material required by the two systems respectively. It has been said that the value of science is to confirm practice, but unfortunately practice only taught what things were not strong enough through the medium of a breakdown. For instance, stresses in the side of a ship caused by a sharp corner of a hatchway appeared less than those of the deck. The usual method was to thicken up scantling where a weakness was made manifest. But that was not always the best way, and the great value of the paper was that it indicated where the material should be put. The speaker would not subscribe to the accuracy of all the figures given, but the paper showed that a rounded corner in the hatchway was the best. That had been generally recognised, for corners now were nearly always rounded. [Mr. Martell at this point corrected the speaker, saying that it was not accurate to say that rounded corners were almost always used; as a matter of fact it was not so.] Continuing, Professor Biles said the standard method of determining stresses on ships was by the girder theory. The theory was only a standard, however, and was not absolute. It enabled one ship to be compared with another, so that to retain its value, if the calculations were to be changed for one vessel, they must be changed for all in order that the recorded data might be brought into use. The speaker was not sure that the author was right in what he said as to rivet holes and neutral axis. The strength of the ship across the line of frames and across the line of butts did not vary so much as often appeared to be imagined, and therefore the assumption was not so far out as the author had indicated; probably the best way would be to adopt the means that Mr. Bruhn had suggested, but all past data should be corrected to conform with future data.

Mr. Purvis spoke of the good work done by members of Lloyd's staff in the past, referring to Mr. William John, Professor Jenkin, and Mr. Reed, all of whom had passed away. He spoke as to the calculations for moment of inertia of a section being made without the rivet holes being taken into account. At Denny's they had added a percentage for tension and another for compression. The author had not mentioned deflection; but there must not be deduction for rivet holes, neither should reductions be made for the moment of inertia.

Captain Kriloff made some interesting remarks referring to the remarkable fact that there was a close agreement between the results of the present paper and Professor Hele-Shaw's method of mechanically working out the stream-line theory by thin films of liquid between glass plates. It was very difficult to determine the stresses due to corners of hatchways by mathematical process; but if Professor Hele-Shaw's experiments were made, it would show the lines of stress were reproduced by the coloured streams in the liquid film. The suggestion that a ship's structure could be determined in this way appeared to strike the meeting as remarkable, and it certainly opens up a wide field for speculation on the relation of physical phenomena. If the author, or Captain Kriloff, or Professor Hele-Shaw, or possibly the three together would follow up this line of research, most interesting results could hardly fail to be reached.

Mr. Corrie, speaking as a member of Lloyd's Committee, was of opinion that hatches are made too large in the present day.

Mr. Stromeyer said that he welcomed the paper, not only because of its intrinsic value, but also because it was, as far as he knew, the only paper which had been submitted to the Institution since his own in 1885, in which the local distribution of stresses was experimented upon. He attached far more importance to the experimental data in the paper than to the mathematical investigations, for there was nothing specially new in the latter, and they did not help very much. He hoped that the subject would be further inquired into experimentally, and, when sufficient data had been accumulated, then a mathematical analysis of the facts would be of the utmost value. He, therefore, deplored, in a certain measure, that so much space had been occupied by the mathematical treatment that the actual details of the twenty experiments had to be omitted. Touching, then, upon the practical side of the question, he pointed out that, being an engineer, he naturally had an antipathy towards sharp corners. No engineer ever wilfully introduces them into his designs, and if they got there, they simply would have to be rounded off in practice. The sharp corners of hatches and other openings in ships had therefore always struck him as being wrong, and practical experience at sea only confirmed this feeling. On the other hand, he could not bring himself to believe that the distribution of stresses as indicated by the curves in the paper was quite correct, for if properly analysed and compounded, it would be found that the shearing stresses at the corners were infinite, that is, irresistible; and if that were so, every hatch corner would break without fail, which was not true. It could easily be shown that, on the contrary, the shearing stresses must always be *nil* across a boundary of a solid; so that, although these stresses would be very severe near a corner, they could not exist at the corner. As regarded remedies, he suggested rounding the corners or cutting away or weakening the objectionable additions at the corners. He was strongly opposed to local strengthening where these strains were severest, because it was the nature of these local stresses that they depended not so much on external forces as on local deformations. The corners would still be strained as severely as ever, and should they break, now that a large part of the ship's motion had been localised by the results, the whole structure would be very much more weakened than at present. These remarks, he said, did not apply to every imaginable case, but experiments such as Mr. Bruhns' would soon determine whether additions were beneficial or otherwise. His own desire had always been not to overload structures; judicious reductions would often be found more advantageous.

Mr. Martell, who occupied the chair, here called upon Mr. F. K. Barnes as a scientific naval architect, who had done much excellent work in the past, and to whom the profession was largely indebted for advances that had been made. Mr. Barnes said that he did not see there was much that could be said in criticism on the paper, which was an excellent piece of work and deserved close study by all concerned in the designing of vessels.

In replying to the discussion, Mr. Bruhn said that Professor Biles suggested that the difficulty at the discontinuities might be got over by building the ship continuous, or by fitting the bridge in such a way that it would slide on the main structure when bent. The former method did not seem to be in favour with shipowners, otherwise it would no doubt be the best. The latter would have practical difficulties in way of its adoption, though they could no doubt be overcome, in which case the hull of the vessel would really be continuous. The question of experimenting on a real model of a ship, instead of on parts of the vessel, is interesting, but he thought it desirable to eliminate, as far as possible, disturbing influences, other than those under consideration. The deck-plating and topside plating would stretch when subjected to straining actions, and the effect at the discontinuities would be the same by whatever means the stretch is caused. It, therefore, appeared to him that the investigation with regard to the stresses at the discontinuities could quite well be made, independent of other considerations. The large stress at the corners of the hatchways, viz., 17 tons per square inch, was very high, and Professor Biles pointed out that if he had assumed a higher stress than 7 tons per square inch on the plating at the sides of the hatchways, he might have obtained even 20 tons or more at the corners, a stress which would be too high for working purposes. That, the speaker said, was true; but the stress is estimated on the understanding that there is no hatch coaming, angle, doubling, or increased thickness of plating. With these increases the stress would probably be reduced to less than half the above amount. Vessels had been built without doublings at the hatch corners; but he thought they had either shown signs of weakness or the stress would be found, on investigation, to be no greater than the material could stand. Though vessels might have been built without doublings at the corners, none had to his knowledge been built without hatch coamings and angles, which would add considerably to the strength, and therefore reduce the estimated stress. With regard to the question of the correction for rivet holes in the moment of inertia calculation, he certainly thought that it ought not to be made. Professor Biles pointed out that the strength (as calculated by the ordinary formula) was about the same in way of a frame and in way of a line of butts, and that the discontinuity due to the correction for the rivet holes was therefore not so great as the author assumed. The sections through the butts were on a par with those through a frame line of rivets, and they would, it seemed to the author, only cause two assumed discontinuities instead of one in each frame space.

Mr. Purvis had, the speaker continued, pointed out that the moment of inertia required for the estimation of the deflection of a vessel should not have any correction made for the rivet holes. This he entirely agreed with, and it bore out the contention that no correction should be made when the stresses are calculated, because that formula is in both cases based on the same principles. Captain Kriloff had remarked that the problem to be solved in estimating the stresses at discontinuities was the same as the determination of the lines of flow in a fluid. The speaker had thought of that analogy before; and it was interesting to see how the extension of knowledge in one direction always increased it in others not directly connected with the question under consideration. Mr. Stromeyer would have liked to see some more results with regard to the experiments when only the stress at the corner is given. He had thought, however, that the paper would be too long and tedious if filled with figures, and for that reason he only gave one example.

TCHEBYCHEFF'S RULE.

A contribution by Mr. C. L. Munday, "On the Advantages of Using Tchebycheff's Rule in Association with the Integrator to Obtain Cross-Curves of Stability" was next read. The method described by the author in his paper is put forward as offering many advantages over Simpson's rule, and, by the consent of Sir William White, had been embodied in the course of study at the Royal Naval College. It will be remembered that Captain Kriloff has described a new method of performing ship calculations based on a quadrature rule of M. Tchebycheff's. As applied at Greenwich, it was used by the students at first to find the displacement and centre of buoyancy of a ship only, but afterwards the ordinary metacentric calculations were also obtained by it. The author stated that the method was unquestionably shorter than that of Simpson, and it gave, with nine ordinates over the length and five water-lines, results practically identical with those obtained by Simpson's rule with 21 ordinates and seven water-lines. As the sections by this Russian rule are not equidistant, its adoption may be hampered by considerations of laying off. In the important calculation for obtaining cross-curves of stability, the saving of time effected appeared to the author so marked that he would call the attention of members to the matter. The assumption on which the rule is based is the same as Simpson's, namely, that the ship curve is a portion of a parabola, but, instead of treating equidistant ordinates by certain multipliers, the positions of the ordinates are selected so that a simple summation of them determines the area. The author gave the mathematical investigation for obtaining the positions briefly in an appendix, which also con-

14-CENTIMETRE GUN AND MOUNTING.

(*For Description, see Page* 402.)

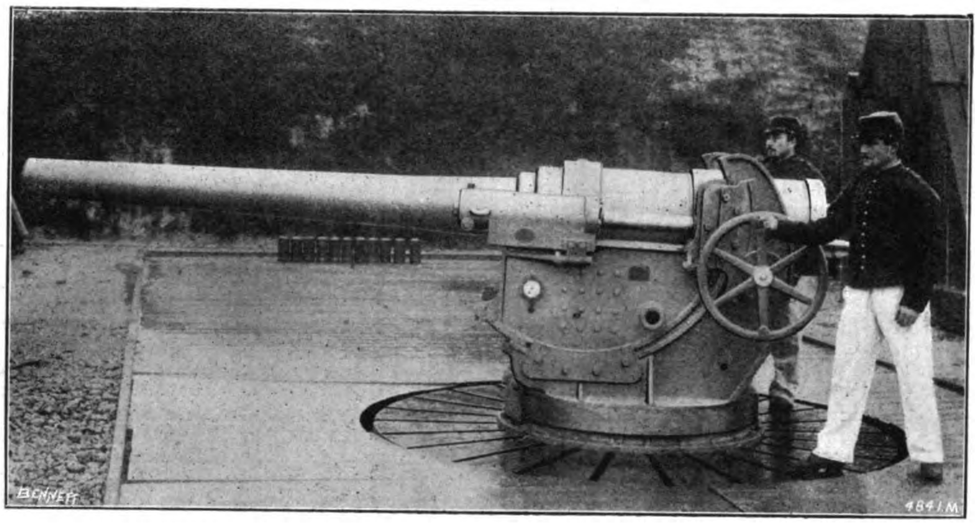


FIG. 439

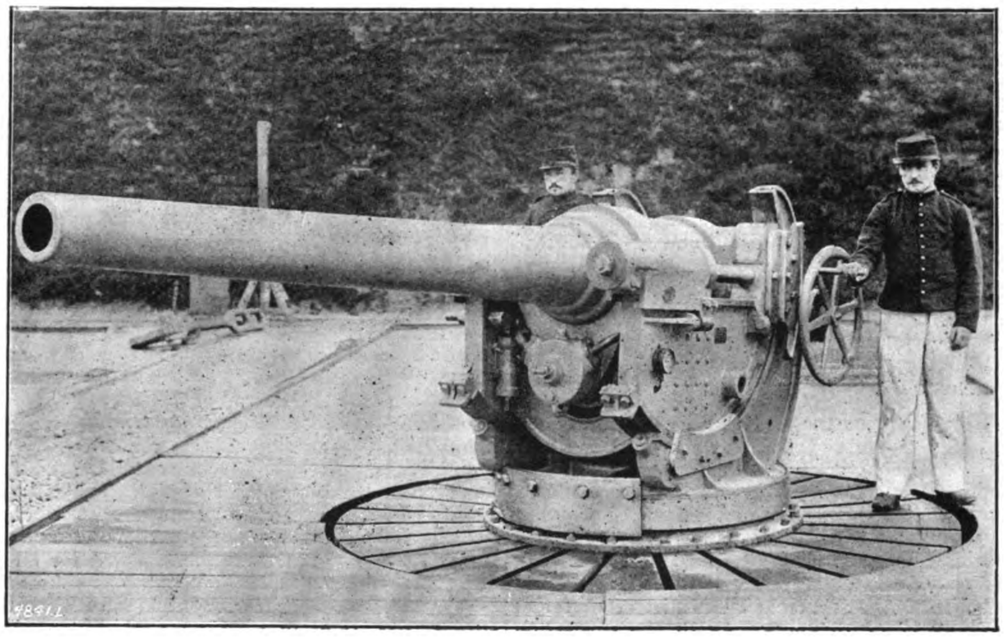


FIG. 440.

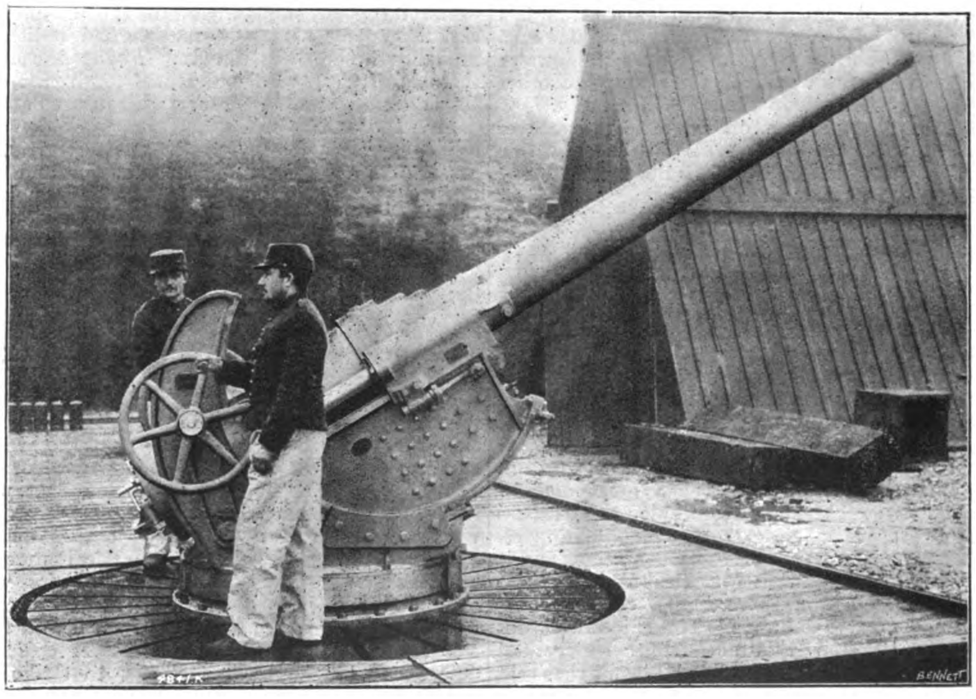


FIG. 441.

MESSRS. SCHNEIDER AND CO.; 15-CENTIMETRE (5.905-IN.) GUN AND NAVAL MOUNTING.

(*For Description, see Page* 402.)

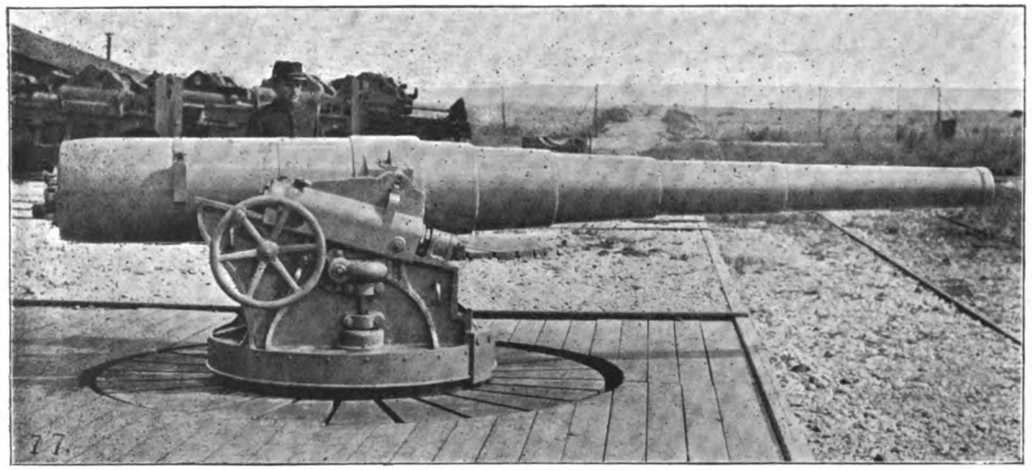


FIG. 442.

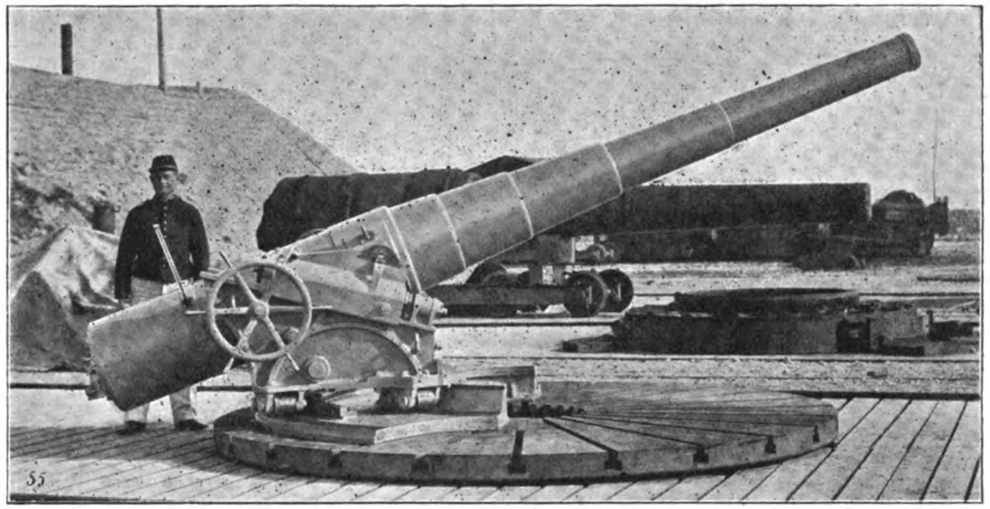


FIG. 443.

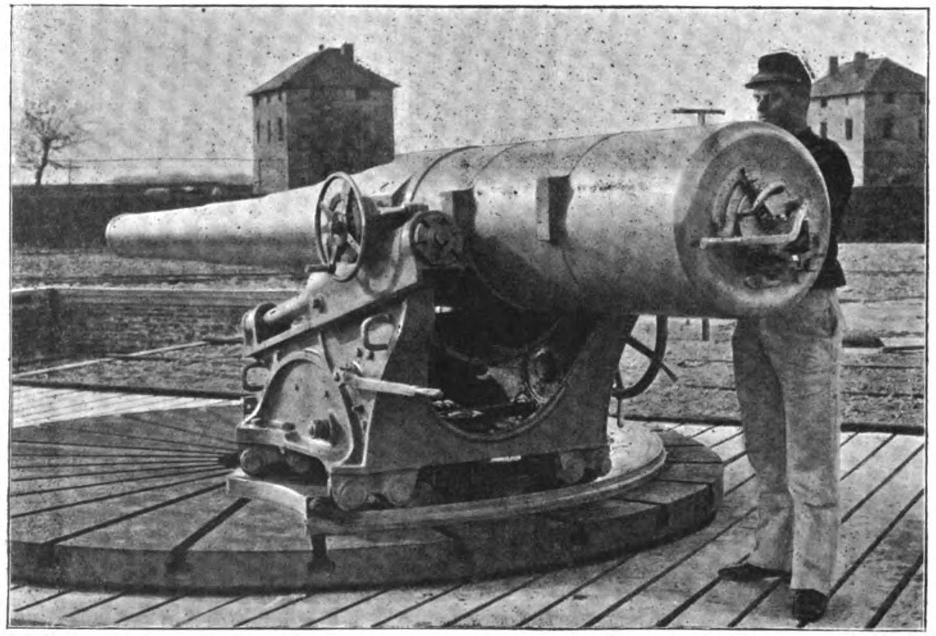


FIG. 444.

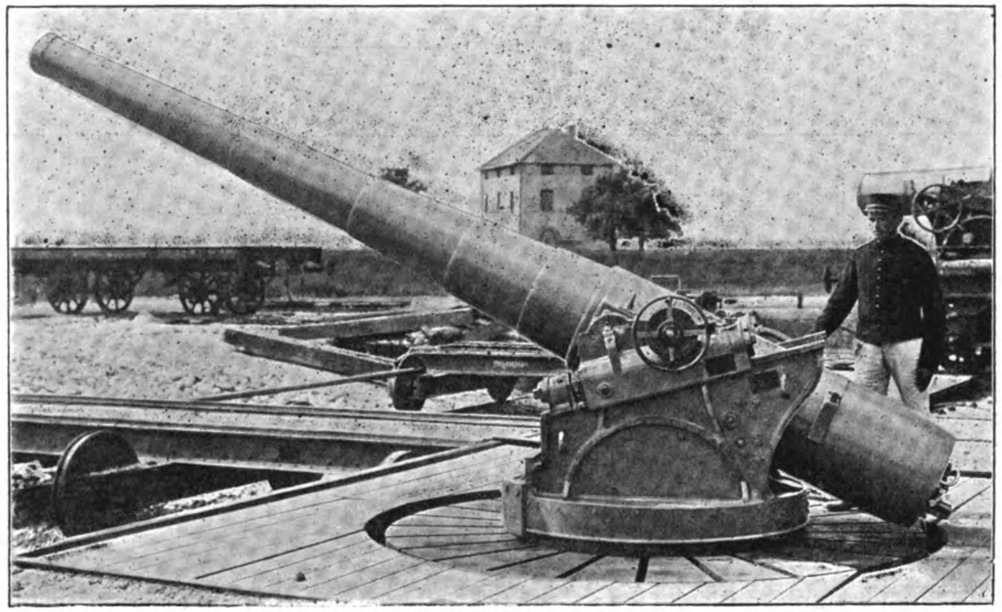


FIG. 445.

the obliquity of the connecting-rod, it might be noticed that the fundamental parts of the engine could be balanced; the other parts could be treated without disturbing the chief parts. In conclusion, he had to thank Mr. Yarrow for the great interest he had taken in the subject, and to letting him make experiments on torpedo vessels.

The proceedings were brought to a close with the usual vote of thanks.

As stated, the summer meeting will be held in July, and will probably take place during the first week of that month.

MESSRS. SCHNEIDER AND CO.'S WORKS AT CREUSOT.—No. L.

Early Types of Naval Guns—(*concluded*).

5¾ - In. Gun on Front Pivoting Mounting, Schneider-Canet System. (Figs. 446 and 447, annexed.)

The following are some particulars of these guns, which have been delivered to the Brazilian Government:

Weight of gun	3050 kilogs.	(6710 lb.)
,, mounting ...	2920 ,,	(6424 ,,)
,, projectile ...	36.3 ,,	(81.8 ,,)
,, charge (prismatic brown powder)	13.6 ,,	(29.92 ,,)
Muzzle velocity	518 m.	(1699 ft.)
Pressure	2000 kilogs.	(12.70 tons per sq. in.)

The breech-closing mechanism and firing device of these guns are very similar to those last described. Of the mounting, the bolster, which is bolted on the deck, forms a circular sector. There are two concentric roller paths. The slide rests on the bolster through the interposition of a series of truncated conical rollers. Steel clamps hold the slide to the bolster, and prevent it from rising during firing. The gun-carriage consists of the ordinary supports placed in guides on the slide; two recoil cylinders, communicating with each other, form part of the gun-carriage.

A pinion that gears in a curved rack fixed to the gun serves to elevate it. The gun is trained by a set of gearing working a pinion which engages a rack fitted round the bolster.

The recoil cylinder is hydraulic, on the Schneider-Canet system, with central counter-rod. The piston is drilled with radiating holes, which allow of the liquid passing from one end of the cylinder to the other. These holes are closed by loaded valves. Vents of small diameter are provided in the valve to insure the return of the gun to firing position.

27-Centimetre (10.630-In.) Gun on Central Pivoting Mounting. (Figs. 448 and 449, Page 447.)

Guns of this type have been supplied to the Greek Navy for the armament of the cruisers Hydra, Spetzai, and Psara.

Weight of gun ...	...35,900 kilogs.	(78,980 lb.)
,, mounting	...16,420 ,,	(35,728 ,,)
,, shield ...	... 1,450 ,,	(3,190 ,,)
,, projectile (armour piercing shell)	250 ,,	(550 ,,)
Weight of charge (prismatic brown powder	165 ,,	(363 ,,)
Muzzle velocity	665 m.	(2182 ft.)
Pressure	2400 kilogs.	(15.24 tons per sq. in.)
Angles of elevation	+ 15 deg. – 5 deg.	

The breech mechanism consists of three main parts, the breech-screw with supporting slide; the obturator and the firing device. The breech-screw is cylindrical, with four plain and four threaded divisions; it is carried on a supporting slide which pivots round a vertical bolt. The mechanism is worked by a crank and toothed gearing. One man can easily open or close the breech, though the whole of the mechanism weighs approximately 520 kilogrammes (1144 lb.). The obturator consists of a plastic disc placed between the front end of the screw and the movable head. Firing is effected by means of a bolt that acts by percussion. The vent is masked by the bolt, and the striker cannot act until the breech is completely closed.

The mounting consists of the bolster, the slide, and the gun-carriage proper. The bolster rests, through two bearing rings, on a wrought-iron sleeper-bed. On the roller path are arranged twenty-four truncated conical rollers, maintained in position by guides. The slide is formed of two brackets stayed together; it rests on the rollers, and is held in place by clamps. On the left bracket is the mechanism for hauling in the gun.

5.75-IN. AND 34-CENTIMETRE SCHNEIDER GUNS.

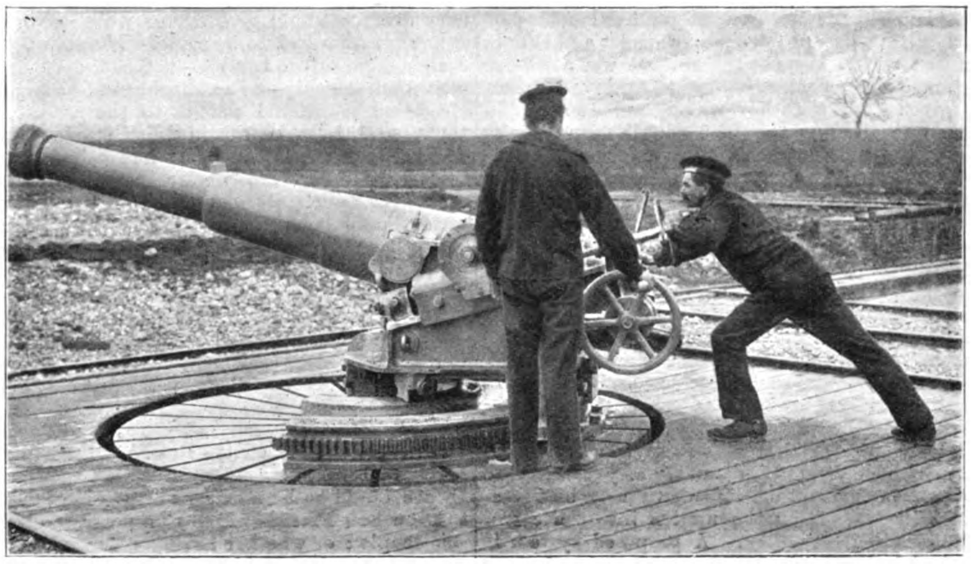


Fig. 446. 5.75-In. Naval Gun and Mounting; Side View.

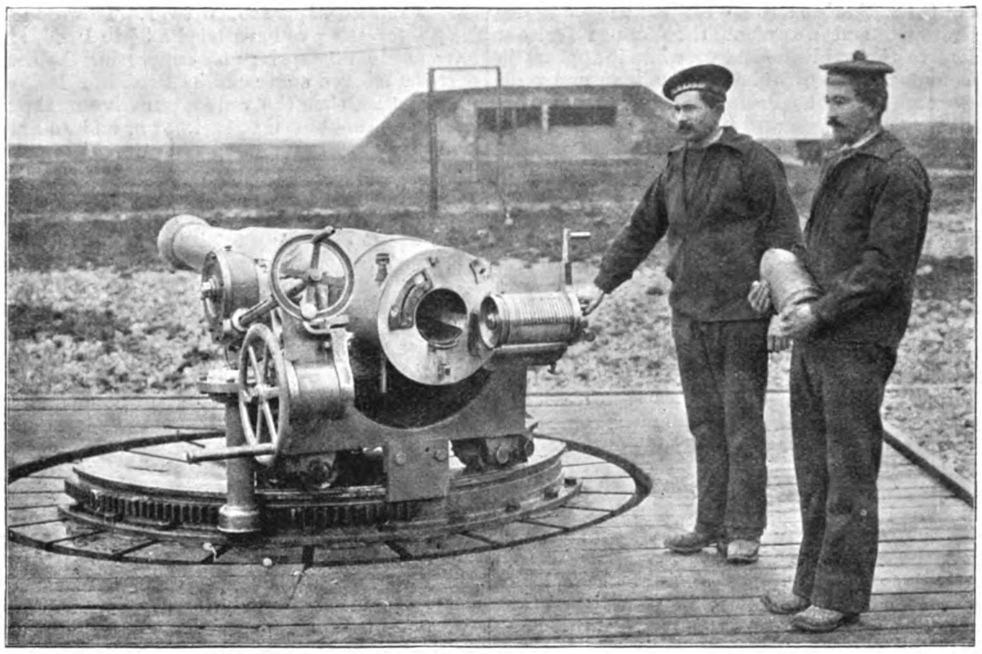


Fig. 447. 5.75-In. Naval Gun and Mounting; End View.

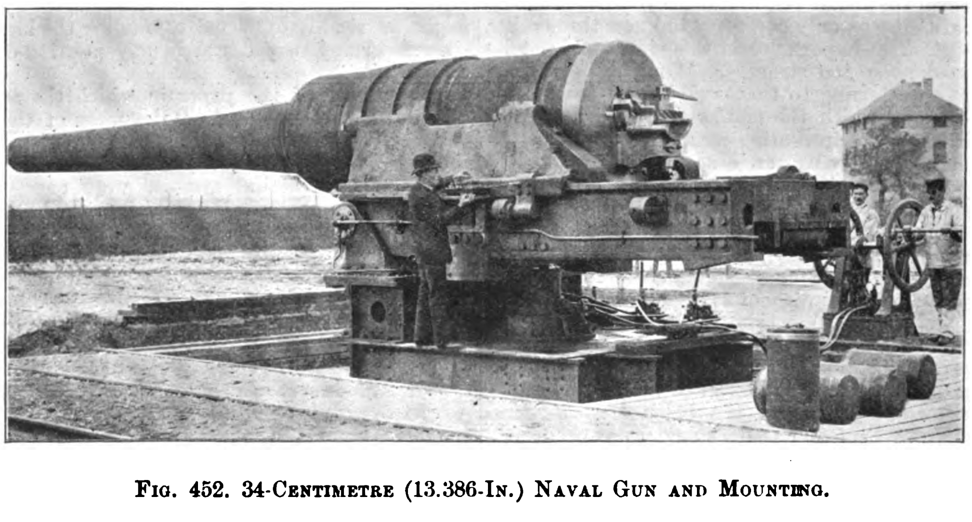


Fig. 452. 34-Centimetre (13.386-In.) Naval Gun and Mounting.

The gun-carriage proper rests on blocks on the slide; it carries two recoil cylinders united together by a stay-piece, which forms the gun rest, and there are also two compensating cylinders. A shield, fitted to the front of the slide, protects the piece and the gunners.

To elevate the gun, there is provided a differential device with toothed-wheel gearing and friction cones, working a curved rack fixed to the gun, which is trained by a set of toothed-wheel gearing, worked by hand or by steam power.

The hydraulic recoil cylinders are provided with central counter-rods on the "Schneider-Canet" system, and with compensating cylinders. The

MESSRS. SCHNEIDER AND CO.; EARLY TYPES OF NAVAL GUNS.

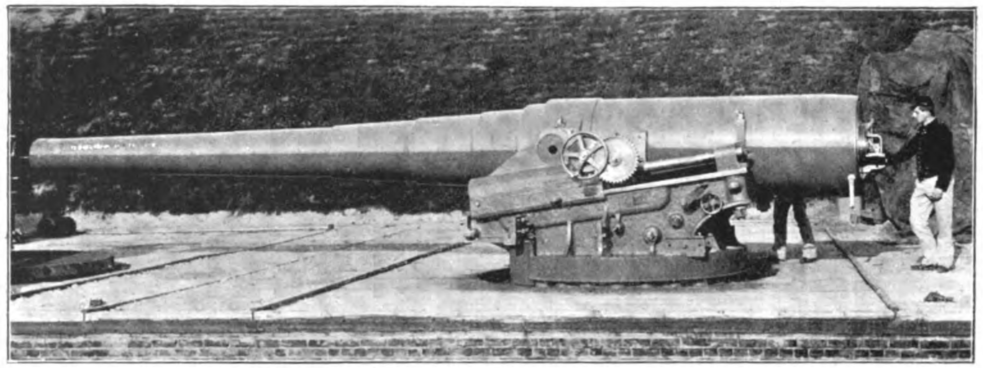


FIG. 448. 27-CENTIMETRE (10.630-IN.) GUN AND MOUNTING.

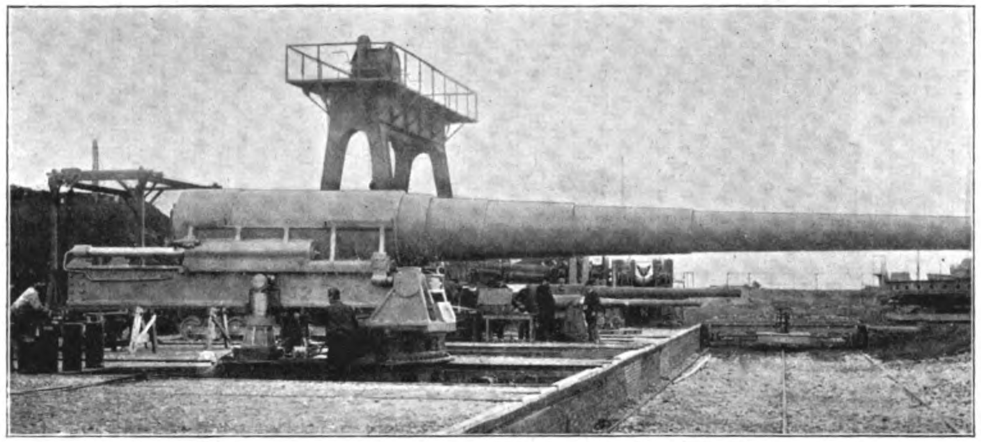


FIG. 450. 32-CENTIMETRE (12.598-IN.) GUN AND MOUNTING.

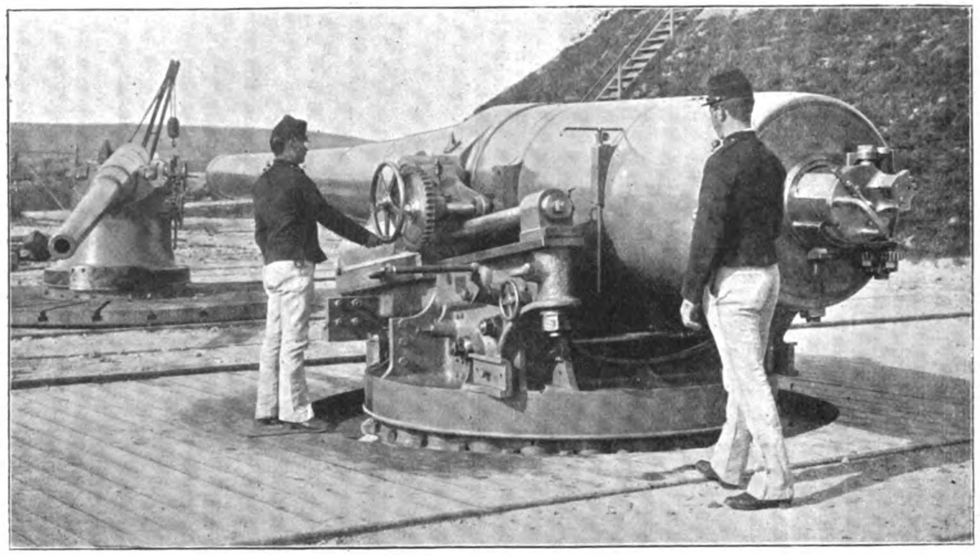


FIG. 449. 27-CENTIMETRE (10.630-IN.) GUN AND MOUNTING.

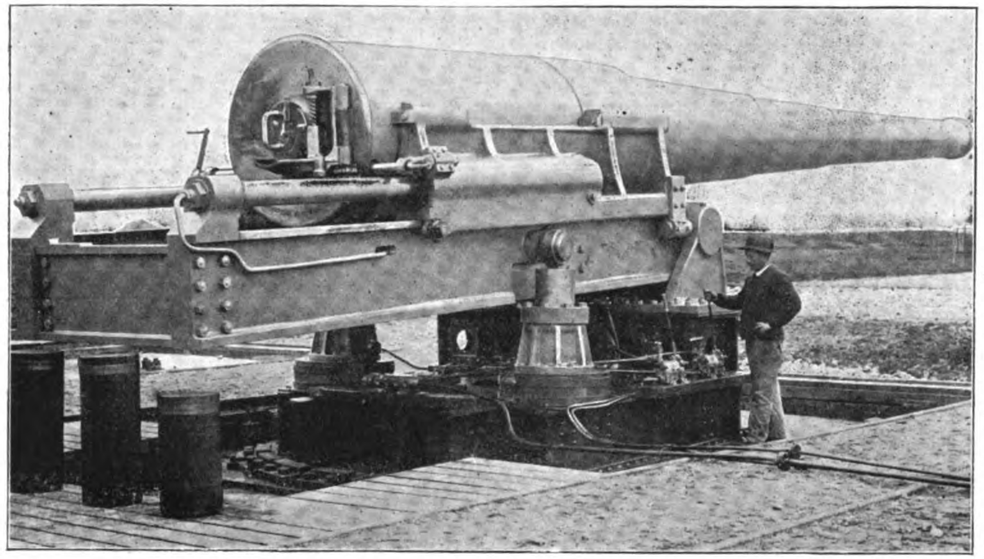


FIG. 451. 32-CENTIMETRE (12.598-IN.) GUN AND MOUNTING.

cylinder piston-rods are fixed to the rear end of the slide paths, while those of the compensating cylinders form one piece with the front cross-stay of the slide. The running-out of the gun can be controlled or stopped at will by operating a valve that puts in communication the recoil with the compensating cylinders.

32-CENTIMETRE (12.598-IN.) GUN, 40 CALIBRES IN LENGTH. (FIGS. 450 AND 451, ABOVE.)

Guns of this type have been supplied to the Japanese Government for armament of the coast-guard ships Itsukushima, Matsushima, and Hashidate.

Weight of gun	66,000 kilogs. (66 tons)
„ projectile ...	450 „ (990 lb.)
„ charge (prismatic brown powder)	240 „ (528 „)
Muzzle velocity	700 m. (2296 ft.)
Pressure	2400 kilogs. (15.24 tons per sq. in.)
Angles of elevation	+ 10 deg. − 4 deg.

The gun is made throughout of steel, and is built up in jackets to the muzzle; it is held in the carriage proper by means of a grooved jacket. The breech mechanism consists of a breech-screw with supporting slide, an obturator and the firing device. The breech-screw is cylindrical, with four plain and four threaded parts; it is carried on a supporting slide. It is worked mechanically by means of a crank and a set of toothed wheel gearing which successively turns the block in its seating, withdraws the block, and turns its support round the vertical hinge bolt. The obturator is plastic, and is situated between the front end of the screw and the movable head. The firing device consists of a bolt which acts by percussion. As long as the breech is not completely closed, the bolt that slides in the rear end of the breech-screw masks the vent, and prevents the introduction of a percussion tube; at the same time the striker cannot act, thus doing away with all risk of premature fire.

The mounting consists of bearing-blocks, a slide and a gun-carriage proper. The bearing-blocks are two in number; they are fixed symmetrically to the platform, with the interposition of a sole-plate; clamps prevent all rising of the gun supports. The slide consists of two beams stayed together, their upper surfaces forming slide paths, the front end is provided with trunnions, and the rear end with blocks in which are fixed the recoil cylinder piston-rods. The gun-carriage proper is semi-cylindrical in shape and rests on the path of the slide; the recoil cylinders and compensating cylinder are cast in one piece with it.

For setting the gun, hydraulic pressure is necessary, owing to the heavy weights that have to be moved. Presses placed each side of the slide serve for elevating. To the head of both plunger pistons is fixed the end of a pitched chain which traverses the gun; this chain takes a half turn round the racer of the central tube which carries the mounting. For training, the handwheel that governs the mechanism is made to turn in the direction towards which the gun is to be moved. The levers and handwheels are all within reach of the gunner.

The recoil cylinders are on the Schneider-Canet system with central counter-rod. They communicate with each other by a pipe which carries a valve-box fitted to the rear of the intermediate "compensating" cylinder. This arrangement gives full control in the operation of running out and hauling in of the gun. A slide valve governs the distribution in the various cylinders.

340-MILLIMETRE (13.386-IN.) NAVAL GUN.
(FIG. 452, PAGE 446.)

Guns of this type have been supplied for the armament of the first-class cruiser Marceau.

Weight of gun ...	...51,250 kilogs. (51.25 tons)
" projectile ...	... 420 " (924 lb.)
" charge ...	... 195 " (429 ")
Muzzle velocity ...	... 625 m. (2050 ft.)
Angles of elevation ...	... + 11 deg. − 5 deg.

The gun is steel throughout, and is held to the gun-carriage proper by grooved jackets.

The breech mechanism consists of a breech-screw, an obturator, and a percussion firing device. The breech is opened and closed automatically by means of a movable cylinder placed in the rear of the slide, and on which is bolted a rack; this works through toothed-wheel gearing and a shaft, the rotation of which effects the opening and closing of the breech. The working of this mechanism is very simple; the piston remaining stationary, it is only necessary to admit water under pressure to the right or the left of the piston in order to cause the cylinder to move and bring the rack in the required position.

The mounting consists of three main parts; the gun-carriage proper, in which is fitted the gun; an oscillating slide, and foundation support. The gun is without trunnions, but it is held by a series of rings which fit in grooves in a semicircular carriage. Four keys, two in front and two in the rear, are lodged in slots cut partly in the carriage and partly in the gun rings. The gun is, therefore, held throughout in place and cannot turn round. The gun-carriage proper rests on the whole of its length on the slide path of the slide; a system of clamps prevents it from getting displaced laterally. The gun-carriage slide blocks are of gun-metal, the sliding surfaces being fitted with lubricators. Buffers are fitted to the gun-carriage guide; this carries also a specially shaped slide-bar, which operates a pin that regulates the circulation of liquid in the recoil cylinders. The body of the slide consists of two I-beams, in the front end of which are fitted trunnions. Two cross-stays, in front and in the rear, insure the perfect stiffness of the system. Inside the slide are the recoil cylinders placed on the right and the left, and the distribution box; the cylinder for working the breech mechanism is in the rear; on the sides are two fixed buffers, which correspond to those fitted to the gun-carriage guide. The slide also carries the support for the regulating pin. The two foundation supports are symmetrical, and are fixed to the platform, with the interposition of a sole-plate, which holds them together in front, and constitutes, at the same time, a clamp to prevent any rising.

The hydraulic press for elevating the gun is bolted to the turret platform. It consists of a cylinder fitted with a jaw, and a hollow piston with a socket in which fits the spherical head of the connecting-rod, this being also joined by a trunnion to the frame. The slide is raised when water under pressure is caused to act under the plunger. For lowering, it is sufficient to cause the water under the plunger to escape. The central supporting tube is fitted under the armoured deck, with a circular rack for traversing the gun. On each side of this tube, and in the same plane with the circular rack, are placed two hydraulic presses provided with two small hydraulic cylinders. On the lugs cast on the small cylinders are fixed the ends of a pitched chain, which passes round the head pulleys of the large pistons; the small cylinders, in which the pressure remains constant, maintain the chain taut. It suffices, therefore, to send water under pressure in one or the other of the presses to cause the turret to turn one way or the other.

The hydraulic recoil system consists of two lateral cylinders and of an intermediate distribution box. The cylinders are of equal diameter, and are carried on both sides of the piston. The distribution box is provided with a valve loaded by Belleville springs and with a regulating pin. The system works as follows: During recoil, the gun draws back the gun-carriage proper, and with it the pin-slide which regulates the circulation in the recoil cylinders. The liquid passes from the rear to the front of the pistons by lifting the distribution valve, and penetrating through the annular opening situated between the walls of the distribution box and the regulating pin. The latter being governed by the specially shaped slide-bar, leaves for the passage of the liquid a section which varies in such a manner as to cause a tolerably constant pressure to remain in the cylinder during the whole time the recoil lasts. When the recoil is spent, the loaded valve falls on its seat, and shuts off all further communication between the front and the rear of the cylinders, the gun remaining hauled in. To run it out again, it is only necessary to direct water under pressure to the rear of the pistons, the water in front being allowed to escape.

In the above brief notices we have only reviewed a small number of the older types made by Messrs. Schneider and Co. in order to give a general history of the principal natures of "Schneider-Canet" naval guns, manufactured previous to the adoption of quick-firing ordnance. Had we considered every type separately, a whole series of descriptions would have to be given, bearing on questions of detail, many of them now obsolete, and on the many improvements made every year in the designing of war material. Our principal object being to give an idea of the Schneider-Canet system as a whole, it was not necessary to enter into more detail in this part of our subject. Besides, owing to the importance now acquired by quick-firing guns, the ordinary types built, even ten years ago, are chiefly of retrospective interest.

YEAR-BOOKS AND ANNUALS.

A Directory of Titled Persons for the Year 1899. London: J. Whitaker and Sons, 12, Warwick-lane, Paternoster-row, E.C. [Price 2s. 6d.].—Whitaker's publications are indispensable to all who desire to know what is passing in the world, and this work, a companion to the world-renowned Almanack, is not only accurate but brought so far up to date as to include the recipients of New Year honours. The notes as to Constitutional questions are valuable, as they contradict many popular illusions. One is that the death of a sovereign of itself involves the dissolution of Parliament: That is not so. Again, the title of Prince of Wales and Earl of Chester is by individual investment and not by birth, as the title long since was merged in the Crown and is granted by the pleasure of the reigning monarch. There were six Earls of Cornwall who were never created Prince of Wales. In the case of the Heir Apparent alone minority does not preclude his sitting in the House of Lords, which, of course, is a hereditary right. There are many notes of the rights and privileges of the different orders, and of the wonderful mysteries of precedence. The work has therefore much more than what Dickens regarded as the absorbing interest of a directory; with its assistance no business house need make stupid blunders as to who and of what rank is their unknown correspondent.

A New Map of Metropolitan Railways, Tramways, and Miscellaneous Improvements, deposited at the Private Bill Office November 30, 1898. London: Edward Stanford.—The new issue of the map prepared yearly by Mr. Edward Stanford, of 26 and 27, Cockspur-street, S.W., showing the Metropolitan railway, tramway, and miscellaneous schemes for which Bills have been deposited with Parliament, has now been published. Bills for no less than fifteen lines are now awaiting Parliamentary sanction. The general nature of these proposals was clearly set forth in our report on the Private Bill legislation proposed for the present session which we published last autumn, but Mr. Stanford's map renders many of the proposals much more easy and comprehensible than did the *Gazette* notices, which frequently fix important points by the intersections of obscure and unimportant streets.

The Export Merchant Shippers for 1899. London: Dean and Son, Limited, 160A, Fleet-street, E.C. [Price 17s. 6d.].—This is the thirty-fourth year of publication of this work, which gives an alphabetical list of merchants with their trading ports and the class of goods they ship. These are arranged according to towns—Derby, Grimsby, and Lincoln being this year introduced for the first time, and in all 700 new names have been added. Then, again, there is a list of manufactures, with the names under each of the manufacturers, so that any one can at once be cognisant either of all the shippers or makers of any product, or of these resident in any particular town. There are also lists of consuls, Chambers of Commerce, tariffs, and of Lloyd's agents and stations. The steady increase in names has suggested a slightly smaller type, which brings the book into more reasonable limits as to bulk. Accompanying the book is a small itinerary of London, by the use of which much time may be saved, as every establishment is noted in its geographical order. There is a slip in the preface—"Thus there seems little doubt that 1898 will be marked as the biggest shipbuilding year on record." Obviously this should be 1899.

The Railway Year-Book for 1899 (Illustrated). Edited by G. A. Sekon. Published by the Railway Publishing Company, Limited, 79 and 80, Temple Chambers, London, W.C. [Price 1s.].—This is an admirably arranged year-book, and is very appropriately called the Whitaker of the railway service. It might almost be regarded as indispensable to the railway worker, investor, and trader. We have a chronological record of railway history from the seventeenth century, a diary of railway events in 1898, a note specially serviceable for secretaries of statutory returns to be made each year, a convenient synopsis of the powers sought in the current session of Parliament for railway works, while full details are given of 36 railway companies, including historical narratives, lists of directors, officers, &c., capital and revenue accounts, with a careful analysis of same, and in most cases a clearly printed map of the line is given separately. There are also many facts about colonial railways, and about railway subjects in general, with lengths of tunnels, time on long-distance runs, comparative details of working the principal lines, &c. It is surprising in the way to note that there are 67 railway directors with seats in the House of Commons, or would it be more appropriate to say 67 M.P.'s have seats on railway directors' boards?

City of London Directory for 1899. London: W. H. and L. Collingridge, *City Press* Office, Aldersgate-street.—This is the twenty-ninth annual issue of this work, which serves a very useful place among the many directories now used. It is essentially a City of London work of reference. Thus there are biographical sketches, with portraits, of the Lord Mayor, the Sheriffs, Aldermen, and officials, a guide and historical narrative of the livery companies, with a list of the members of each. Many of the old historic buildings are described, and there are the usual alphabetical commercial and trades directories, street directories, a list of public companies with the City, and other such details—ecclesiastical and educational, mercantile and municipal, &c. The work is brought well up to date, and there is a large scale map of the City divided into the various wards. The book is indispensable to all connected in any way with the City. The binding, by the way, consorts with the dignity always associated with the City.

The Chronicle and Directory for China, Japan, Corea, Indo-China, Straits Settlements, Malay States, Siam, Netherlands, India, Borneo, the Philippines, &c., for the Year 1899. Hong Kong: The *Daily Press* Office, Wyndham and D'Aguilar streets.—The immediate future is bound to see a great expansion of trade with the East, and our manufacturers will do well to thoroughly study commercial treaties, trade methods, routes, and the geographic and climatic conditions of possible *clientèle*. In this directory they will find all they need under these respective heads, and it will go a long way to supply that acquaintance with the countries which can, of course, be best attained by a visit of more or less duration to the East.

The Cyclist's Indispensable Handbook and Year-Book for 1899. Edited by Henry Sturmey. London: Iliffe, Sons, and Sturmey, Limited, 3 St. Bride-street, Ludgate-circus, E.C.—This is the nineteenth year of this annual. It is now reduced in the size of the page, although increased otherwise in bulk, and the change makes it a much handier book. A feature, as in previous years, is the illustrated record of novelties in cycle construction and accessories for 1899, and we commend the compiler for his conciseness and clearness of the explanations. A chapter is added on the weight of cycles, and a useful list is given for the first time of the makers of all accessories. There is the usual data as to records, portraits of champions, and a directory of all clubs and cycle companies.

ARGENTINE IMMIGRATION.—In the course of January 12,621 immigrants arrived in the Argentine Republic. The corresponding total for January, 1898, was 10,508.

pose of adding small amounts of nickel to pure aluminium. The nickel was melted in a plumbago crucible under a layer of borax; and at a proper temperature the aluminium was added, and the whole mass was stirred with a plumbago stirrer. The alloy immediately became incandescent and boiled. It was then poured into iron moulds, in the form of ingots weighing about 10 lb. The metal when poured was very fluid and free from the viscosity so often noticed in nickel and nickel alloys. The colour of the alloy is grey, not unlike that of wrought iron, and the fracture is devoid of any crystalline appearance. It is quite brittle, and can be readily ground to a powder in a mortar. More metal was made than was needed; and what remained unused was placed in a covered wooden box and set away. In about three months, as it was again necessary to use the alloy, the box was opened; and, much to my surprise, nothing but a dark grey powder was found in it. This condition of the alloy could not be accounted for. An attempt was made to melt the powder and pour it again into ingots, but with negative results. Analogy pointed to disintegration; and it was decided to make a fresh sample of the alloy, and watch the material from the beginning. In the second experiment the conditions were identical with those of the first, with the exception that fluor spar was substituted for the borax. This change was made because it was thought that perhaps the borax might have been decomposed so that boron or sodium, or both, had entered the alloy. No difference could be detected between the appearance of this metal, and that of the preceding experiment. The ingots, visible at all times, were allowed to lie in the open air. In about one month cracks appeared on the surface of the ingot, and, as time elapsed, became more extended and penetrated to a much greated depth; soon new cracks appeared and the ingot split into many large pieces. Such a change went on for two months more, or until the whole mass became a coarse powder. The experiment was tried again by melting the nickel and aluminium together under a flux; and again, in order to make sure that no outside reagent was present in the alloy, the ingredients were melted without any fluxes. In each case the results were the same. It is well known that many alloys are subject to disintegration, notably an alloy of tin and aluminium. Indeed, brass is subject, more or less, to this phenomenon; but the author believes that the disintegration of an alloy of nickel and aluminium has never before been observed. An alloy of nickel 90 per cent. and aluminium 10 per cent. was made by the author September 16, 1895; and a recent examination of the ingot failed to reveal any trace of disintegration. Such alteration is limited, so far as yet observed, to the half-and-half alloy.

IRON ORE IN VIRGINIA.

"The Rich Patch Iron Tract, Virginia," by H. M. Chance, described the topography and geology of about 9000 acres in Alleghany Co., Va., adjoining the Low Moor tract, and was illustrated by geological maps.

There are in it two distinct beds, one of Oriskany brown hematite ore and one of red hematite, but mining has been confined to the lower bed. The ore contains practically no sulphur and ordinarily below 0.03 per cent. of phosphorus. The iron ranges from 42 to 55 per cent., averaging 47 to 49 per cent. With careful preparation it may be raised to 50 per cent., and the silica kept down to possibly 11 to 14 per cent., although under the present methods of preparation it has ranged from 15 to 19 per cent. The Buena Vista furnace when run exclusively on this ore produced a ton of pig iron with an average consumption of 2.19 tons of ore. The ore of the lower bed is found in a regular synclinal trough, the bed having an average thickness of 35 ft. to 40 ft. The quantity of ore in the two beds is enormous. One range, estimated conservatively at 20 ft. thick, extends east and west about 6½ miles, or 32,000 ft., with not less than 500 ft. on the slope above water level. Another range is 30,000 ft. long, 300 ft. deep, and 30 ft. in average thickness, and a third range is estimated at 20,000 ft. long, 500 ft. deep, and 300 ft. thick.

The method used in extracting this ore is that commonly used in the region in mining brown hematite ore under cover. The levels are driven close together, connected by up-raises, which are used as chutes for loading the ore into cars on the main drift or car level below, and each drift is robbed back from the boundary by withdrawing or blasting down the timbering, allowing the overlying material to fall behind, as fast as robbing progresses. By this method practically all of the ore is extracted, none being left in pillars, as is done in other styles of mining. This method has reached its best development in this district on this property, and notably at the adjoining Low Moor property and at Longdale, where the same vein is mined.

The method of preparation is capable of material improvement without increasing the cost of the ore, and without involving a large additional outlay for plant. The ore is largely lump ore, which requires no preparation. A variable percentage of the output is so-called "wash" ore, which consists of fine particles of ore ranging in size from wheat grains to fragments 2 in. or 3 in. in diameter, and containing a little clay and sand, which are removed by washing in revolving cylindrical washers. The clayey matter dissolves easily in water, and the ore is washed quickly and effectively by the apparatus in use. It is evident that this apparatus does not remove particles of coarse sand, fragments of flint, sandstone, and other impurities which may exist in the ore. Properly to prepare this one for furnace use, these impurities should be removed by jigging the ore, as is commonly done in many of our brown hematite ore districts. The addition of jigs would not only increase the percentage of iron in the ore as shipped, but would also materially decrease the percentage of silica; it would also make it possible to utilise some lump ore which is occasionally rejected because particles of flint or quartz are imbedded in the lumps, and which in the aggregate amount to a considerable quantity. This material should be crushed and jigged, and the washed product added to the washed ore. The average of wash ore shows about 60 to 80 per cent. of ore, or a loss in weight by washing of from 15 to 40 per cent., varying, of course, with the amount of clay and other impurities, such as sand, decomposed slate, &c., which it contains.

CHROMITE IN NORTH CAROLINA.

"Chromite in North Carolina" was read by Mr. J. H. Pratt, of Chapel Hill, N.C. The following are some extracts from this interesting paper:

Extending from Ashe County to Clay County, N.C., there is a series of disconnected peridotite outcrops; and chromite is associated with all these peridotite rocks. It is, however, in few localities only that the mineral has been found in considerable quantity. Although prospecting for chrome ore in this State was first undertaken over thirty years ago, and has been continued spasmodically ever since, there has never been any systematic development of the localities. The general character of the chrome ore is nearly uniform throughout the entire area, being very hard and compact, though often of a fine granular appearance, and there is but little that is at all friable. The masses of chromite are usually very free from seams of peridotite or its alteration product, serpentine. This simplifies the concentration, and a high-grade ore can usually be obtained by cobbing and hand-picking.

An analysis of a selected specimen of the chromite gave:

	Per Cent.
Cr_2O_3	58.00
Al_2O_3	15.52
FeO	14.45
MgO	8.26
SiO_2	3.20
CaO	.70

Although this analysis represents a selected sample of the chromite, yet from the character of the material it is not unreasonable to expect an ore that, by hand-picking and cobbing, will assay in the neighbourhood of 52 per cent. of chromic oxide, with a low percentage of silica.

(*To be continued.*)

MESSRS. SCHNEIDER AND CO.'S WORKS AT CREUSOT.—No. LII.

QUICK-FIRING GUNS—(*continued*).

2. BREECH MECHANISM.

THE Schneider-Canet breech-closing arrangements, though comprising a large number of types, embody general characteristics common to all of them. They all have been thoroughly tested, and the various types are adapted to fulfil the different conditions required for naval and land service. The designing of breech mechanisms having been carried out simultaneously with that of the whole material, it is necessary, in order to form an idea of the important progress made, to pass in review successively the various typical patterns that have been manufactured and put into service.

Until 1895 the Schneider-Canet guns were exclusively fitted with breech-blocks having interrupted screws. This system, and its many undoubted advantages over the wedge-closing devices, are now well known, and we shall not enter into details on this point. It will suffice to remark in passing that every nation has now adopted the breech-screw mechanism.

Since 1895, Messrs. Schneider and Co. have put into service, after protracted experiments, an entirely new type of breech-closing arrangement, which is known as the "concentric threaded breech-piece"; this combines the good qualities of the wedge and screw system, without any of their disadvantages. In its most modern form, which has resulted from experience gained during the last twelve years, the Schneider-Canet breech mechanism combines the following advantages:

Ease and rapidity in working.

Excellence in the design of the various parts composing the mechanism, and facility with which it is taken apart.

Complete safety during all the various phases of service.

In the following descriptions we shall consider the principal types that embody special features separately, classifying them, for greater convenience, according to the number of motions required to operate the complete opening of the breech. This will lead to an approximately chronological enumeration of the various types, corresponding generally to the dates of trial and adoption in service. The arrangement will, better than any other classification, enable our readers to follow the steady progress made in the Schneider-Canet quick-firing system with regard to the breech mechanism.

The classification will therefore be as follows:

1. Three-motion breech-piece.
2. Two-motion breech-piece.
3. One-motion breech-piece.
4. Concentric threaded breech-piece.

We shall only describe a few specimens of the first type, as it was first adopted several years ago, and being now antiquated is only used for new guns when expressly specified, or when it is a question of completing existing armaments in a uniform manner. The various breech-pieces of this type differ one from the other in a few accessory details, the main parts being practically all similar. They have been applied to guns of all calibres, including those of 27 centimetres (10.630 in.) and in working they invariably gave satisfaction. One of the delicate parts of this type of breech, the plastic obturator, has been carefully improved by Messrs. Schneider and Co. in order to insure its satisfactory action under the various conditions of service. The practical result has been a composite elastic obturator, which does away with all the difficulties that attended the use of those of the ordinary kind.

The five types illustrated by Figs. 454 to 476 (pages 510 and 512) consist each of a breech-block with interrupted screw, an obturator, and the firing device. The breech-block is made with three threaded parts and three interruptions; it is carried on a bracket which pivots round a vertical hinge bolt. The obturator consists of a plastic elastic disc, placed between the moveable head and the rear end of the breech-screw.

To open the breech it is necessary (1) to lift the hand lever in order to disengage the cam, and to give to the breech-piece one-sixth of a revolution with the help of the same hand lever; (2) to lower the lever in order to disengage the obturator, to pull the block from the breech by taking hold of the fixed handle; and (3) to turn it back to the side on the vertical hinge bolt. To close the breech the same motions are repeated in inverse order. During these various operations a special slide bolt, not fitted with springs, but acting on two combined inclined planes, unites alternately the breech-screw to its support and the support to the gun. The views we give reproduce the successive phases of opening the breech, they show:

1. Breech closed.
2. Breech-block disengaged, lever brought down.
3. Extraction of breech-block.
4. Swinging of breech-block to the side.

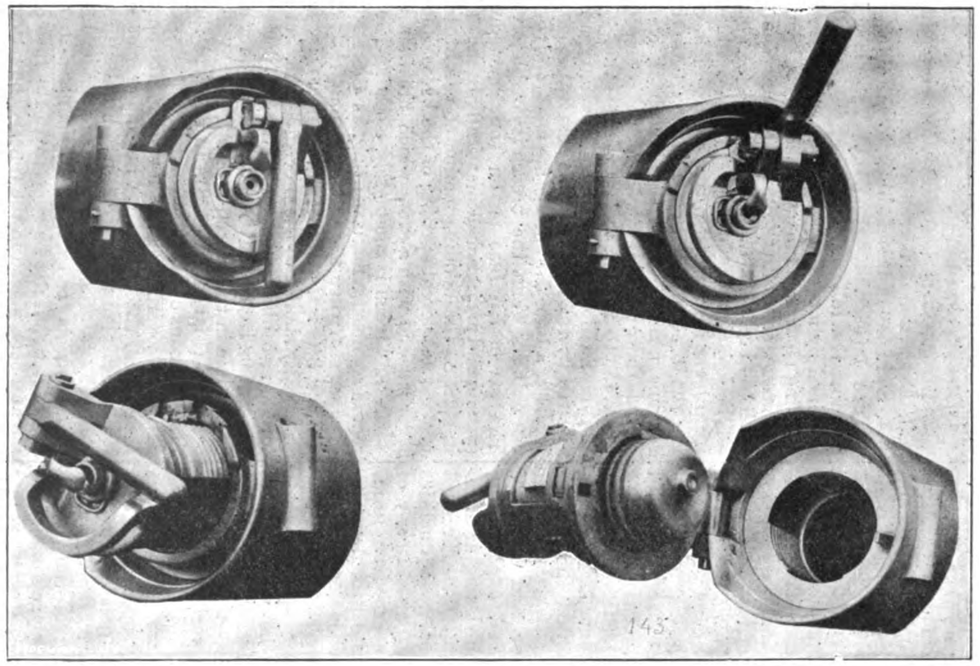
Type 1 (Figs. 454 to 457). This breech-piece contains the following accessory devices: Firing is obtained by means of a friction fuse. During the opening motions a finger worked by a cam, which forms one piece with the hand lever, masks the vent until the breech is completely closed. To prevent all backward movement of the breech-block, the hand lever is provided with a cam, which, on closing the breech, fits in a mortice. As the vent remains masked, until the breech is completely closed, there is no risk whatever of premature fire. Figs. 458 to 461 is a variant of this type.

Type 2 (Figs. 462 to 465). In this type firing is effected by a slide bolt, which acts by percussion, by means of a line. No springs are used, and the striker can only act when the breech is completely closed. The percussion fuse is on the Schneider-Canet system, and is ejected automatically from the breech in starting the opening motion of the breech. To prevent accidental opening of the breech-block, the lever is made with a cam, which fits in a mortice when the breech is completely closed. The gun is secure against premature firing, as the striker can only act also when the breech is completely closed.

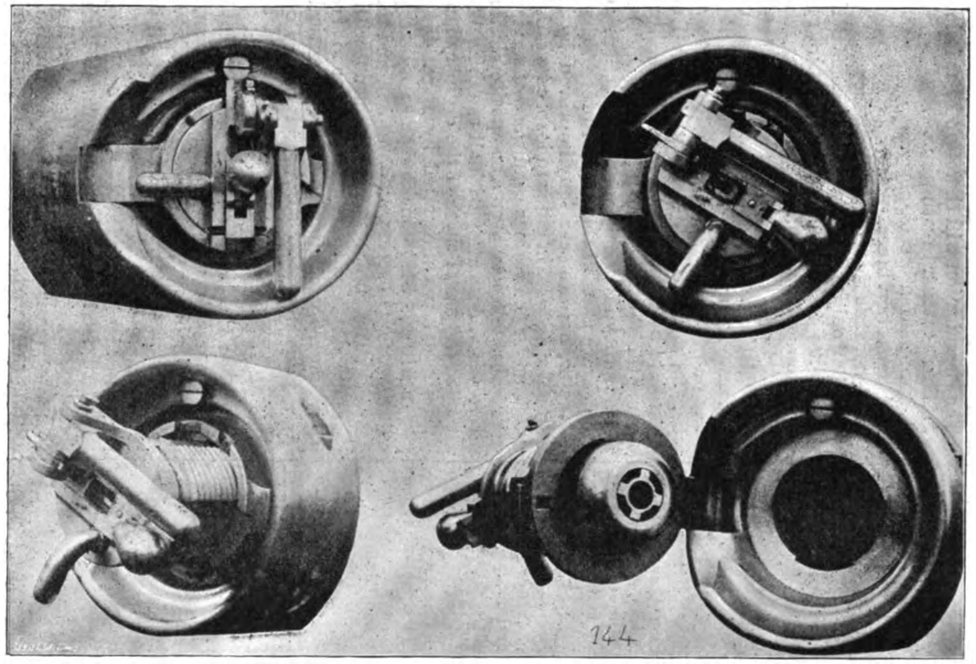
Type 3 (Figs. 466 to 469). This arrangement is practically similar to the preceding one, but is used for larger-calibre guns. The various parts of the mechanism have been simplified and hidden as much as possible in the breech itself.

Type 4 (Figs. 470 to 476). In this type the gun is fired by means of a bolt that slides in the breech-piece and acts by percussion. On starting the opening of the breech, the bolt being no longer placed opposite a rectangular space cut in a circular groove on the rear end of the gun, the vent cannot be freed; moreover, as the striker is maintained slightly lifted, it would not be opposite to the fuse had this already been placed in the vent. The striker is set by hand and acts by means of a firing line. The lever is provided with a cam that fits in a mortice

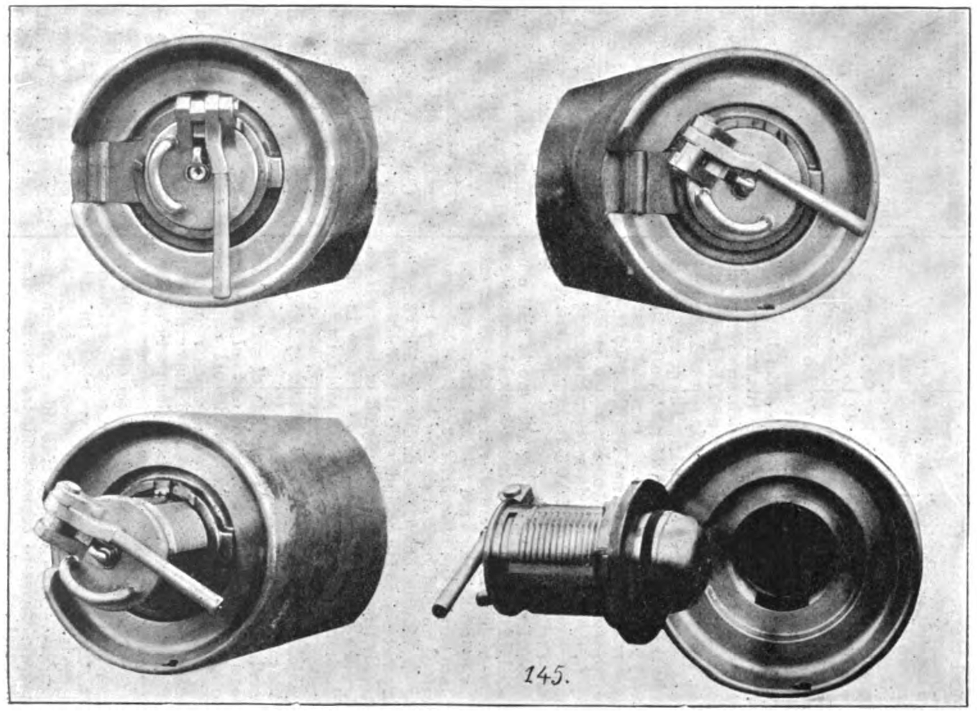
SOME EARLIER TYPES OF SCHNEIDER-CANET QUICK-FIRING GUN BREECH MECHANISM.



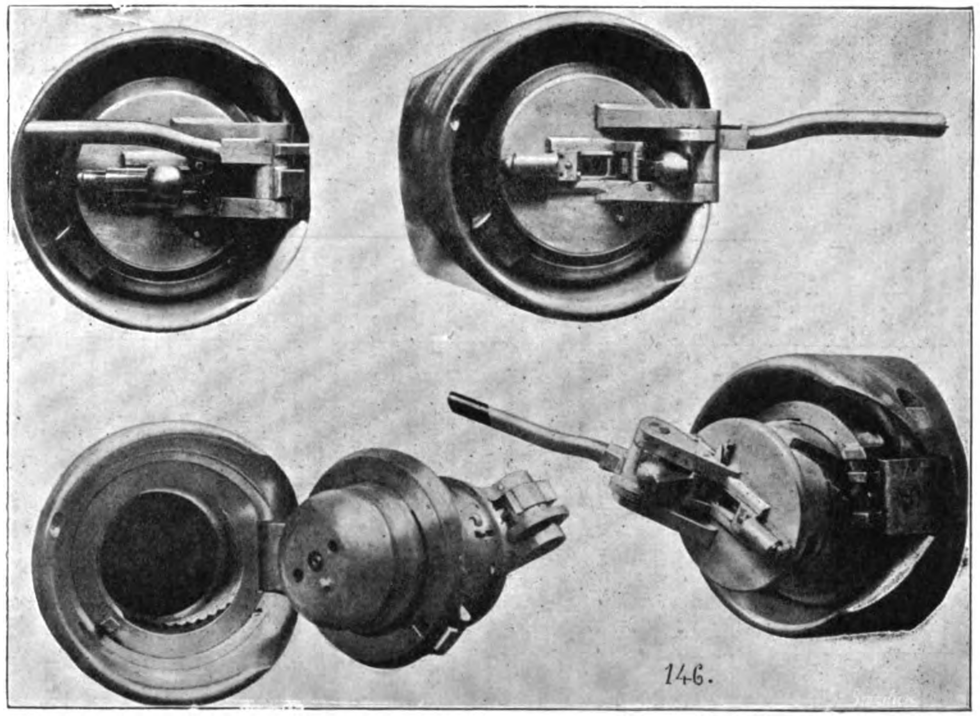
FIGS. 454 TO 457. FOUR POSITIONS OF BREECH MECHANISM, TYPE 1.



FIGS. 462 TO 465. FOUR POSITIONS OF BREECH MECHANISM, TYPE 2.



FIGS. 458 TO 461. FOUR POSITIONS OF BREECH MECHANISM, VARIATION OF TYPE 1.



FIGS. 466 TO 469. FOUR POSITIONS OF BREECH MECHANISM, TYPE 3.

THE SCHNEIDER-CANET BREECH MECHANISM FOR 12-CENT. AND 138.6-MILL. QUICK-FIRING GUNS.

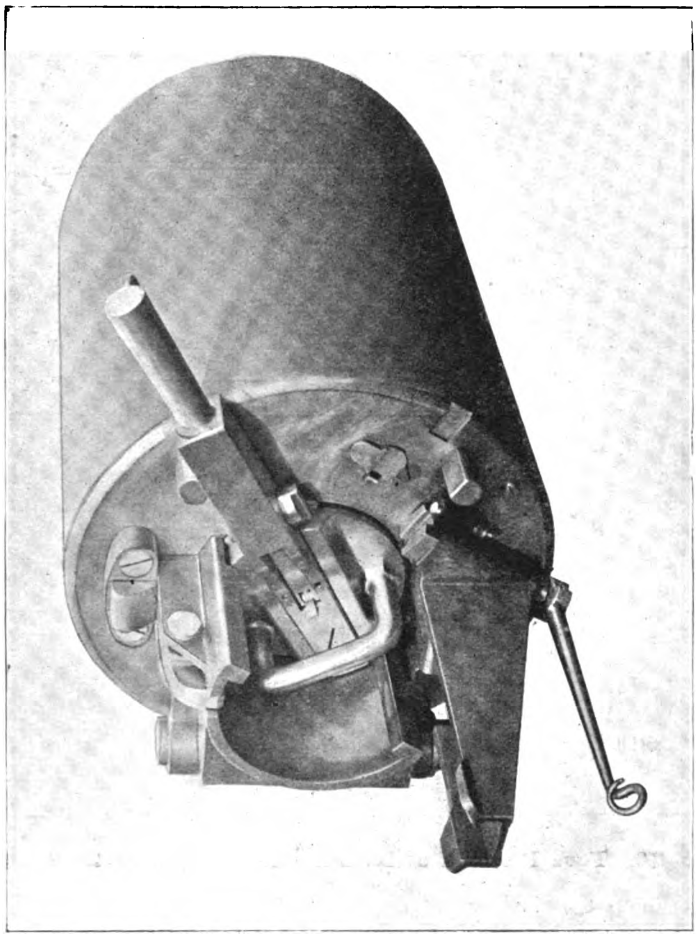


FIG. 478.

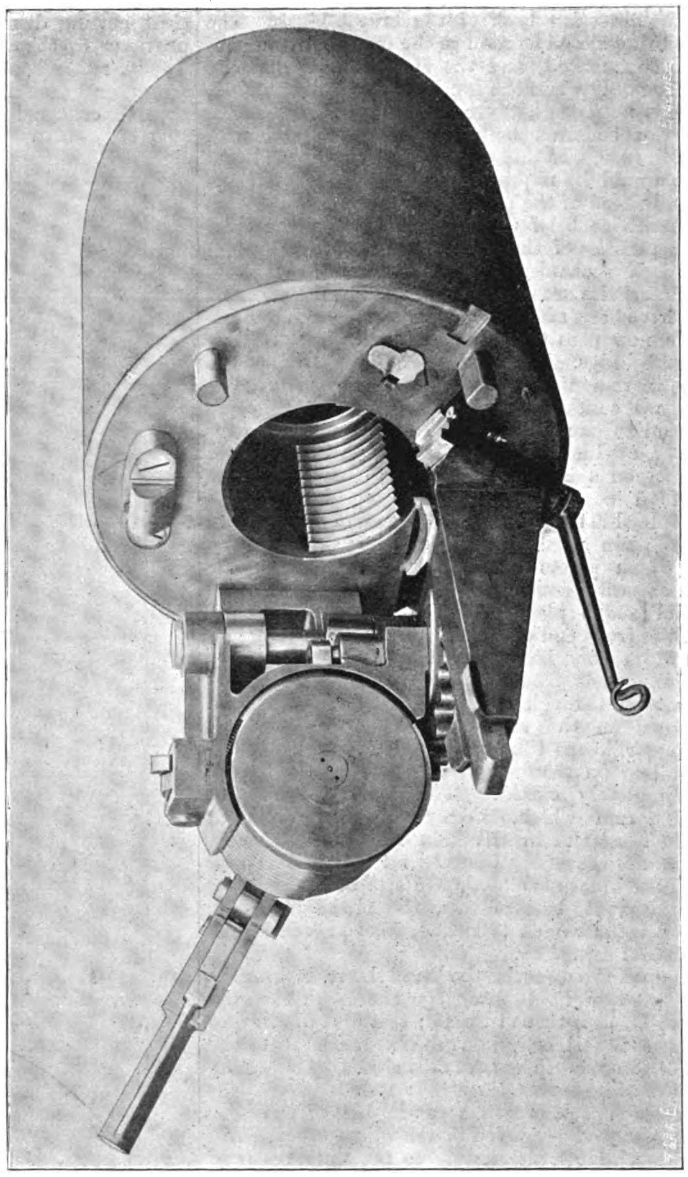


FIG. 480.

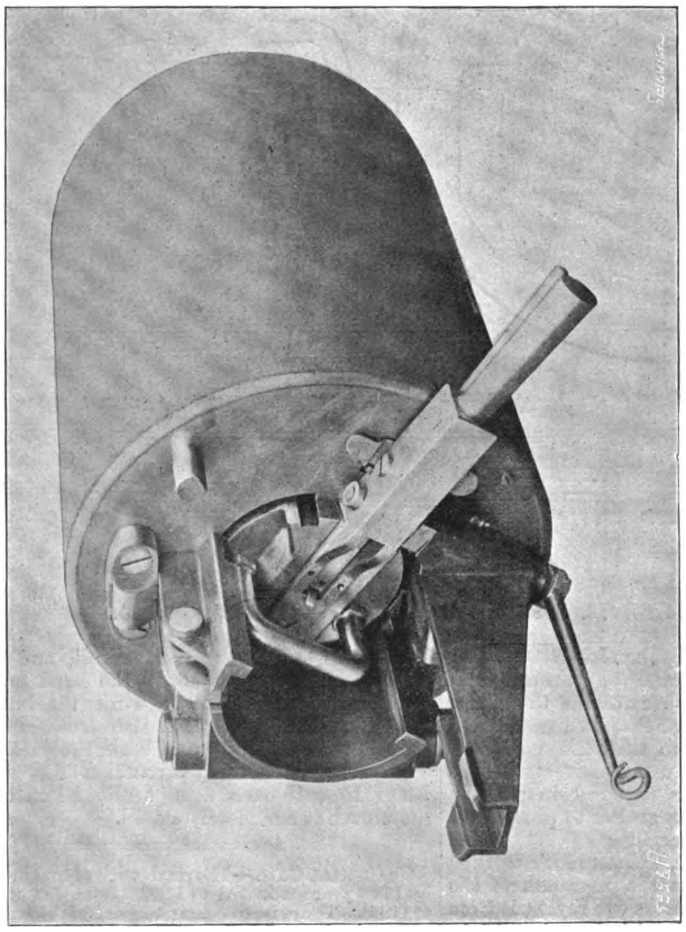


FIG. 477.

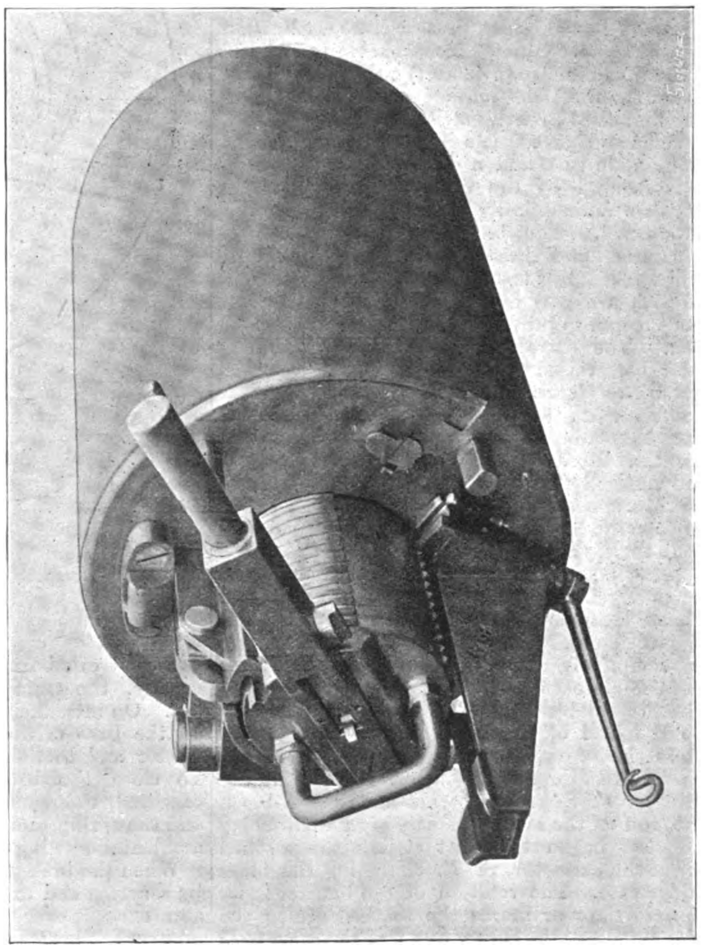


FIG. 479.

when the breech is completely closed, thus preventing the throwing back of the breech-block. The vent being closed as soon as the operation of opening is commenced, and the striker being opposite the fuze only when the breech is completely closed, there is no risk whatever of premature fire. The gun can be fired both by percussion and with friction fuze. In this type only a few slight alterations would be required to use metallic cartridge cases, instead of the plastic obturator.

The above brief descriptions explain the chief characteristics of the earlier types of this system of breech mechanism, and it will be seen that these characteristics are still more defined in the patterns that have been manufactured subsequently.

We now pass to a further development, illustrated by Figs. 477 to 480, page 511. In this the three movements are still effected successively, but they are continuous, so that practically they are reduced to one operation. The breech-piece consists of a cylindrical screw, but the threads are set out as on a helicoidal surface; there are two threaded parts and two interruptions (in the example illustrated there are three threaded and three plain parts). The block is carried by a rest which pivots round a vertical hinge bolt. The obturator consists of a plastic elastic disc of special shape placed between the movable head and the front end of the breech-piece; or metallic cartridges may be used. Firing is effected by a sliding bolt fitted with a striker that acts by percussion through a spring that presses against a tappet on the rear end of the breech-block. A trigger keeps the gun cocked, and it is fired by pulling on the firing line only when the breech is completely closed. The lever is provided with a cam which, when the breech is closed, fits in a mortice in the slide rest of the breech-screw, and prevents all accidental back movement. Until the breech is closed, the striker is not opposite the vent, besides this, the striker can only act when the breech is locked, thus preventing all accidental firing.

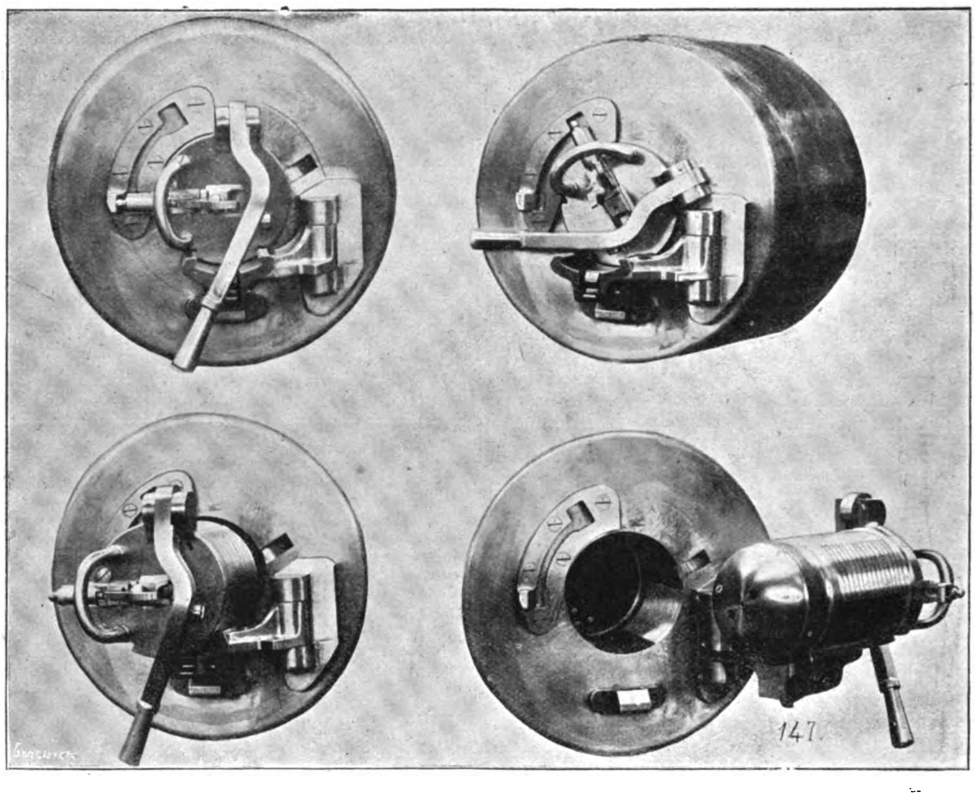
To open the breech, the hand lever is brought from left to right, to disengage the cam; then the breech-block is turned round; this first disengages the threads and brings out the breech screw to the side of the gun. The breech is closed by repeating these motions inversely.

In this type of breech a special bolt of the same pattern as that employed in the other types, joins the breech-block alternately to the slide rest and this to the gun.

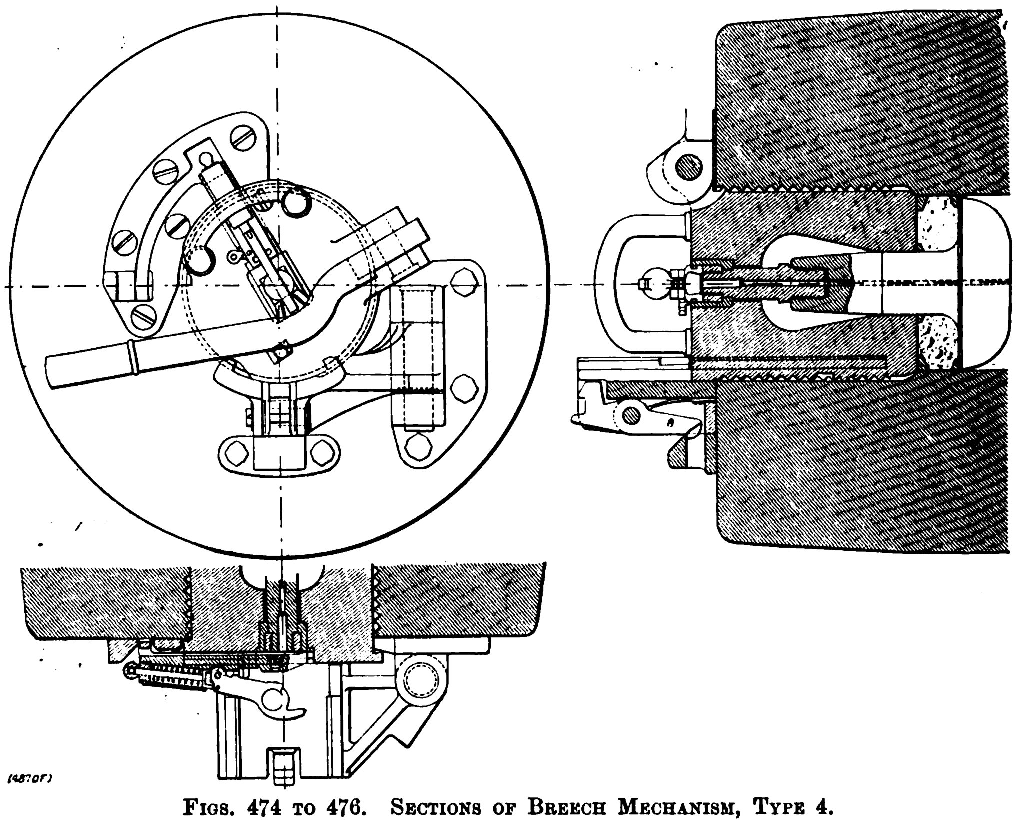
A good idea of this type of mechanism is given by Figs. 477 to 480, which illustrate the application to the Schneider-Canet 12 centimetre (4.724 in.) and 138.6 millimetre (5.456 in.) quick-firing guns. As fitted to the 138.6 millimetre (5.456 in.) guns of the first-class French battleship Charles Martel, the arrangement consists of a breech-block, a pivoting slide rest, and a double latch. Obturation is insured by the brass cartridge-case, the empty case automatically leaving the breech when it is opened. The breech-block is made with fifteen interrupted threads, on four equal sectors, and is worked by means of a hand lever; a cam fitted with a spring fits in a mortice on the rear end of the gun to prevent accidental opening of the breech. The extractor consists of a thick rectangular bar raised in front to form a clutch and toothed laterally. A toothed sector that turns freely on a hinge engages the extractor permanently and forms a socket in which a cleat can enter, fitted to the bracket. The cleat is placed vertically, its top part being made to rest by means of a spring, on the hinge bar.

To open the breech, the hand lever is turned one-eighth round, the small lever that works the spring cam being taken hold of at the same time, as the latter then gets disengaged from the gun and causes the hand lever to act freely. The screw-block is then pulled out, guided by the bracket clutches; when completely out, it strikes against the butt end of the clutches, the shock causing the head of the bracket double-latch to be freed from its catch, while the heel of the latch engages in a groove made in the screw, the cleat being in the hollow made for it in the toothed sector. On pulling the hand lever sharply the bracket and breech-block turn round on the hinge; shortly after the turning motion has begun the cleat strikes the toothed sector of the extractor, the shock freeing the brass cartridge-case. The rotation of the bracket in its motion to the rear moves the toothed sector, the extractor-rod and the empty case; at the same time the hinge bar causes the cleat head to rise, the cleat getting disengaged from the toothed sector previous to the complete rotation of the bracket. The extractor has then been brought back to such an extent that the cartridge-case has advanced several centimetres from the rear end of the gun, and can be removed by hand. By working rapidly, the empty case would be thrown right out. On introducing a fresh cartridge the flange on the base of the cartridge-case brings the extractor and toothed sector to their first positions. To close the breech the usual movements are executed, the hand lever is replaced in position and the spring cam fits in its groove to prevent all accidental opening of the breech.

When the breech is closed, a small block worked by a spring and arranged on the rear end of the gun, extends over the hand lever to prevent it from moving; it is fitted laterally with a spring catch. When the gun is fired and during recoil, the block by its own weight and under the action of recoil, enters a groove in the gun, disengages the hand lever, and the spring catch enters a notch which prevents its return; it is then possible to work the lever in order to open the breech. In case of missfire the gun does not recoil, and the block remains in its position above the hand lever, thus rendering it impossible to work the latter. To open the breech-block it is therefore necessary, in such a case, first to push back the safety block. The gun can be fired by percussion or by an electric fuze. In both cases firing cannot be effected until the breech is completely closed.



FIGS. 470 TO 473. FOUR POSITIONS OF BREECH MECHANISM, TYPE 4.



FIGS. 474 TO 476. SECTIONS OF BREECH MECHANISM, TYPE 4.

TRANSVAAL COAL.—The production of coal in the Transvaal last year amounted to 1,907,808 tons, of the value of 668,346*l*. The corresponding output in 1897 was 1,600,212 tons, valued at 612,668*l*.

RADIAL DRILLING MACHINE.

THE boring and tapping machine, which we illustrate on page 503 was built this year by the Russian Locomotive and Engine Works, of Charkow, which are under the management of Mr. P. Rizzoni. The machine is constructed for boring holes and cutting threads in armour-plates in the bent state. The boring spindle can be driven at ten different speeds by the intermediary of a five-step cone pulley and of various wheel gears. The arm which moves up and down can be turned through an angle of 100 deg. The slide can be adjusted radially both by hand and power. The spindle is balanced; it is put in gear automatically or by hand by means of worm gearing. Its own motion can be varied by a four-step cone pulley. There is a special device for promptly releasing the nut when cutting threads up to 6 in. in diameter, for which purpose a screwed tool is employed. This device is also made use of when the boring spindle is to be shifted longitudinally, independently of its coupling mechanism. A handwheel has been provided for this operation. The device renders essential service in drilling deep holes, as the tool can quickly be fixed at various heights, and the borings can be removed at short intervals. The chief dimensions of the machine are as follow:

Diameter of boring spindle	160 mm. (6.3 in.)
Vertical travel of boring spindle	700 „ (27.6 „)
Maximum radial range ...	3750 mm. (12 ft. 4 in.)
„ elevation of boring head above floor	3200 „ (10 „ 6 „)
Vertical travel of arm ...	2000 „ (6 „ 6 „)
Weight of machine without bedplate	38 tons

AMERICAN LOCOMOTIVES.
TO THE EDITOR OF ENGINEERING.

Sir,—In many press notices issued from time to time we have had impressed upon us that "Further orders for locomotives, &c., have gone to American competitors," these for use on several of our English railway systems; and a discussion or inquiry into the reasons would be both instructive and useful, for undoubtedly false statements have and will be made, and blame will be laid upon the shoulders of our English engine-building firms, reflecting discredit, alike, both on employers and employés.

That orders have been given is a fact; and presumably these orders have been given on market competition with our own builders. Then:

1. These orders have been given because the locomotives are wanted, and wanted urgently.
2. The engines can be more quickly delivered by the American than by the English builders.
3. It will be presumed they will be cheaper.

Now the point which seems to need elucidation is the second one, for, if it be true, that the Americans can build and deliver the engines in a shorter time, then the third point (at any rate partially) follows:

Can such work be more quickly turned out by the American engine-builders? is what those interested will ask. How can this be so? Is it a reasonable conclusion? especially seeing that many of our English firms have experienced little difficulty (or none they could not overcome) in coping with previous orders, and the standard of designs cannot have so materially altered, but it would have been easier for these firms to have again supplied the demands made.

To the observer it would seem that the American firms can and do get through the work more quickly; in point of fact, that their methods of production are in advance of our own, and a careful consideration of the subject should be useful in finding out where the gain in speed is, and how obtained. I believe that an average English workman is as good and as quick, indeed compares to advantage with any other nationality; and we have had optical proof that, as far as erecting goes, our workmen can join issue with any other, and, this fact is forced upon us, that the gain in speed is in the very careful consideration given by the American engineers to the details worked up right from drawing-office, through foundry, forge, machine-shop, to the erecting-shop, such detail that does not stop at the consideration that to produce a certain machine form or component part a casting has to be made, or a forging and a certain amount of drilling, planing, milling, &c., has to be done to complete the form; but intense thought is given even in the mixing of the metal in the cupola, more care is given to the "skin" as to the effect the produced castings, or in another case the produced forgings, will have upon the life and the work of the tools and machines used in advancing the work. Taking care that the minimum of work is put upon the form at the maximum of speed, more thought is given to the suitable speeding of the tools and to suitable arrangement than (in many cases, at any rate) is deemed necessary by our English firms; and, too, more emphasis is laid upon the curtailment of unnecessary work.

Now, Sir, in conclusion, I think it should be particularly urged that our English firms and workmen can and do produce work equal to, nay, even better than those of any other country, and this giving of orders to American locomotive builders is no reflection upon the standard of our work, but to the mind of the average observer is a distinct reflection upon our methods.

And the sooner our English firms thoroughly and practically arrive at this conclusion, the sooner will our papers be free from paragraphs headed "More foreign locomotives for our English railways."

Yours faithfully,
Birmingham, April 13, 1899. MACHINE WORK.

FRIENDLY SOCIETIES.
TO THE EDITOR OF ENGINEERING.

SIR,—In your issue of the 7th inst. under "Industrial Notes," you gave an interesting account of the "Ancient Order of Foresters," but I should like to point out that one part of it is incorrect.

You say "The Ancient Order of Foresters is but one of several great orders, the Oddfellows coming next in importance as regards numerical strength and financial worth."

Now, Sir, as an Oddfellow, I should like to inform you that the "Manchester Unity Order of Oddfellows" is the largest and richest friendly society. The aggregate membership in all classes is 944,769, while the total funds amount to upwards of 9,500,000*l*.

You will, therefore, see by the figures you published that the Foresters must still play "second fiddle" to the Manchester Unity of Oddfellows, both numerically and financially.

Yours truly,
Warwick, April 13, 1899. W. HAMMOND.

ELECTRICAL MOTOR CARRIAGES.
TO THE EDITOR OF ENGINEERING.

SIR,—There seem to be so many obstacles to the ultimate firm establishment, and apparently inseparable from the early life of a new industry, such as the adverse state of the law, the over-sanguine inventor, and, lastly, the professional company promoter, that those who are most interested in the matter, and one who has largely contributed to the years of labour necessary in making the electrical vehicles a practical success, take all these things as a matter of course. But when a gentleman of the standing of Sir David Salomons states (assuming that he has been correctly reported in "The Royal Magazine" of this month) that the electrically-propelled carriage is an impossibility, it is to be pardoned if the remark is not allowed to pass unchallenged. And one is almost inclined to think that it was made without due consideration, as was the case when the same gentleman, in estimating the cost of propulsion by electricity a year or so ago, based his calculations on the cost of electric current at 4d. per unit, whereas at that very time it was to be obtained in London at 1d. per unit!

That one does not see many self-propelled carriages on the streets here is not evidence that they are unpractical. Our natural caution in adopting new ideas and our love of horses are enough to account for this; although, as a lover of horses myself, one of the last uses I would put a horse to would be the hauling of a tramcar or an omnibus; and I think that many of the horses one sees in cabs are fit subjects for anyone's compassion, and the sooner their use is rendered unnecessary by the introduction of electricity the better.

In spite of the long start which the automobile movement has had on the Continent, and in view of the fact that it is only during the last two years or so that one was allowed to run a motor vehicle on the street here at all, it is a very significant fact that the principal systems of electrical vehicles which have been adopted in Paris are of English origin.

The argument which Sir David is reported to have used when discussing the "inutility" (*sic*) of electrical motors, "it is as if one should go for a fast drive and expect the horses to gallop along with a load of passengers as well as a dozen sacks of coal," is not to the point; and one is tempted to remark that the horses would go very fast indeed if they had no load at all to carry.

But why Sir David should try to prove the matter by wishing to carry accumulators (represented by the sacks of coal) in a horse-drawn vehicle, I fail to understand; for when we carry a set of accumulators in our electrical vehicle, we do not want to carry a horse, but do without them.

In conclusion, I can only say that regarding the weight of an electrical carriage, it is now quite possible to produce one capable of carrying two persons for a 40-mile journey, the total weight of the carriage being under 12 cwt., at a cost for electric current of 2s., and an annual expense for renewal of accumulators of 20*l*.

Thanking you for your courtesy in inserting this letter, and apologising for taking up so much of your valuable space,

I remain, Sir, yours truly,
C. OPPERMANN.
The Automobile Club, S.W., April 17, 1899.

CATALOGUES.—Mr. Alfred Wilson, engineer, Stafford, has sent us a copy of his catalogue, in which the well-known Wilson gas producer is illustrated and described. Various tables of physical constants, and the like, are included in the letterpress.—The United States Metallic Packing Company, Soho Works, Bradford, have sent us a catalogue of the air-compressing plant made by Messrs. Curtis and Co., St. Louis, for whom they are the English agents.—Other catalogues received from the same firm describe the Bradford portable power drill and receiver, and other machine tools also operated by compressed air as well as the packing, which forms the firm's speciality.—The Edison and Swan United Electric Light Company, Limited, of 36 and 37, Queen-street, Cheapside, have sent us an illustrated description of a new electric light fitting which they have designed for carrying lamps and globes outside shop windows and in other similar situations.

LAUNCHES AND TRIAL TRIPS.

ON Tuesday, the 11th inst., Messrs. Craig, Taylor, and Co. launched a fine steel screw steamer from the new portion of their shipbuilding yard into the new turning berth at Thornaby-on-Tees. The dimensions of the vessel are 299 ft. by 43 ft. by 21 ft. 3 in. moulded. Triple-expansion engines have been constructed for the boat by Messrs. T. Richardson and Son, Limited, Hartlepool, the cylinders being 22 in., 35 in., and 59 in. in diameter by 39 in. stroke, with two large boilers working at 163 lb. pressure. The vessel has been built to the order of Mr. Felix de Abasole, of Bilbao. As the vessel left the ways she was christened the Archanda.

The trial trip of the s.s. Birker Force took place on the 12th inst., and proved highly satisfactory, a speed of 10½ knots being attained. This vessel was recently launched by the Irvine Shipbuilding and Engineering Company, Limited, Irvine, for the Birker Force Steamship Company, Limited, Whitehaven, and is specially fitted for their coasting and Continental trade. Her dimensions are 165 ft. by 25 ft. by 12 ft. moulded, with a carrying capacity of about 600 tons. The machinery, which was supplied by Messrs. Hutson and Son, Limited, Glasgow, is of the compound surface-condensing type, having cylinders 18 in. and 42 in. in diameter by 30 in. stroke, the boiler working at 140 lb. pressure.

The s.s. Jabiru which has been built by Messrs. Wigham Richardson, and Co., at the Neptune Works, Newcastle-on-Tyne, to the order of the Cork Steamship Company, Limited, of Cork, for their Continental service, sailed from the Tyne on Thursday evening the 13th inst. The vessel is 260 ft. long by 34½ ft. beam; she is built to attain the highest class in Lloyd's Register, and is fitted with triple-expansion engines. This steamer is the fourth built for the Cork Steamship Company by Messrs. Wigham Richardson, and Co., and there are two more in hand.

The s.s. Cork was launched on the 13th inst. by Messrs. Blackwood and Gordon, to the order of the City of Dublin Steam Packet Company, of Dublin, to be employed in the cross-channel trade between Dublin and Liverpool as consort to the four popular steamers Louth, Wicklow, Carlow, and Kerry, also built by Messrs. Blackwood and Gordon. The dimensions of the Cork are as follow: Length, 260 ft.; breadth, 34 ft.; depth, 16 ft. 9 in. The engines are of the triple-expansion type, of fully 3000 horse-power.

On Thursday afternoon, the 13th inst., there was launched from the Shipbuilding and Repairing Works of the Blyth Shipbuilding Company, Limited, of Blyth, a steel screw steamer named Warwick, built to the order of Messrs. Atkinson Brothers, of Newcastle-on-Tyne. The dimensions of this vessel are: Length, 243 ft.; breadth, 36½ ft.; depth, 18 ft. 9 in. Triple-expansion engines will be supplied and fitted by the North-Eastern Marine Engineering Company, Limited, of Wallsend.

IMMIGRATION INTO BRAZIL.—It appears that no fewer than 760,000 Italian immigrants have arrived of late years in Brazil. Of these immigrants, 400,000 remained in the State of San Paulo.

WATER-TUBE BOILERS.—The Imperial and Royal Austro-Hungarian cruiser Zenta, constructed by the Stabilimento Tecnico Triestino, has successfully passed all her official trials in the Adriatic, attaining with ease the speed of 20.9 knots mean with 7800 indicated horse-power, which is 8 per cent. above the guaranteed power. This fine vessel is 312 ft. long by 40 ft. beam, and about 2300 tons displacement. The triple-expansion twin screw engines are supplied with steam by eight Yarrow water-tube boilers of similar construction to those recently fitted with success on the Dutch cruisers Holland, Zeeland, and Friesland. At the present time when various types of water-tube boilers are on their trial by the Admiralty, the success of these simple English boilers is of interest. The Dom Carlos, cruiser for the Portuguese Government, built at Elswick, and fitted with 12 Yarrow boilers, has also been most successful on her official trials.

WATER SUPPLY OF LEEDS.—At a meeting of the waterworks committee of the Leeds City Council on Friday, it was stated that the Home Office had, in the interest of the water supply of the city, decided to order the closing of the burial-ground at West End Church. This will be the second burial-ground in regard to which a similar step has been taken, the other being at Fewston. An application was received by the committee from the Shadwell Parish Council, asking the council to supply Shadwell with water, and the committee agreed to do so on the same terms as those upon which it now supplies Roundhay. A sub-committee was appointed to open tenders for a new 18-in. main, which is to be begun from Woodhouse Moor to the service reservoir at New Wortley, the object being to improve the supply to Wellington-road and that neighbourhood. A long list of extensions of mains was submitted, and these were agreed to, the applicants paying the usual 10 per cent. on the outlay. It was reported that the depth of water in Eccup reservoir was 43 ft. 3 in., or within 19 ft. of its total capacity. There is thus good ground for believing that the great engineering difficulties in connection with this watershed have at last been overcome, and that there is little fear of Leeds being ever again threatened with a water famine. The present storage in the Leeds Corporation reservoirs represents 106 days' supply. A year ago the quantity represented 104 days' supply.