Newcastle-on-Tyne, on the 29th of September 1868. Mr. Jones was at that time secretary of the North of England Iron Trade Association, at a meeting of which body he read his now historic paper, in which the general idea, which was afterwards put into practice on the founding of the Institute, was sketched in. When the Institute was established, Mr. Jones, as is well known, became secretary, a post which he continued to fill until his death. It was his hand, we believe, which drafted the rules and bye-laws by which the Institute is governed. Lists of officers and places, where autumn meetings have been held, are contained in this section, and a record is given of the number of papers read in each year. The total amounts to 522, and the total number of pages in all the volumes from the first is 25,620, whilst there have been 990 plates. An epitome of the finances from the commencement, and a list of the recipients of the Bessemer gold medal conclude this part of the volume. In the next section is given a list of papers and addresses from the commencement, arranged chronologically, and a second list arranged according to subjects. The latter, especially, will prove a valuable addition to the reference library of the metallurgist. The bulk of the book is occupied by the index of authors of papers and those who have spoken at the meetings. In these days of many societies and institutions it is easier to remember who has said a certain thing, than to remember where and when he has said it. It is here that the "Name Index" will be especially useful. Opening the book at random, for instance, we light on the name of "Hadfield, Robert Abbott," and find over three pages of references, all arranged alphabetically. Thus, if we remember that at some time Mr. Hadfield said something at a meeting somewhere, about the elimination of sulphur, or think it likely he might have said something on the subject, we find under the letter S, "Sulphur, elimination of," together with the year the remark was made and the volume and page of the Transactions where it is recorded. Papers read before the Institute, abstracts published in the Journal, and even the dates at which members have been elected, are all contained within this comprehensive "Name Index." The book represents a vast amount of hard work and careful revision, which has all been done by the ordinary staff of the Institute.

The Process Year-Book for 1898. Edited by WILLIAM GAMBLE. London and Paris: Penrose and Company. The series of annuals which have been published by Messrs. Penrose and Co. during the past few years form an admirable record of the progress which has been made in the development of the numerous methods of producing those engravings which are included in the comprehensive term, "process blocks." The year-book for 1898 now before us is an exceedingly handsome volume, which fully maintains the high standard established by its predecessors; and it should be in the hands of every one interested in the production of illustrated literature. Its illustrations include samples of photogravure, collotype, copper etching, half-tone work, both ordinary and engraved, three-colour process work, photo-litho work, bitumen work, &c.; and, apart from its technical value, it is of great interest from an art point of view. We congratulate Messrs. Penrose and Co. on the admirable way the book has been produced.

BOOKS RECEIVED.

Bezugsquellenbuch für das Bau-und Ingenieur wesen Sowie die einschlägigen Industrien und Gewerke. Herausgegeben von der Redaction der Zeitschrift "*Der Deutsche Steinbildhauer und Steinmetz.*" Munich: Eduard Pohl.

Traité d'Exploitation des Mines de Houille. Par CH. DEMANET. Deuxième édition, revue, augmenteé et misé au courant des progrès les plus récénts. Par A. DUFRANE-DEMANET. Brussels: Société Belge d'Editions.

Théorie Mécanique de la Chaleur. Par R. CLASIUS. Deuxième édition, refondue et complétée, traduite sur la 3e édition de l'original Allemand par F. FOLIE et E. RONKAR. Tome premier: *Développement des Formules.* Tome deuxième: *Théorie Mécanique de 'Electricité.* Brussels: Société Belge d'Editions.

Working Men's Insurance. By WILLIAM FRANKLIN WILLOUGHBY. New York: Thomas Y. Crowell and Co. [Price 1.75 dols.]

Alternating Currents of Electricity and the Theory of Transformers. By ALFRED STILL, Assoc. M. Inst. C.E. London and New York: Whittaker and Co. [Price 5s.]

Die Jungfraubahn. Elektrischer Betrieb und Bau. Von C. WUST-KUNZ und L. THORMANN. Zurich: Art. Institut Orell Füssli.

MESSRS. SCHNEIDER AND CO.'S WORKS AT CREUSÔT.—No. XVIII.

ARMOUR-PLATES.

UNTIL 1876 the calibre of guns used for firing against armour was progressively increased, culminating in the production of the 100-ton, and heavier guns; as a necessary consequence, the thickness of armour-plates was also increased and unceasing efforts were made to improve the quality of material and the method of manufacture.

To Messrs. Schneider and Co. belongs the credit of being the first to manufacture and submit for firing trials, thick armour-plates made of steel. To this interesting departure in the manufacture of armour for ships of war, dating back now for more than 20 years, we shall refer in more detail later. For the present it is sufficient to say that since 1876 the process of development at Creusôt has been continuous, and has resulted in the magnificent material, many examples of which we publish on pages 588, 589, 590, and 592. For more than 60 years before the Armstrong 100-ton gun was fired at the Schneider steel plates in the Italian proving grounds, the question of protecting ships and forts from the effects of shot, had occupied the attention of engineers. Compared with the gigantic requirements of to-day, the problem was one of almost absolute insignificance; but everything being relative, it was as desirable then to keep out the round 32-lb. or 64-lb. shot, as it is now to break up the heaviest steel projectile of to-day. We must go back to the time when England and the United States had been at war, and the question of protecting New York Harbour was of vital importance. John Stevens, of Hoboken, an engineering genius, who lived before his proper time, had conceived—and for more than 50 years his idea was laboured at by himself and his sons—the plan of a steam-propelled and rotated floating battery, the guns of which should be sheltered behind the iron-plated walls of a turret. The experiments made at that early date were very limited, and are of historical interest only. Thirty years later, however, they became of somewhat more importance. Passing by Colonel Paixhans' recommendation in 1821 for protecting shore batteries with iron armour, we come to the actual trials made in 1827 by Major-General Ford at Woolwich. The structure consisted of a granite wall 7 ft. thick, faced with two layers of iron bars, the inner one attached horizontally and $1\frac{1}{4}$ in. square; the outer row fixed vertically, consisted of bars $1\frac{1}{2}$ in. square. After 20 rounds from a 24-pounder gun, at 634 yards' range, the defence was practically destroyed. In this, the first-recorded of the not-yet-ended-struggle between gun and armour, victory lay with the former, as it has continued to do for the most part ever since. Messrs. Stevens, of Hoboken, appear to have carried out long and costly, though quite futile, experiments, on the subject of armour and projectiles. In 1841 they were in a position to form the conclusion that 4-in. wrought-iron plates would suffice to keep out 9-in. shell fired at short range. It was on this deduction that the Stevens battery was finally completed about 1853, at an enormous cost, embodying many modern devices, including breechloading guns, but of little or no practical value. From 1846 to 1856 experiments with iron armour were almost continuously carried on at Portsmouth and other British Dockyards. Those of 1854 were of special interest. The target consisted of $4\frac{1}{2}$-in. wrought-iron plate on a heavy timber backing; this showed relatively great power of resistance, but it could not resist the attack of a 68-pounder fired with a 16 lb. charge, at a range of 400 yards. This was sufficient to destroy both target and backing. During the same period, many interesting experiments with armour-plated land batteries were carried out by General Totten in the United States, and always with the result of proving the superiority of the gun. But by far the most important work done during the ten years under consideration, was that of Dupuy de Lôme, in France. Under his auspices, floating batteries had been built for service in the Baltic during the Crimean War; they were heavy wooden-framed vessels covered with wrought-iron plates $4\frac{1}{2}$ in. thick, 3 ft. long, and 20 in. wide. The following is an extract from a report by Commander Dahlgren, on their performance in action: "The French floating batteries, Devastation, Lave, and Tonnante, steamed in to make their first essay, anchoring some 600 or 700 yards off the south-east bastion of Fort Kinburn. . . . The Russians could only reply with 81 cannon and mortars, and no gun of heavier calibre than 32-pounders, while many were lower. . . . . This was the sole occasion in which the floating batteries had an opportunity of proving their endurance. . . . . They were hulled repeatedly by shot; one of them (the Devastation), it is said, 67 times without any other effect on the stout iron plates than to dent them, at the most $1\frac{1}{2}$ in. Still there were ten men killed and wounded in this battery by shot and shell which entered the ports." The armour-plates scored an easy victory over the guns, at this, the first and last engagement (if we except some of the naval fights during the American Civil War), fought under conditions that were soon to become obsolete. The end of the Crimean War witnessed the end also of the old order of artillery, and the creation in 1855 of the first Armstrong breechloading gun. From that time, in this country and abroad, dates the revolution in the construction of artillery which culminated, as regards weight and calibre, with the 100-ton Armstrong gun of 1876, and the far more formidable weapons of to-day, produced by the same firm, by Krupp, Schneider, Canet, and a few others at the present time. The great and rapid changes in gun construction since 1855 have given problems more and more difficult of solution to the manufacturer of armour, for the power of the attack advanced always more rapidly than that of the defence. The first record of a steel plate being tested is one that was tried at Woolwich in 1857; it was but 2 in. thick, and failed rapidly, as did also the 4-in. wrought-iron plate, with 2 ft. of oak backing, that was broken up the same year, also at Woolwich, by wrought-iron shot. It is of interest to note that a steel plate, at a little later date, was fired at in Russia, with somewhat better results. The next six years brought remarkable developments, both in guns and armour; manufacturers still famous in their specialty, such as Brown and Cammell, had succeeded in the commercial production of iron armour-plates up to 6 in. in thickness, while gun-makers like Armstrong and Whitworth were making artillery of such calibre and energy as to still maintain the balance slightly in favour of the guns. Round shot had given place to pointed projectiles, either of chilled cast iron, like the Palliser; of wrought iron case-hardened; or of Bessemer steel. The following list of armour-plates that were tested at Portsmouth in February, 1864, will give an idea of the condition of the industry at that time:

Names of Makers.	Ship for which Plates were made.	Thickness of Wrought Iron.
John Brown and Co.	Lord Warden	$5\frac{1}{2}$ in.
Ditto	Ditto	$4\frac{1}{2}$,,
Ditto	Royal Alfred	$4\frac{1}{2}$,,
Ditto	Prince Albert	$4\frac{1}{2}$,,
Mersey Company ...	Agincourt	$5\frac{1}{2}$,,
Cammell and Co. ...	Lord Clyde	$5\frac{1}{4}$,,
Millwall Company...	Bellerophon	6 ,,
Beale and Co. ...	Pallas	$4\frac{1}{2}$,,

As we have seen, it is to the French engineer Dupuy de Lôme, in 1854, that is due the credit of being the first to design and have constructed floating batteries for actual warfare, protected with iron armour. The plates for the Lave, Tonnante, and Devastation were manufactured by Messrs. Schneider and Co. The first armoured frigates, Gloire and Heroine, were built immediately afterwards; their iron armour-plates were 12 centimetres ($4\frac{3}{4}$ in.) thick, and resisted fairly well the fire from all the guns of the time.

The building of the Gloire may be regarded as the real starting point of the armour-plate industry; from that time dates also the serious beginning of the struggle between projectile and armour. Since then armour-plate makers have been constantly engaged in devising means to produce armour that shall be successful in warding off every blow; and on their side the gun-makers have been equally energetic in making guns of increased resistance, higher velocities, and flatter trajectories, whilst improvements in the manufacture of projectiles and explosives have been equally progressive.

In the foregoing paragraphs we have given some general idea of the early development of the armour-plate industry, and we may now pass on to consider the great part taken by Messrs. Schneider and Co. in the more recent and important developments, commencing with the year 1876, when the Italian Government was building the two great battleships Duilio and Dandolo. It was at this

MESSRS. SCHNEIDER AND CO.'S WORKS AT CREUSÔT; TESTED ARMOUR-PLATES.

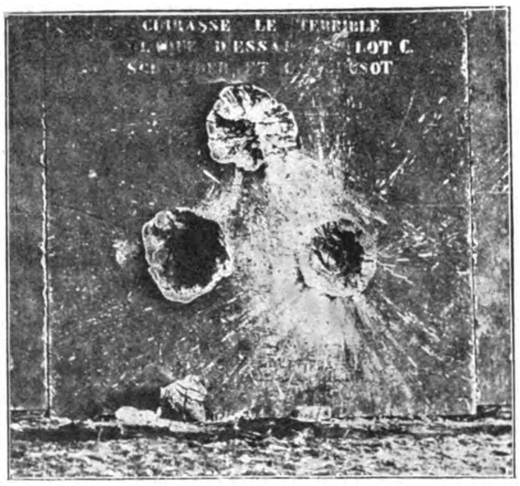

FIG. 144.

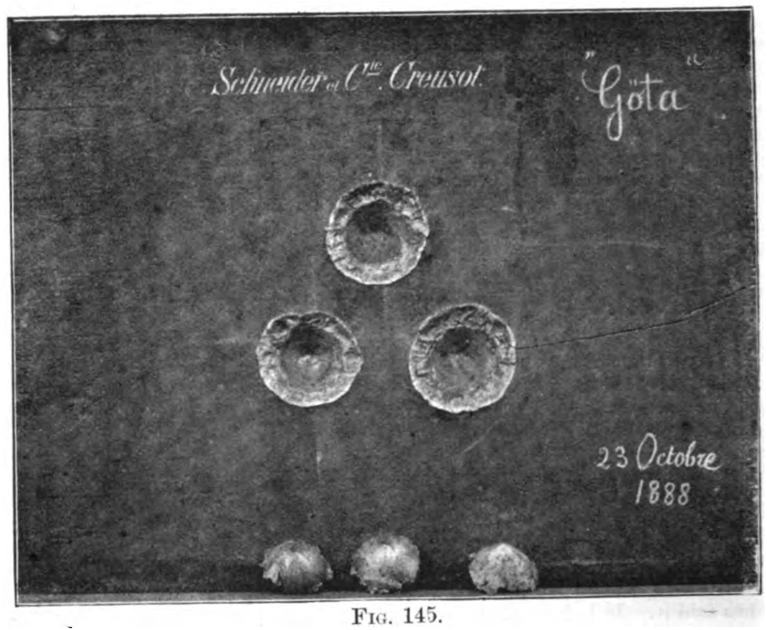

FIG. 145.

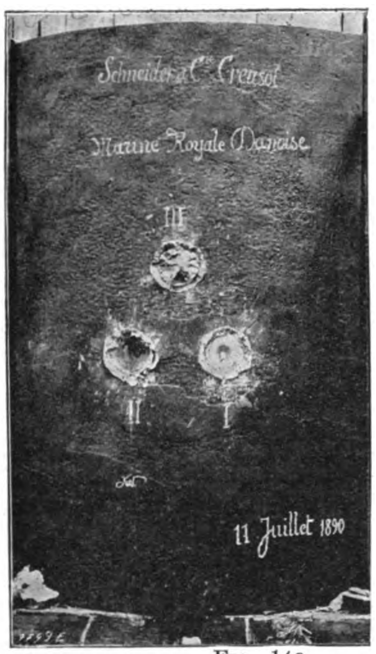

FIG. 146

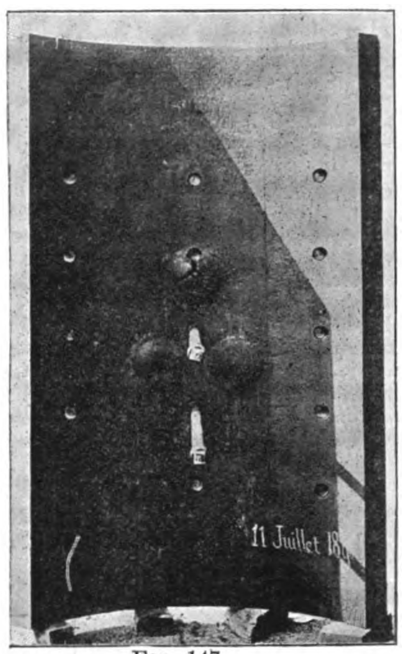

FIG. 147

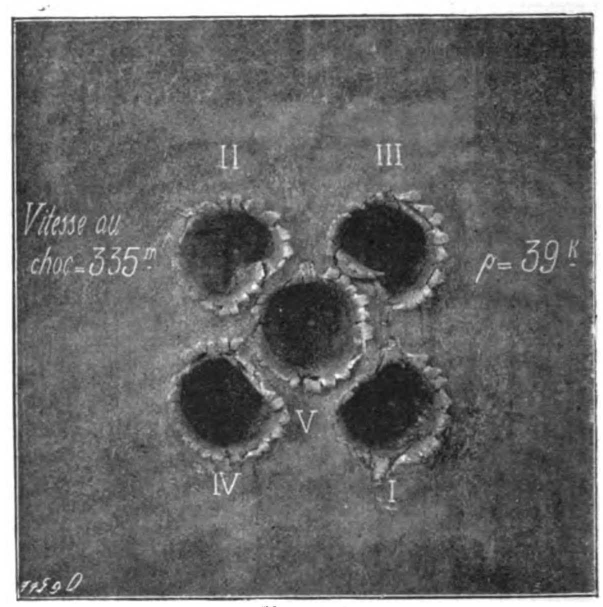

FIG. 148.

time that Messrs. Schneider and Co. decided upon a series of now historic trials, with the view of proving the superior value of steel over iron for armour-plates. These trials were conducted at the proving yard of Muggiano, near Spezia; they took place in September and October, 1876, and demonstrated the superiority of Messrs. Schneider and Co.'s steel plate over the others tested at the same time. The order for the Duilio and Dandolo steel armour was immediately after given to Creusôt. Imperfect as were their early plates, compared with those they now manufacture, the advantages to be derived by the use of all-steel plates became apparent to the naval advisers of many Governments, and the conclusion was very widely arrived at that iron had become inadequate for ship protection, and had to be abandoned.

Thus in July, 1879, the Danish Navy instituted competitive trials at the Amager proving yard, near Copenhagen. At these trials the Creusôt plate was not the only steel plate tested; other makers, whose interest had been aroused by the result of the Muggiano trials, also sent steel plates for test. The trials at Amager, however, established the superiority of "Schneider-metal" and the "Tordenskjold" deck-armour and turrets were ordered from Creusôt. After the value of steel plates had been established, the manufacture of compound armour was commenced in this country. This type was invented by Mr., now Sir Alexander, Wilson; it gave from the beginning satisfactory results in many cases and was adopted by various Navies. Meantime Messrs. Schneider and Co. were steadily working out improvements in the manufacture of homogeneous steel armour, with the result that the resisting power of their plates was constantly increasing; they obtained at this period, from the French, the order for the Terrible's armour.

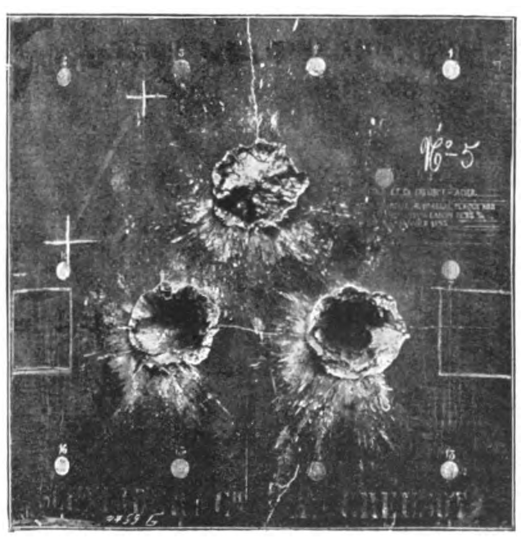

FIG. 149.

Other important trials took place at the Muggiano proving yard, in November, 1882, and in October and November, 1884, which resulted in Messrs. Schneider and Co. obtaining the order for the Lepanto's armour-plates. These trials were so conclusive that the Terni Company decided to put down a powerful plant for the manufacture of plates on the Schneider process. The 1882 trials resulted also in deciding the Italian and the French Navy, and subsequently other Navies also, to adopt the Schneider patent armour-plate bolt.

About this time the United States of America took serious steps towards creating a Navy. An important part of their new naval programme was a decision as to the type of plate to be accepted, and the encouragement of private companies to develop the manufacture of that special type. They chose in 1887 the all-steel Schneider plate. The Bethlehem Iron Company, who were appointed by the United States Government for the supply of armour, contracted with Messrs. Schneider and Co. for the designing of the necessary plant, and sent engineers and officers to Creusôt to follow the manufacture in every detail. From the outset this branch of industry acquired in the United States a very great development, which is justified by the high quality of the American armour-plates manufactured. Notwithstanding the progress they had already made in the production of armour, by their experience in the manufacture and in the handling of

MESSRS. SCHNEIDER AND CO.'S WORKS AT CREUSÔT; TESTED ARMOUR-PLATES.

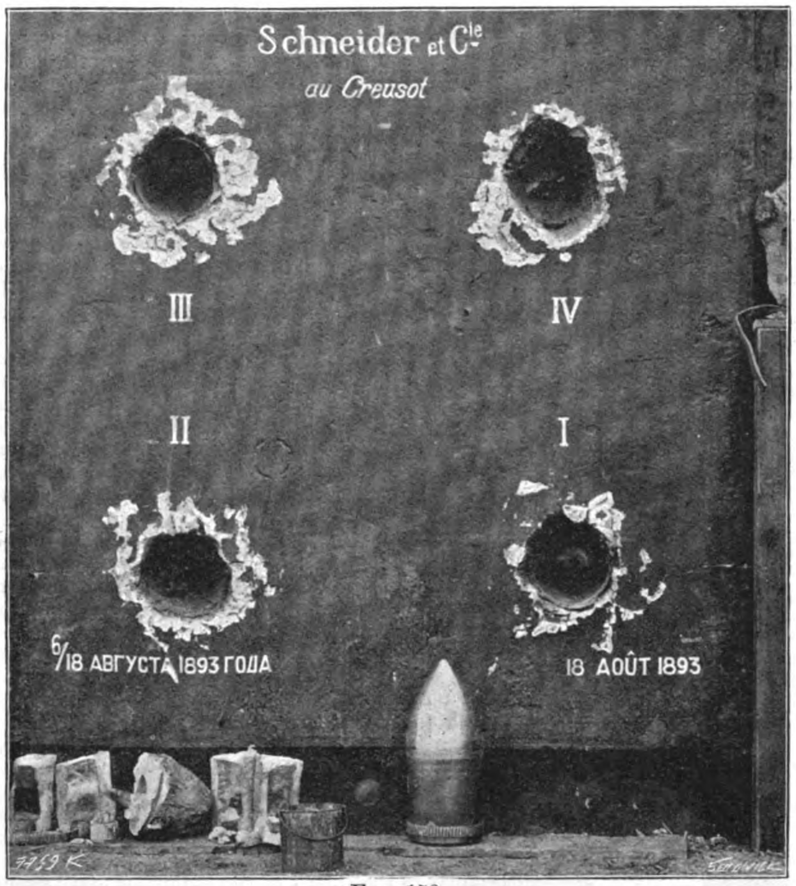

Fig. 150.

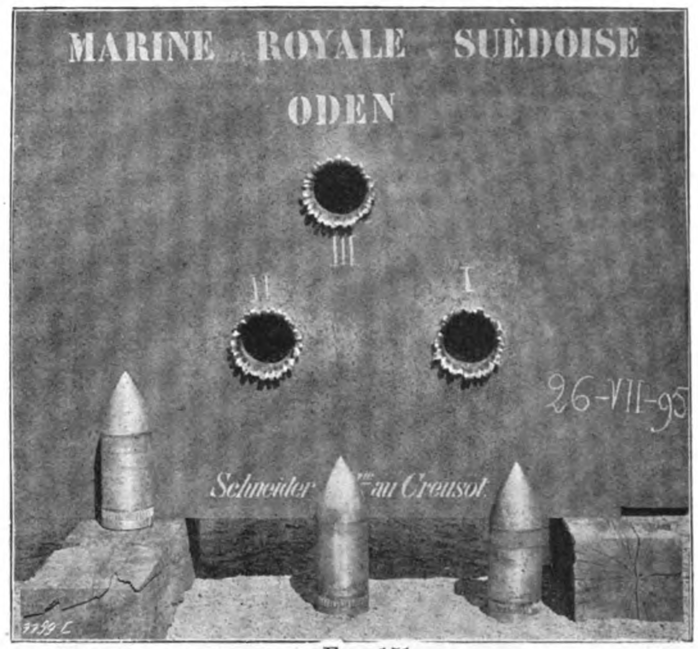

Fig. 151.

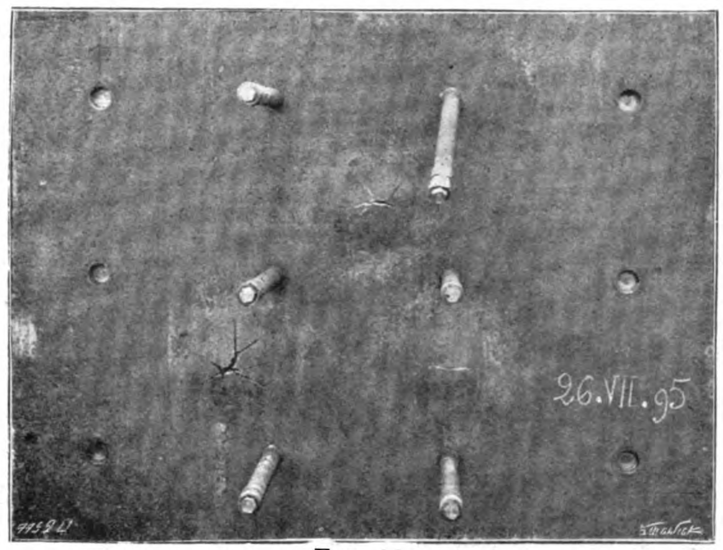

Fig. 152.

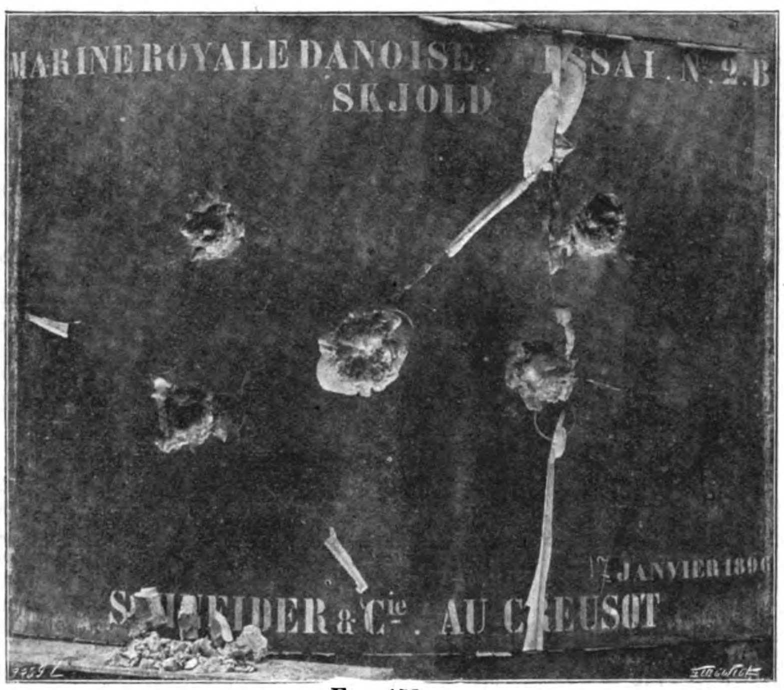

Fig. 153.

Fig. 154.

various grades of steel, which enabled them to control at will the degrees of hardness then required, Messrs. Schneider and Co. made a considerable improvement by placing upon the market nickel-steel plates. They were the first to discover that nickel in steel gives great tenacity to the metal. The trials carried out on September 18 and 19, 1890, at the Navy proving yard of Annapolis (U.S.) were quite a revelation. Messrs. Schneider and Co.'s nickel-steel plate, manufactured at Creusôt, carried the day, the one second in value being a steel Schneider metal plate, sent over from Creusôt at the same time. The presence of nickel in steel, not only increases in a remarkable way the toughness of a plate, but also its power of resisting penetration; this is especially the case with plates of medium thickness. At the present time, though improvements have been realised in the manufacture of plates by hardening the surface, the steel used still contains nickel, and this fact demonstrates the value of Messrs. Schneider and Co.'s discovery. Nickel steel of soft grade is now used with the best results, instead of extra-mild ordinary steel for the manufacture of deck plates.

We now arrive at the period when Harvey was perfecting, in the United States, his process for hardening plates with a powdered cementing material, and at the same time Messrs. Schneider and Co. were endeavouring to increase still more the resistance to penetration. They were the first in France to design, put in practice, and regulate cementing by gas, as already described in a previous article; this treatment, with water-hardening, gives plates, the front surface of which is of such hardness that the heaviest projectiles are broken on impact. Having demonstrated the value of this method, Messrs. Schneider and Co. lost no time in constructing a new and costly plant for the purpose, and were then enabled to produce cemented plates, and to deliver them to the Russian Navy for the Three Saints, to the Danish Navy for the Skjold; they were the first to supply the French Navy with large quantities.

While Messrs. Schneider and Co. were continuing to improve their process of cementation, the first Krupp plates appeared, the remarkable feature of these being that they do not crack under fire, a quality due to a particular treatment to which the metal is submitted; this characteristic increases in a marked degree their resistance to penetration. Messrs Schneider and Co. have acquired the process of manufacture of these new armour-plates, so as to be able to meet the demands of the Governments after the completion of each lot. It is to be noted that inspecting officers choose generally, for firing tests, those plates which show surface imperfections, or those concerning which doubts may have arisen during manufacture, either owing to some incident, or from the results shown by some of the testing operations of the materials, during the various processes of fabrication. Some particulars of the plates illustrated are given in the Table below.

We append a list of the tonnage of steel armour-plates manufactured at Creusôt, from 1876 till May 1, 1898.

	Tons.	Tons.
French Navy	...	26,193
Italy	8040	
Spain	3298	
Russia	2805	
Sweden and Norway ...	2582	
Chili	1387	
Denmark...	1027	
Greece	777	
Japan	633	
China	342	
United States	132	
Holland	98	
Belgium	15	
Austria	4	
	—	21,140
		47,333

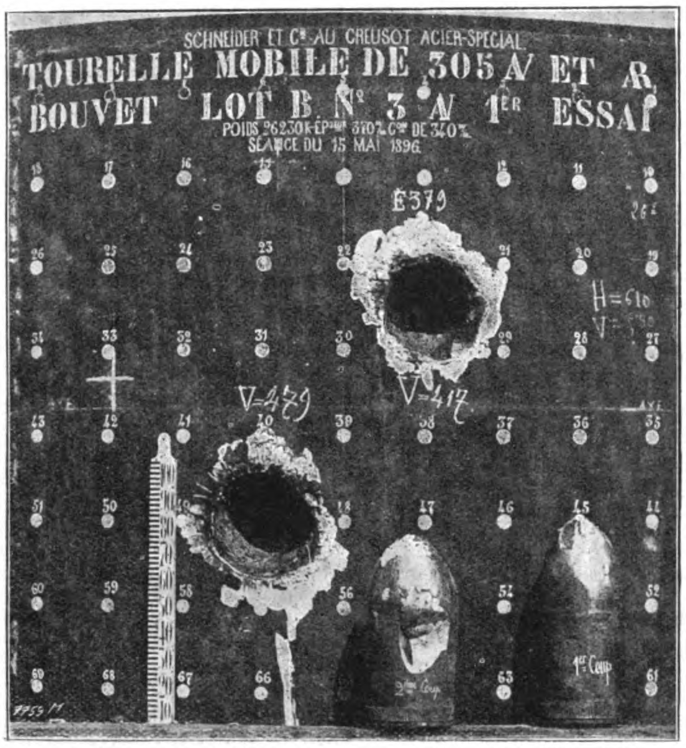

FIG. 155.

TESTS OF STEEL ARMOUR-PLATES MADE BY MESSRS. SCHNEIDER AND CO., CREUSÔT. (FOR ILLUSTRATIONS SEE FIGS. 144 TO 160, PAGES 588, 589, 590, AND 592).

—	Date of Trial.	Country for which Plate was Tested.	Name of Ship.	Thickness of Plate.		Calibre of Gun.		Remarks.
				mm.	in.	cent.	in.	
Fig. 144 ..	Dec., 1881 ..	France ..	Terrible ..	600 and 402	19.69 and 15.83	32	12.60	Three rounds, powder charge.—First and second round, 67.430 kilos. (148.35 lb.); third round, 72.420 kilos. (159.3 lb.).
Fig. 145 ..	Oct., 1888 ..	Denmark ..	Gota	243	9.56	15	5.90	Homogeneous steel, "Metal Schneider."
Fig. 146 ..	July, 1890 ..	" ..	Tordenskjotd ..	115	4.52	15.0	5.90	Homogeneous steel, "Metal Schneider," three rounds.
Fig. 147 ..	" 1890 ..	" ..	" ..	115	4.52	15 0	5.90	Ditto Ditto
Fig. 148 ..	Jan., 1892 ..	Roumania	.. ..	120	4.72	15.0	5.90	Cast steel.
Fig. 149 ..	" 1893 .	France ..	Tréhouart .	320	12.60	32.0	12.60	Schneider homogeneous steel.
Fig. 150 ..	Aug., 1893 ..	Russia ..	Trois Saints ..	406	15.99	24.0	9.45	"Metal Schneider."
Fig. 151 ..	July, 1895 ..	Sweden ..	Oden	250	9.84	15.0	5.90	Rear of plate.
Fig. 152 ..	" 1895 ..	" ..	"	250	9.84	15.0	5.90	
Fig. 153 ..	Jan., 1896 ..	Denmark ..	Skyöld	200	7.87	15.0	5.90	Cemented steel.
Fig. 154 ..	" 1896 ..	France ..	Massena .	100	3.94	13.68	5.40	Ditto
Fig. 155 .	May, 1896 ..	" ..	Bouvet .	370	14.57	34.0	13.39	Ditto
Fig. 156 ..	June, 1897 ..	Spain ..	Cataluña ..	250	9.84	15.0	5 90	"Metal Schneider." Holtzer projectile. The striking velocities are shown in the illustration.
Fig. 157 .	" 1897 ..	" ..	" ..	250	9.84	15.0	5.90	Rear view of same plate.
Fig. 158 ..	" 1897 ..	..	..	150	5.90	15.0	5 90	Experimental cemented steel plate. Weight of projectile 45 kilos. (99 lb.).
Fig. 159 ..	Oct., 1897 ..	France ..	Gaulois.. ..	270	10.63	27.44	10.80	Cemented steel.
Fig. 160 ..	April, 1897 ..	..	.. .. ..	156	6.14	15.0	5.90	Experimental plate. Cemented steel. Holtzer projectile, 45 kilos. (99 lb.).

which would require armour-plates showing this remarkable resistance to cracking after a certain number of rounds.

As a supplement to this short sketch of the important part taken by Messrs. Schneider and Co., in developing and improving the manufacture of armour, we publish in Figs. 144 to 160, on pages 588, 589, 590, and 592, some reproductions of photographs of tested plates. Apart from two (Figs. 158 and 160) which have undergone experimental trials, carried out by Messrs. Schneider and Co. at their Villedieu proving yard, Creusôt (see page 38, Fig. 8, *ante*), all these plates were tested officially, and for this purpose had been chosen by inspecting officers, from the lot they represent and

QUEENSLAND.—The estimated population of Queensland at the close of 1897 was 484,700. This shows an increase of 12,521, as compared with the corresponding population at the close of 1896.

THE NORTH GERMAN LLOYD T.-S.S. "KAISER WILHELM DER GROSSE."

(Continued from page 495.)

IN continuation of our illustrations of the Kaiser Wilhelm der Grosse, we reproduce on our two-page plate several illustrations of the propeller and of the steering gear. Figs. 82 and 88 show one of the twin-propellers by which the vessel is driven. Each propeller has three blades of Vulcan bronze, which is made up of copper, zinc, and a little of aluminium and of tin—the company do not care to publish the exact proportions. They attain a tensile strength of 42 to 46 kilogrammes per square millimetre (26.7 to 29 tons per square inch), with an elongation of from 20 to 25 per cent. on a length of 7¾ in. The boss of the propeller is of cast steel. The propeller is 6.8 metres (22 ft. 3¾ in.) in diameter, with a pitch of 10 metres (32 ft. 9⅞ in.). The real surface of the two propellers is 22.7 square metres (244.34 square feet), and the other dimensions and details can easily be gathered from the drawings reproduced. The propellers overlap to the extent of 8 in., and for this reason the port propeller is 35½ in. ahead of the starboard, while the distance between centres of shafting is 21 ft. 8 in.

The ship has the usual space left in single-screw ships, as well as being bossed out, and thus there is no part of the shafting carried outboard. The stern framing has been made of special design and particularly strong. Its form and size is well shown by Figs. 94 to 96, on the two-page plate. It is of U-section, hollow, and is scarfed to make the plate connection suit the run of the ship. With the two internal struts it weighs 90 tons.

The steering gear is supported immediately over this casting; and we will now proceed to describe the mechanism by which the rudder of 16.8 tons weight, shown in Fig. 94, is operated. It has been supplied by Messrs. Brown Brothers and Co., Limited, Edinburgh; and while it is similar to that fitted in the Campania and Lucania, there are one or two differences. As with our merchant cruisers, there was a condition laid down by the German naval authorities that the gear should be completely under the load water line; Brown's gear is very suitable under such conditions. The general principle is well known now, the steering engine being attached to the tiller, which has at its after end a double jaw fitted with bearings, and carrying between the jaws a vertically-disposed pinion, which engages with a toothed quadrant bolted to the deck. The main steering engine on the fore end of the tiller receives and exhausts steam through a double stuffing-box arrangement, mounted above the cylinders on the axis of the tiller. The cylinders have piston valves, and reversal is effected by changing the direction of the steam entering the cylinders, through a piston valve between the cylinders. The piston-rods actuate by the usual gearing a bronze wormwheel, connected, by means of an internally-expanding friction clutch with spring relief gear, to a steel pinion about 18 in. in diameter. This pinion works into the above-mentioned toothed segment, about 18 ft. radius to the pitch line, firmly bolted to the deck. The friction clutch is really an internal brake having a lining of hard wood, which is screwed up and held in position by powerful springs, sufficient to cause enough grip to put the rudder hard over with the ship going at full speed, but ready to let go on any dangerous strain, above what is involved in this, coming on the gear from any cause whatever. In the Kaiser Wilhelm der Grosse, as in the Cunarders, the fineness of the run of the ship increased the difficulties associated with under-water gear, and it was decided to fit connecting-rods between the rudder crosshead and the steam tiller, with a crosshead in a recess abaft the rudder-head, as shown in the illustrations on the two-page plate; the connecting-rods work forward, instead of aft, as in the usual application of the principle of Brown's gear. The connecting-rods are 20 ft. long, and the tiller is 16 ft. 6 in. long, of cast steel. It acts through the connecting-rods on a 4-ft. rudder crosshead. Both steering engines work in enclosed oil tanks.

The valve gear on the steering engine is operated upon by a hydraulic telemotor cylinder shown in Figs. 92 and 93, connected by two lines of ½-in. copper pipes to two steering stations on the ship. For the forward station the telemotor standard is placed to the port side of the steering-house and a connection made by a shaft to the steering standard in the centre. Above this standard, on the bridge, another similar steering standard is placed, the connection being also made by means of a shaft. This steering position is used only for navigation in dangerous or crowded waters at the entrance to rivers, &c. The second telemotor standard is placed on the poop deck over the second-class saloon, the communication to the steering gear below being by means of the usual piping. There is also a steering station close by the steering gear, so that no inconvenience would result from the communication pipe getting damaged.

Brown's "telemotor" consists essentially of a pump of special construction, the piston of which is moved up or down under the control of a small steering wheel attached. Both telemotor and pipes are full of water mixed with glycerine to obviate the chance of freezing. The operation compresses in either direction two spiral springs just over the main steering gear, so that when the helm is hard over, and it is desired to steady the ship, it is only necessary to "let go" and the springs will cause the whole gear to travel to midship line. These springs perform another important function, viz., any tendency of the telemotor indicator to get out of correspondence with its cylinder aft is corrected by a communication being opened between both ends of the cylinder every time the wheel is moved from port to starboard or *vice versâ*, thus allowing the springs to bring the rudder to mid-gear.

Auxiliary steam steering gear one-third less powerful than the main steering gear, is provided. This is fitted forward of the segmental pinion rack, and is geared up by cast-steel gearing, and with pitch wheel and chain, the latter of which passes round rollers on the ends of the segment rack, and lays hold of the end of the steam tiller. Spring boxes are fitted to leading pulleys for taking up the slack of the chain. The auxiliary gear is connected and disconnected by means of an expanding internal clutch or brake, similar to that employed in connection with the main gear. The change from main to auxiliary gear and *vice versâ* is made with great rapidity irrespective of the condition of the sea, and can be effected within 20 seconds.

There is a close association between steering and the capstan and anchor gear, which latter we illustrate on page 593, as supplied by Messrs. Napier Brothers, Limited, Glasgow. First, we give the details of anchors, chains, and tow-lines and hawsers carried by the ship :

Anchors.

Two Bower anchors (Hall's patent stockless)	6000 kg.	(5.9 tons)
Two ,, ,, ,,	6000 ,,	(5.9 ,,)
One stream anchor ,, ,,	2500 ,,	(2.46 ,,)
One kedge, Trottmann..	950 ,,	(0.935 ,,)

Chains.

540 m. (295 fath.) stud-chain cable ..	76 mm.	(3 in.)	in cir.
150 m. (82 ,,) mooring chains (stud)	50 ,,	(2 ,,)	,,

Tow-lines and Hawsers.

185 m. (100 fath.) steel-wire or hemp	165 mm.	(6½ in.)	in cir.
	465 ,,	(18¼ ,,)	,,
185 ,, (100 ,,) hawser, hemp	..405 ,,	(16 ,,)	,,
185 ,, (100 ,,) ,, ,,	..320 ,,	(12½ ,,)	,,

The forward anchor and warping gear for working the 3-in. cables is illustrated on page 593. The anchor engines have 17-in. diameter cylinders by 14-in. stroke, and the warping engines 13-in. diameter cylinders by 12-in. stroke, and both are so arranged that in the event of either being disabled the other may do the work. That is to say, the large engines could work the anchors and do the warping at the same time, and *vice versâ*. All the gearing is placed on the deck, and is readily accessible. This constitutes a better working arrangement than was the case with some earlier ships which had the gearing on the underside of the deck. The wormwheels have gun-metal rims with machine-cut teeth and steel centres, working into steel-forged worms accurately machined. Formerly cast-steel wormwheels with phosphor-bronze worms were used. On the poop deck there is one warping capstan with 2-in. cable-holder for working the stream cable, the engines having cylinders 12 in. in diameter by 12 in. stroke, while on the same deck there is one steam warping capstan without cable-holder, the engines having cylinders 9 in. in diameter and 10-in. stroke.

The other deck gear may here be briefly referred to. There is little cargo to be dealt with, but for this purpose six winches have been provided by Achgelis, of Gestemünde. Five of them have 6-in. cylinders working at 10-in. stroke, and one of them has 8-in. cylinders working at the same stroke. In addition, there are two boat-hoisting winches with 5-in. cylinders working with a 8-in. stroke, and this naturally leads to a reference to the boats carried. There are 16 of them, 30 ft. long by 8 ft. 6½ in. beam and 3 ft. 6 in. deep, and two only slightly smaller, while in addition there are six semi-collapsible boats, also 26 ft. long and 7 ft. broad. All are carried clear of the promenade deck on the sun deck. Here also we may note one of many little commendable innovations introduced ; the lifebuoys, instead of being circular, are shaped like a horseshoe; and when one comes to think of it, great difficulty may be experienced by a man in the water in his efforts to get the circular buoy over his head. The opening in the horseshoe enables him readily to slip it under his arms.

(To be continued.)

THE IRON AND STEEL INSTITUTE.

IN our last issue we gave an account of the opening proceedings at the recent meeting of the Iron and Steel Institute, held on Thursday and Friday of last week, under the chairmanship of the President, Mr. Edward P. Martin. We now continue our report.

BLAST-FURNACE GAS FOR MOTIVE POWER.

The first paper read at the meeting was the contribution of Mr. Adolphe Greiner, Director-General of the Société Anonyme John Cockerill, of Seraing, Belgium. This paper we shall print in full on an early occasion.

In the discussion which ensued, Mr. James Riley was the first speaker. Referring to the authorities quoted by the author, Mr. Riley said that there was more literature on the subject than that which had been mentioned in the paper. The first reference to the use of blast-furnace gases for power purposes, with which he was acquainted, was in the *Iron and Coal Trades Review*. A paper had also been read by Professor Watkinson on the subject, and another by Mr. Dickson. There was also Mr. Galbraith's paper, to which reference had been made by the author. Mr. Greiner had, however, ruled the latter contribution somewhat out of the contest, as dealing with an engine "not really driven by ordinary blast-furnace gas, as the gas used was drawn from furnaces using anthracite as fuel ; and its calorific power, according to Professor Rowden, was superior to that of producer gas." Mr. Riley went on to say that the President of the Institution had made reference in his address to his (Mr. Riley's) connection with this subject ; but had the opportunity occurred, Mr. Riley would have put forward the name of another gentleman connected with the subject ; that was Mr. Thwaite. Mr. Riley's company had a gas engine at work at Wishaw, the one to which Mr. Galbraith had referred in his paper. It developed 14 horse-power, and gave satisfactory results when using blast-furnace gas. The coal used, however, was the hard Scotch splint coal, and the gas produced was that from the blast-furnace. In this sense it was blast-furnace gas, as understood in a large district of Great Britain. The gas, before reaching the gas engine, however, had to pass through the recovery plants for the extraction of ammonia and tar products. It was, therefore, clean gas, but was somewhat impoverished by the extraction process. With that gas they assumed that 130,000 cubic feet of gas were made per ton of coal ; and, as they were in the habit at Wishaw of measuring the gas, that figure might be assumed to be correct. They also knew the power developed, and arrived at the conclusion that 1.6 lb. of coal were required per brake horse-power per hour. But, as already stated, the gas had been cleansed, and in the figures given no account had been taken of the impoverishment, although in the process 20 per cent. of the original cost of the coal was realised. In every respect the results were satisfactory. There had been a few difficulties in matters of detail at first, but these had been got over. Trouble had arisen through failure of ignition, but this was being removed by electrical means. Mr. Riley thought, that, under these circumstances, he had been justified in making the experiment. An engine had already been at work a good many months, taking gas from a coke-fed blast-furnace in Lincolnshire, and this had given satisfactory results. Arrangements were likewise being completed at a large ironworks in this country, in which a 250 horse-power gas engine would be installed. No doubt the members of the Institution would like to know the results when the experiments were completed. Mr. Riley thought the author was very sanguine in his anticipations, but his figures were more than interesting, and pointed to a way in which economy might be reached, and money saved, in the carrying on of iron works. It was, however, possible to understand that hesitation might be felt in the expenditure of the large capital required for the installation of plant ; but, as experience was gained and the prospect of success became assured, the hesitation would pass away. He, himself, had a great belief in the system. Ironmasters in this country had been accused of lagging behind those of some other nations, but he thought that what had been stated would prove that we are still making some progress, and in one respect at least were showing the way to the rest of the world, as we did of old. Mr. Riley concluded by giving some figures which had been worked out on the assumed work of two blast-furnaces producing 800 tons of iron per week from hematite ore when using Durham coke and limestone, 20½ cwt. of coke being burnt per ton of pig. The indicated horse-power per ton of pig came out 6.70, which gave an advantage of 45.0 per cent. for using the gas in a gas engine, as compared to burning it under the boilers. The speaker gave details on which the calculation was made, and he thought they would prove a corrective to the more sanguine estimate of the author of the paper.

Mr. Snelus said that when he first went to Cumberland, not so very many years ago, it was a question whether gas could be burnt under boilers instead of blowing it away to waste, many authorities holding that hematite furnaces could not be worked with closed tops. That period had been lived through, and it seemed to him that the matter now before the meeting would also prove a feature of great importance as conducive to economy in the production of iron. The author's estimate of power to be obtained by using blast-furnace gases in a gas engine was 10 horse-power per ton of pig. It would be seen, therefore, that the saving was very great. In the present day, when power was so conveniently transmitted to a distance by electricity, it would be possible to generate power and use it for other works. He would like to ask what was the calorific power of the gases after the tarry products had been taken out ; for Mr. Riley's experiments proved that even with the impoverished gas abundance of power was to be obtained. To lay down the engines required, however, would involve the outlay of a very large capital, but that was a matter that must be met. He was often told that inventors were a great nuisance, as they were always making people spend money when they would rather go on as they were. That, however, was impossible. To stand still was to go back, and if that came about the country would be in a very sorry plight.

Sir Lowthian Bell asked what was the temperature of the gas as it entered the engine cylinder, and also after the explosion. In reply to this the author said that he did not know the exact temperatures, no measurements having been taken, but it was quite possible to hold one's hand on the cylinder. Mr. James Riley here stated that the temperature of the exhaust was 240 deg. Fahr.

Dr. Ludwig Mond said he had only glanced through the paper, but that was enough to convince him of its importance. He had never been able to see why it should be doubted that the gas from a blast-furnace should be available for power. Dowson gas was not quite free from solid matter. He was somewhat surprised that the experiments made had been on such a very small scale. He had lately taken up the question of driving gas engines with producer gas, and had had at work for a considerable time a 125 horse-power gas engine. This was a great success. It had been at work for three months continuously night and day, without being cleaned. The question of continuous running was an important one in many industries, and he believed that the engine at Winnington was the first one that had been run for three months without stopping, week-days and Sundays, night and day. When they had stopped it at last, it was for the purpose of examination and overhaul, but it was found that it required nothing to be done to it. He might mention that he had had tenders from English makers for gas engines up to 500 horse-power. Mr. Westinghouse, in America, had had a 750 horse-power gas engine running a continuous trial of several weeks' duration. This was the largest gas engine yet made. The result had been

MESSRS. SCHNEIDER AND CO.'S WORKS AT CREUSÔT; TESTED ARMOUR-PLATES.

(*For Description, see Page* 587.)

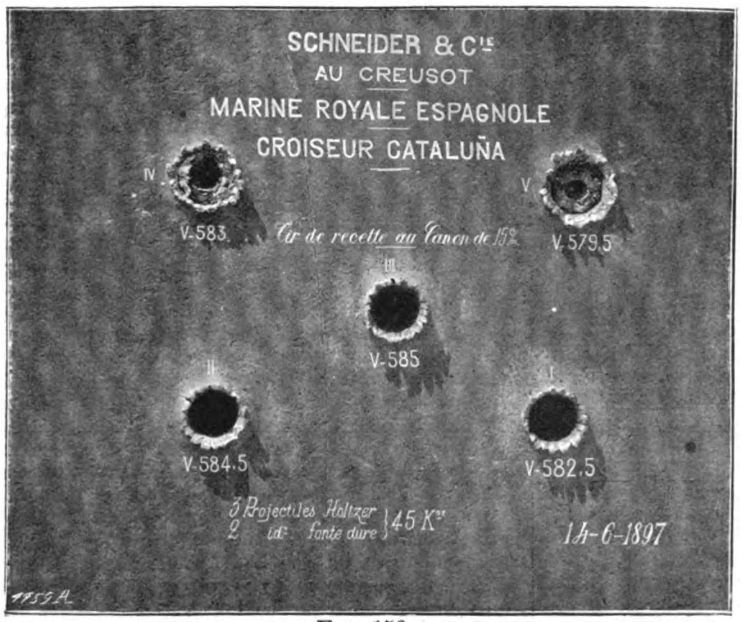

Fig. 156.

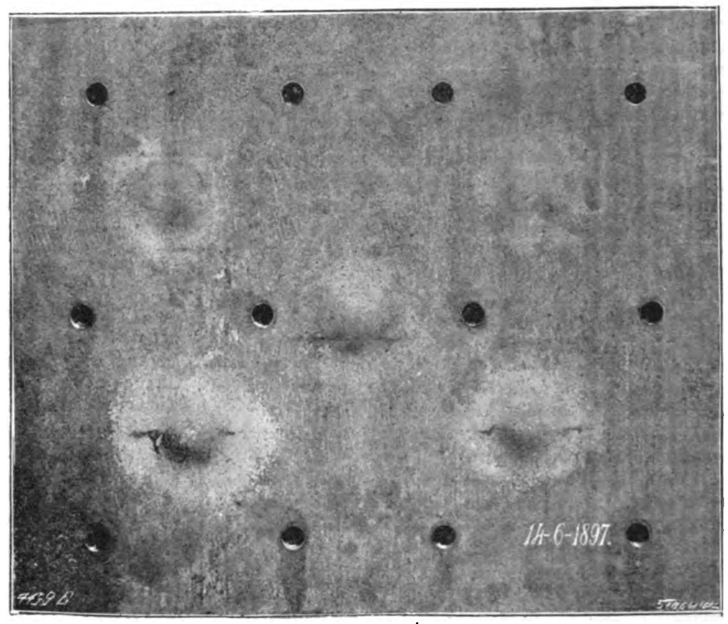

Fig. 157.

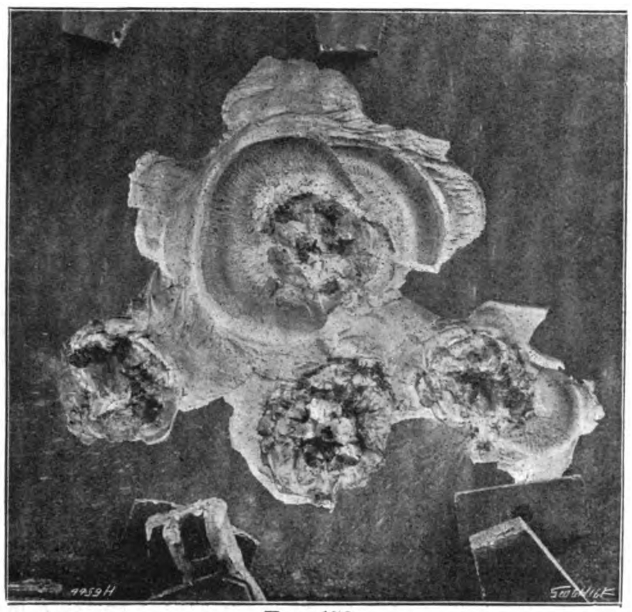

Fig. 158.

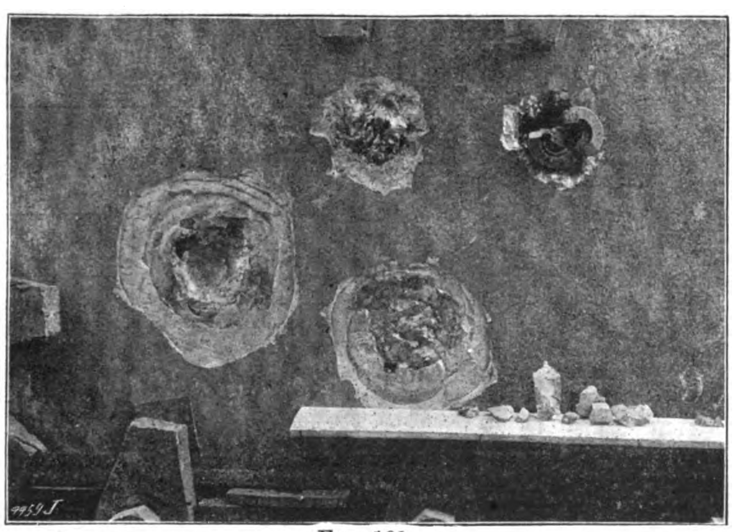

Fig. 160.

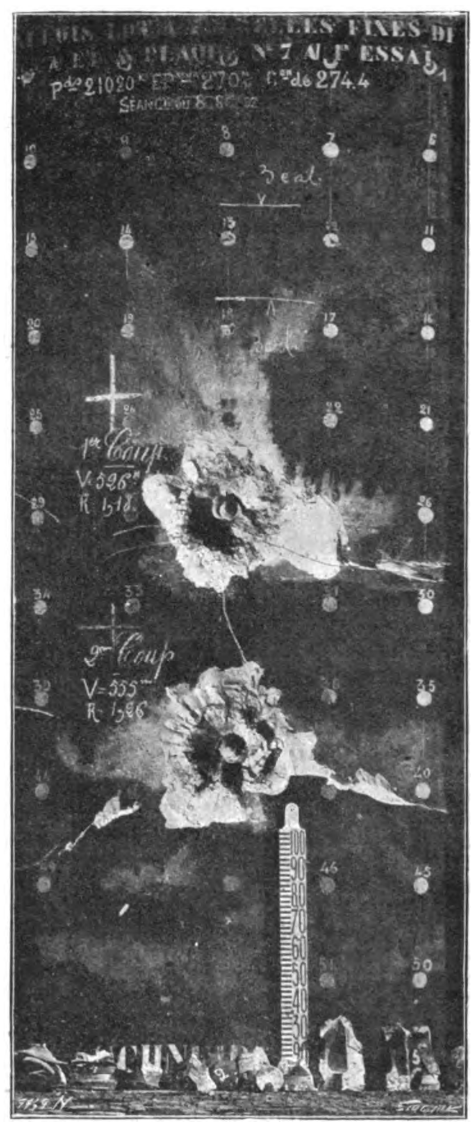

Fig. 159.

satisfactory, and Mr. Westinghouse was confident that he would be as successful with this larger engine as he was with the 250 horse-power gas engine, of which he had sold a considerable number.

Mr. Hawdon asked what amount of water was required to wash the gases, and whether it was not apt to give a very wet gas. The gases that came away from a blast-furnace being at a very high temperature, evaporated the water with which they first came in contact. Unless a great deal of water were used so as to bring down the temperature sufficiently to condense the steam thus formed, a gas containing a great deal of moisture would be the result, and this, he concluded, would be difficult to explode in the gas engine. He would like, therefore, to know how much water was used per unit of gas, and how much vapour was added to the gas by passing through the washing process.