necessary for the return of his people, he would have to reconstruct himself on entirely new lines, and being no longer a young man, and therefore set in his ways, it would be difficult and perhaps impossible to regain his former popularity. There were two alternatives open to him to select from, before closing up his empty church. Should he on the one hand try to adopt the methods adopted by his more successful brother, to whom his congregation had flocked; or on the other, was not the situation after all a temporary or traditional one in which, guided by his own matured advice, based on broad views gained by long experience, a young and resourceful assistant could meet the present crisis? It did not require long reflection to convince himself that imitation could never equal the original, and the second alternative was finally considered food for reflection. In the present issue it is likewise presented as offering a possible solution of the problem.

The factors entering into the causes of change in industrial conditions are many and varied, and scientific reasoning regarding them, may be true or false with equal probabilities. It must fall back finally upon trial, and success or failure in the future to prove its case.

But whatever the inference, there is no escaping the fact that such changes take place along lines of least resistance. When, therefore, an effort is to be made to counteract a move in the process of development, these lines must be strengthened beyond the ability of the attacking force to penetrate them.

The chief reasons why the older nations fall by the way is that the thickness of the warp and woof of the mantle of customs and laws that was woven to protect them, prevents their adapting themselves rapidly to the changing conditions of their environment. Such changes, if permanent, are steps in the march of progress, which are directed by unyielding laws working with extreme severity towards the consummation of an inscrutable plan.

England's manufacturing industries, old as the nation itself, weighted down by traditions which have incrusted them, rumble along the highway of trade in ruts so deep that they can with difficulty be extricated. There seems to be an orthodoxy in matters commercial which has been adhered to with a faith stubborn to conviction. Whatever may be the reason, it seems to be true that the Englishman adheres to his ideals longer than his American cousin, and when finally he awakens to the fact that they are destroyed, he receives a shock which apparently bewilders him.

Americans have had no standards. Their knowledge in general has been derived from precedents, and a proper selection of the good from the bad experience of the past. They have adopted the best devised methods of reducing cost, and raising quality of product, regardless of the expense attending such a policy, trusting to their soundness to bring about satisfactory results.

It is still a question in the mind of sociologists whether the methods adopted to turn out work quickly and cheaply is not developing a country of specialists who have not the deeper knowledge of affairs which eventually determines the greatness and soundness of a nation. Americans, however, possess a self-confidence in their resourcefulness in cases of emergency which has stood by them in the past, and will in all probability not fail when the next necessity for it arises. But even if Englishmen may satisfy themselves by the most logical reasoning that the methods of American competition will eventually react upon their body politic, the fact still remains for England to consider now that when her trade is gone, it is gone, and it does not require demonstration to prove that it is easier to hold possession than to get it back after it has been taken away.

Improvement comes from sad experience, and as in civilised society, self-protection demands laws leading to the betterment of conditions, so also the protection of commercial interests leads to the establishment of regulations, which make for improvements affecting mutual welfare. Thus it would seem that the situation in England demands that some existing laws be modified, and that others be enacted to meet the impending situation. There must be no compromise with expediency. Politics must not enter into the question. Such laws must be enacted at the behest of the united manufacturing interests of the country, which must come together for deliberation and determination.

The man who has sense enough to know that the fabric of customs and laws which has taken a thousand years to weave, cannot be disrupted in as many days, will find himself a long way on the road in the right direction towards advocating effective legislation. It is to be borne in mind in considering a commercial race between two nations, that there is no limit to progress, and that there is plenty of time. That nation which promulgates and adheres to the best methods will reach the goal first and hold it. That ever present problem, the so-called "labour question," must be met in England as in America, through a more thorough understanding by employer and employés, and of what those two classes owe to each other. Such an understanding can come about only through education in social science in the public school, the university, and by the press. It would pay the labour unions well if they would employ the ablest political and social economists of the nation as their leaders, and to represent their interests at the councils of the manufacturers. The situation must be studied by specialists in organisation and management. Provision must be made in the technical schools for courses in manufacturing engineering, where specialists of this type can be turned out. New shops should be organised under their direction; old ones gradually regenerated by their suggestions. Thus the most practical and scientific methods would be adopted which, with an individuality adapted to each case, would lead to rapid progress in eliminating error.

Conflicts will arise between theorists and practical men, but success will attend those who with tact have the courage to adopt a broad policy of management. The question would soon be, not whether a manufacturer can afford to adopt such a policy, but whether he can afford not to adopt it.

It is an ever true maxim in life, and one especially applicable to the present instance, that the only successful method is one which will produce the best results with the least expenditure of time and money. Once such a method has been adopted, and the opposition it creates has been crushed or worn out, it is surprising how it will persist. It is like a tender but prolific herb implanted among other vegetation which may be hardier than it is. Give it every opportunity to start, with soil, moisture, sun and air favouring, and it will overrun its neighbours to their extinction.

All about is the great mind of the universe ready for absorption. I take it for granted that England's commercial interests will move to assume a more favourable attitude towards it. Undoubtedly blunders will be made in the process, but it is only by doing something and correcting mistakes as we make them, that progress is made. The man who does nothing fearing that he will err, gets nowhere and is left behind.

So if in the future, English enterprise fails to develop along modern lines, it will be because negative influences overpower those that make for progress, and hold it down to where it is and has been.

In situations as complex as this the most astute reasoner has no precedent on which to base his arguments. He may perhaps have temerity enough to point out the way, but it is doubtful whether those to whom he may address himself, would or could accept his suggestions. No two men would agree with him.

"We see by the light of thousands of years,
And the knowledge of millions of men,
The lessons they learned through blood and in tears,
Are ours for the reading, and then
We sneer at their errors, and follies, and dreams,
Frail idols of mind and of stone,
And call ourselves wiser, forgetting it seems,
That the future may laugh at our own."

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

COAST-DEFENCE GUNS.

A CERTAIN number of types of Schneider-Canet naval guns described in preceding articles, possess details in common with the artillery specially designed for coast defence; such details are, however, more or less modified in some of the latter guns in order to meet the particular requirements they have to fulfil. As regards, for instance, mountings for quick-firing guns of equal calibre, those for coast defence frequently differ from those for naval guns, in the arrangements provided for giving the former a greater range of elevation. To obtain this, the bolster is fitted to a base with a special platform or to a masonry foundation, thus insuring the required height of soleplate for coast-defence batteries. Notwithstanding the fact that both these types of quick-firing ordnance are very similar, we shall describe some examples of coast-defence guns, in order to point out their special characteristics, with which, by the way, we are getting practical experience just now in South Africa.

The ordinary class of non-quick-firing material, which is still used for the armament of coast-defence batteries, includes all the series of large-calibre guns of medium lengths which are derived from the older non-quick-firing types, but are improved. Such a *matériel* is quite in the right place in coast defences, for it constitutes a powerful armament, and does not require, in time of peace, a numerous *personnel* for maintenance. All the parts are of very simple construction, designed so as not to be affected by variations in temperature. In action these guns can be worked by untrained men, and the careful drilling of the *personnel* is not difficult, and does not take up much time. In order to fulfil the various requirements of this particular service, the Schneider-Canet coast-defence armament includes guns, howitzers, and mortars.

27-*Centimetre* (10.630-*In.*) 28-*Calibre Coast Defence Gun* (Fig. 679).—A large number of guns of this type have been built, especially for the Japanese Government.

Weight of gun ...	... 25,890 kilog.	(57,060 lb.)
" mounting	... 35,720 "	(78,727 ")
" projectile	... 216 "	(476 ")
Elevation	... + 20 deg. – 20 deg.	
Training	... 270 deg.	
Muzzle velocity with prismatic brown powder	... 570 m.	(1870 ft.)

The gun is built throughout of steel; it consists of a thick tube which runs the whole length of the gun and is strengthened by sets of coils. It is provided with a two-motion breech-block of the type described in a preceding article dealing with large-calibre breech-blocks; friction fuses are used for firing, obturation being insured by a special steel cup.

The mounting consists of three main parts, the bolster fixed to the platform, the slide, and the gun-carriage. The bolster acts as a fixed support for the movable slide, the latter revolves round its vertical axis on coned rollers. The bolster is made with a horizontal ring which forms a roller-path and is strengthened by ribs where required. The top part of the bolster contains a vertical cylinder which fits in a corresponding one on the slide and forms a pivot for lateral training. The slide is made with two vertical checks on the top part of which bear the carriage slide shoes; the cheeks are strengthened by ribs and are joined together at their lower part by a domed cap cast in one piece with them; inside the cupola is a vertical cylinder which completes the pivot above referred to. A horizontal ring, formed by the bending up of the lower edge of the dome, acts as a bearing surface for the slide on the rollers. The slide contains the elevating mechanism, with a platform for the gunner, the lateral training mechanism and the charging cradle with its platform. In order to facilitate the running out of the gun without increasing the angle of incline of the slides, cylindrical rollers are provided, the top part of which project slightly above the surface of the slides; the carriage therefore rolls on the slides during recoil and running out. The cheeks are made in front with an excess of metal for holding the recoil cylinder piston. When the carriage runs out, buffers bear on the front stay of the slide, thus preventing a too sudden stoppage. Four clamps at the lower part of the slide bear during firing against the lower edge of the bolster, and cause the slide and bolster to offer together a large vertical resistance, while they allow the required angular displacement for lateral training.

The mechanism for elevating the gun is placed in a chest on the right cheek, and works in the following manner: The gun is provided with a toothed sector on which acts a pinion keyed on a shaft, the latter being also fitted with a helicoidal wheel worked by an endless screw. The crank acts on a pair of bevel wheels, one of which is on the endless screw shaft. The platform for the gunner is on the right cheek. Lateral training is obtained by a chain placed in a recess round the circumference of the bolster. It is guided by two friction rollers, and passes on a grooved pulley cast in one piece with a helicoidal wheel; the latter is worked by an endless screw. The endless screw is keyed on a shaft provided at both ends with a toothed wheel; two other shafts placed in front

SCHNEIDER-CANET 27-CENT. 28-CAL. COAST-DEFENCE GUN AND MOUNTING.

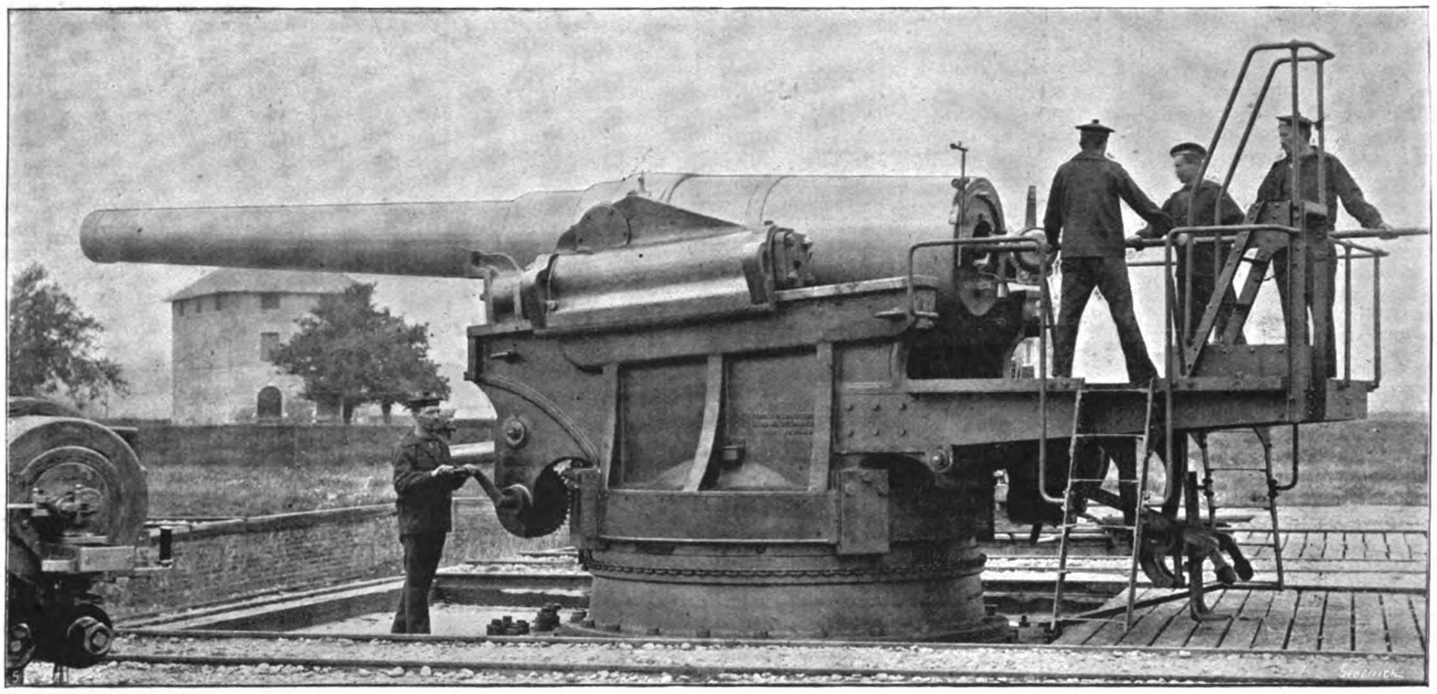


Fig. 679.

of the mounting, work the toothed wheels, and transmit the motion to all the system. The various parts being embodied with the slide, this gets displaced on the bolster immediately the grooved pulley is made to draw on the chain.

A charging cradle is used for raising the projectile from the ground level to the rear of the gun; it is placed at the end of a lever which revolves round a horizontal axle carried in bushes in the rear of the slide. On this same axle are keyed: (*a*) a cam, on the circumference of which is a chain, the other end of this is fitted to a spring recuperator; and (*b*) part of a helicoidal wheel. This is driven by an endless screw which in its turn is worked by a set of pinions, these being driven by a crank. The spring recuperator to which the chain is fitted consists of a piston, the rear surface of which bears on a series of Belleville springs contained in a fixed cylindrical chest. This arrangement renders the efforts for raising the cradle containing a projectile, and the lowering of the empty cradle, practically equal. When the lowering of the empty cradle takes place, the Belleville springs are pressed down through the traction of the chain which is drawn by the crank, the relaxing of the springs taking place during the hoisting of the cradle loaded with a projectile. The charging platform is in the rear of the slide, two ladders giving access to it.

The gun-carriage proper is in the shape of a cradle; it contains the two recoil cylinders which end at their lower part in two shoes that travel on the rollers of the slide and form clamps which prevent all raising of the system when the gun is fired. There are two ribs through one of which the two conduits of the recoil cylinders pass; the ribs insure the stiffness of the whole arrangement. The trunnions bear on the top part of the recoil cylinders in trunnion plates; they are kept in place by means of top trunnion plates and screws. Lugs on the outside of the cylinders serve for taking the material to pieces and for its re-erection.

The hydraulic recoil cylinders are fitted with central counter-rods, on the Schneider-Canet system; the pressure inside the cylinder is constant during the time recoil lasts. The pistons are joined to the slide; when a round is fired, the gun draws back the mounting and the glycerine contained in the recoil cylinders is compressed between the front surface of the pistons; it raises the valves placed in the centre of the pistons and flows through an annular opening cut round the counter-rod. When recoil is spent, the valves under the action of their springs fall back on their seats, and the liquid can only return to its former place through the small vents cut in the valve seats.

27-*Centimetre* (10.630-*In.*) 30-*Calibre Coast-Defence Gun, on Central Pivoting Mounting* (Figs. 680 to 687, page 54).—

Weight of gun	26,500 kg. (58,400 lb.)
„ mounting ...	36,500 „ (80,440 „)
Angles of elevation ...	+ 20 deg. — 8 deg.
Recoil of mounting... ...	1.100 m. (43,307 in.)
Weight of powder charge...	82 kg. (181 lb.)
„ of ordinary projectile	216 kg. (476 lb.)
Muzzle velocity	600 m. (1970 ft.)

The gun consists of a steel tube, strengthened by a jacket and eight steel hoops. The breech-block is made with three threaded parts and three interruptions, the rear thread being continuous for limiting the travel. The body of the breech-block is made with two grooves for guiding it on the supporting bracket. The fuse is threaded and is fired by friction or by electricity.

The mounting is on the Schneider-Canet system, with inclined slide, central pivoting, and with hydraulic recoil cylinder. The gun, when loaded, being perfectly balanced on its trunions, one man alone can give it the required elevation. It can also be trained by one man, owing to the care taken in the arrangement of the conical bearing rollers. For elevating and training the gun, the only effort is that required for compensating friction. No shock is caused in the recoil cylinder when the gun is fired; the rods are protected from the effects of grape shot, and the cylinders being of constant volume, air cannot penerate in them, so they remain perfectly tight. The mounting body is of cast iron; it is made with a large base; the recoil cylinders are placed as near the trunnions as possible, thus reducing to a very large extent the reversing moment. The loading platform is placed about 1 metre below the gun; a wide opening is cut out of it for allowing under the greatest angles, a free passage to the breech end of the gun during recoil. When the gun is run out, this opening is covered by the movable flooring joined to the mounting; it is uncovered automatically during recoil. This does away with the trouble that attends the use at the rear of the gun of a portable flooring for loading and which has to be removed previous to firing. Upon the cast-iron body is the cast-iron inclined slide with two cheeks stayed together in front; a cast-iron transom is fitted to the slide; there is a cast-iron bolster on which the transom turns through the medium of a set of twenty-four coned rollers.

The mechanism for elevating the gun consists of a horizontal shaft with two cranks in the front of the slide, combined with two pairs of bevelled pinions on a vertical axle; a shaft, circular in front and square in the rear, and inclined at the same angle as the roller-path of the slide; a conical pinion made to slide on the square part of the shaft; a vertical shaft on which are fitted a conical pinion and an endless screw; a horizontal shaft fitted with a helicoidal wheel and a pinion; a sector fitted to the gun, the helicoidal wheel being made to slide on the shaft. The required pressure for insuring the necessary compression of the system is given by screwed nuts and two Belleville springs, this arrangement deadening all shocks on the mechanism. Index plates show the direction for turning the cranks. One gunner, in 25 seconds, can elevate the gun from − 8 deg. to + 25 deg. When the gun recoils, the mounting draws along with it all the parts contained in the elevating mechanism and the bevelled pinion slides on the square shaft. The gun can, therefore, oscillate whatever be the position of the mounting on the slide. The gunners can maintain their hold on the cranks during firing.

The mechanism for lateral training consists of a transverse shaft with two cranks; two cylindrical wheels; a transverse shaft on the transom, on which is keyed an endless screw; a vertical shaft provided with a helicoidal wheel and a pinion; a toothed ring fixed to the bolster; the helicoidal wheel is made to slide on its shaft; the pressure required for insuring the necessary contact is given by screwed nuts with two Belleville springs, this arrangement deadening all shocks on the teeth of the mechanism; index plates are provided for showing the direction in which the cranks have to be turned. One gunner suffices for training the gun through a small angle; for turning it completely round it takes two men five minutes. The gunners need not release the cranks while the gun is fired. There is also a mechanism for running in the gun, but it is only resorted to for maintenance and repair.

The device for checking recoil consists of two forged-steel cylinders cased in the lower part of the mounting and provided in the middle of their length with a lug for fixing them; they are closed at both ends by covers. The two plunger-rods are fixed to the front stay; the plungers are made with two round holes through which pass rods of varying sections. (Figs. 685 to 687.)

When the gun is fired, the mounting recoils and draws back the cylinders. The liquid in the front of the pistons flows to the rear through the openings made between the rods of varying sections and the holes in the piston. The sections of the rods are so calculated that resistance is constant during the time recoil lasts. When the gun runs out again, the liquid flows back through the same openings, the travel of the gun is moderated by the friction of the various parts and the shock on the front buffers is very slight. The constant resist-

SCHNEIDER-CANET 27-CENTIMETRE 30-CALIBRE COAST DEFENCE GUN AND MOUNTING.

(For Description, see Page 41.)

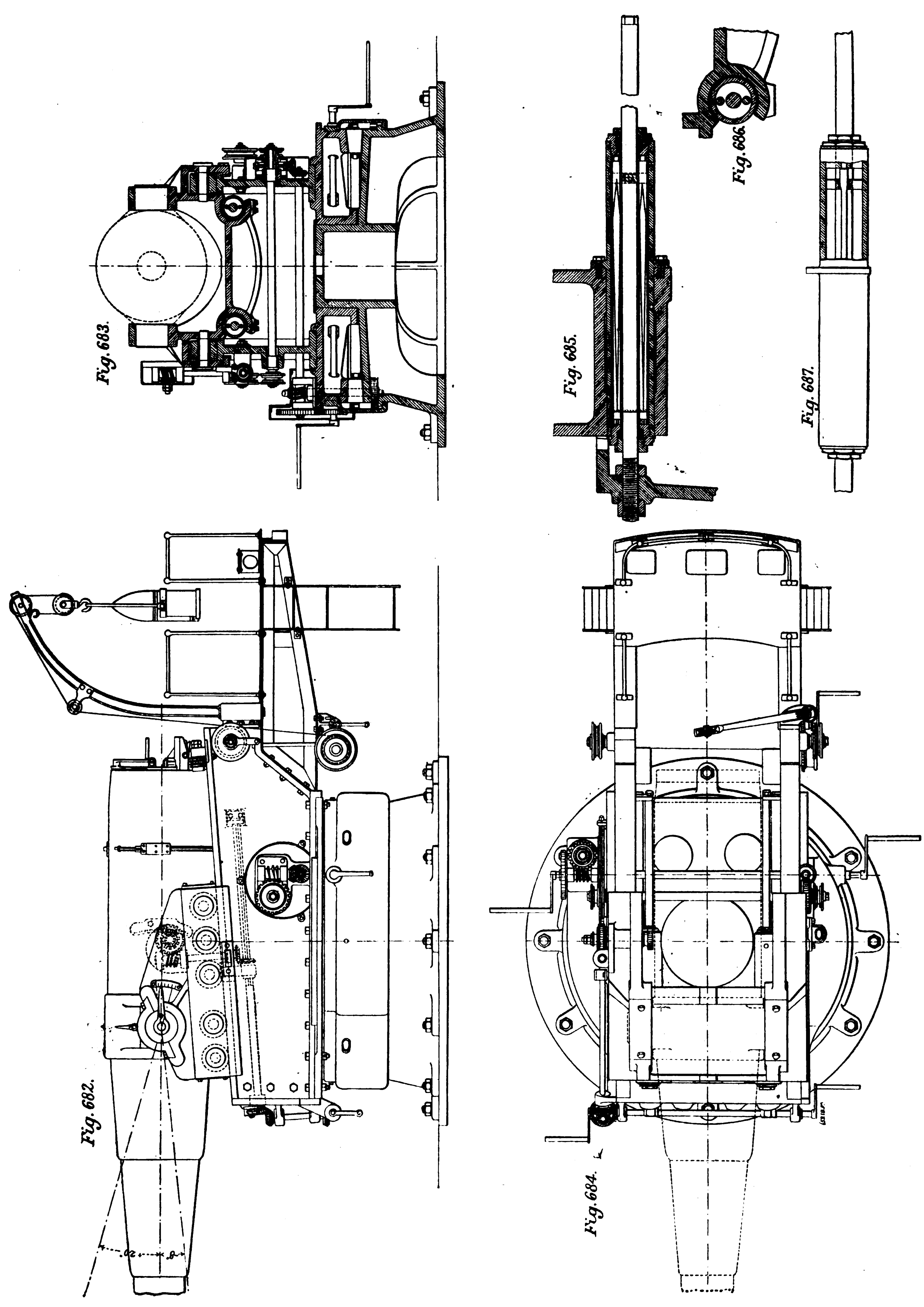


Fig. 682. Fig. 683. Fig. 684. Fig. 685. Fig. 686. Fig. 687.

ance recoil cylinders do not cause any strain on the mounting, and it gives practically equal recoil speeds whatever be the firing angles. The firing platform is in two parts, one fixed and the other movable.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

(BY OUR NEW YORK CORRESRONDENT.)

As the December, New York meeting of this Society was to be the last one of the century (according to German decree) it would seem that everyone had made a special effort to be present and to assist in making it a success. The result was one of the best meetings the Society has ever held, and one which had a much larger attendance. It was quite noticeable that a great number of the older members had presented themselves, and this, too, at a time when American manufactories seemed to be busier than at any previous time in their history. The meeting commenced at 9 P.M., December 5, and the large audience listened to an address by the President, Admiral George W. Melville; the title was "Engineering in the United States Navy," and the distinguished speaker reviewed the history of marine steam engineering and steamships from 1814 to the present time. We have already published this address in full, so that no attempt will be made here to condense it. The author brought the subject right down to the Parsons steam turbines, and paid Mr. George Westinghouse a handsome compliment in regard to his development of the new motor in this country. An informal "smoking" reception ensued, and the members generally were not only pleased with the President's address, but seemed to find pleasure in the succeeding festivities.

The report of the finance committee showed that the expenditures for the year were 34,542 dols., the cash in hand being 10,092*l*. dols. The total assets of the Society amount to 53,006 dols. During this session the membership was increased by the addition of 52 members, 13 associate members, and 42 juniors.

The arrangements for visiting Europe in 1900 were discussed, and the invitation of the Institution of Civil Engineers of Great Britain was read, extending their hospitality to the members purposing to attend the Paris Exposition next year. Those who were the recipients of the attentions shown by the Institution in 1889 will never forget how unbounded and thoughtful it was, and it is quite fair to presume that a large number of the "eighty-niners" will be in the party of 1900, which already numbers over 500. The next question taken up was that of the "Robert Fulton Memorial." The Mechanical Engineers propose to erect a suitable monument over his resting-place in Trinity Churchyard, New York City, and have raised a fund already of over 900 dols. for this purpose. It is believed that all mechanical engineers will be glad to further this project in some way, and that the monument will speedily be erected. The following were announced as the choice of the Society to be its officers for the ensuing year: Chas. H. Morgan, of Worcester, Mass., president; Jesse M. Smith, of New York, Stevenson Taylor, of Hoboken, N.J., and David Townsend, of Philadelphia, vice-presidents; F. H. Boyer, of Summerville, Mass., John A. Brashear, of Allegheny, and Alfred H. Raynal, of Washington, managers; William H. Wiley, treasurer.

Next came a report which may excite considerable discussion, and cannot fail to be of the greatest interest to manufacturers, steam users, and mechanical engineers in general. It was the report of the "Committee on the Revision of the Society Code of 1885 Relative to a Standard Method of Conducting Steam Trials." This revision was rendered necessary by the advance of scientific investigation and the new methods and new instruments following such progress. We shall take an early opportunity of publishing an abstract of this report, which filled 78 octavo pages; all, no doubt, are full of interest, but want of space forbids us to attempt more than an abstract. This report was so satisfactory to all present that it was adopted without debate. In fact, the greatest credit is due to the committee for the masterly way they have handled the subject, and the great amount of time they have devoted to its consideration. If posterity does not "rise up and call them blessed," it will show a greater lack of appreciation than the distinguished leaders of the profession who were present, for unstinted praise was given them and the thanks of the Society, while the acceptance of the report was a greater compliment still. The committee on standard methods of conducting steam engine trials reported progress, and so did that for standard generator sets; this last committee stated that they had found a hearty co-operation among the members of the American Institute of Electrical Engineers. After re-appointing the committee on standard pipe flanges the Society was ready to listen to the first of the series of papers for this meeting. It was entitled "The Steam Engine at the End of the Nineteenth Century," and was by our past-president and distinguished member Dr. Robert H. Thurston, of Cornell University. The paper consisted in general of the tests of a pumping engine built by the Nordberg Manufacturing Company for the Penn Water Company, and located near Pittsburg. The reason for this selection is that this engine has shown the highest duty on record. The author, in his introduction, quoted from the famous work of M. L. S. Carnot, which he had translated and edited. He also noted certain ideals which M. Carnot had described, and which in the light of modern engines certainly showed a wonderful foresight. It is impossible to reproduce this paper, but an abstract shall be published on an early occasion.

COAL CALORIMETRY.

The next paper was entitled "The Berthier Method of Coal Calorimetry," by C. V. Kerr. The author explained the Berthier method, and admitted its defects; at the same time he considered it preferable to the Mahler bomb calorimeter which has received the commendation of the Committee on Boiler Tests. Professor Kinealy in the discussion thought it worthless to determine the heating power of coal. Mr. Kerr gave tables of results, but admitted the Berthier theory might be defective.

TEST OF TWO 10-MILLION GALLON PUMPING ENGINES.

We pass to the next paper, viz., "Test of Two 10-Million Gallon Pumping Engines at the Baden Pumping Station, St. Louis Water Works, June, 1899." This was by John A. Laird, St. Louis, Mo., and an attempt is made to condense the most important and interesting features.

The engines tested are duplicates, built by the Edward P. Allis Company, and are of the now well-known type of Reynolds pumping engine, which all of the large builders have adopted. They are three-cylinder triple-expansion, condensing, vertical, with rigid connection between plungers and pistons, three single-acting plungers. The diameters of cylinders are respectively 30 in., 54 in., and 80 in. The plungers are 25½ in. in diameter, and all are 64 in. stroke. There are two receivers, the heating coils inside of which are helical, and extend for the full length of the receivers. The cylinders are jacketed on the sides, but not on the heads. The jackets, cylinder heads, receivers, and all other heated surfaces about the engines are covered with 2 in. of magnesia and 2 in. of hair felt, the whole enclosed in walnut lagging. The distribution of steam through the jackets and receivers is shown in Fig. 1 (see page 45). This system was designed by Mr. Arthur West, and has the effect of reducing the amount of jacket steam by a small percentage. The steam distribution valves are all Corliss, except the low-pressure exhaust, which are poppet. The clearance on high-pressure cylinders is 1.036 per cent.; on the intermediate, 1.18 per cent., and on the low, .509 per cent.

According to accepted practice on triple-expansion pumping engines, the governor only controls the cut-off on the high-pressure cylinders, the others being regulated by hand. There are two piston-rods to each cylinder, packed with Tripp's metallic packing. They connect to an Allis four-cornered crosshead, to the centre of which is attached the connecting-rod, and to the corners, the four pump-rods. The piston-rods are each 4 in. in diameter, and the pump-rods, 4½ in. The pump barrels are directly underneath the steam cylinders, and the valve chambers are on the centre line of the engine. The plungers are single-acting. The pump valves are 3½ in. in diameter, have a ⅜-in. lift, and are placed on cages with twenty valves on each cage. There are seven cages on each diaphragm, and the free waterway through the valves on any one diaphragm is about equal to the area of the plunger. The bedplates, carrying main shaft pillow blocks, rest on masonry piers. The suction pipes run through the engine pit wall to a wet well from which all six of the engines in the house will draw. The level of water in the wet well was about 17½ ft. above the bottom of the pumps during the test, making about 13 ft. of head on the suction valves. This suction head was practically constant, and the discharge head did not vary more than one-half of 1 per cent. above or below the mean.

All of the auxiliary pumps required to run the engine, as the feed pump, air pump, and air compressor for charging the air chambers, were attached to and run by the main engine during the test. The circulating water was taken from the suction pipe and returned to the same, as shown in Fig. 2 (page 45).

The boiler plant for the station consists of eight 300 horse-power boilers of the water-tube type, manufactured and furnished by the John O'Brien Boiler Works Company, of St. Louis. The boilers each have 3000 square feet of heating surface, and are equipped with the Hawley down-draught furnace. The upper grate has 37.6 square feet of surface, and the lower 50.3 square feet. The stack is 150 ft. high, with 7 ft. internal diameter. The smoke connection to stack is sheet iron overhead, and covered with magnesia blocks and canvas.

The contract had a most useful and stimulating feature; a bonus was to be paid of 1000 dols. for each million foot-pounds the duty goes above 125,000,000 gallons with a forfeiture of 2500 dols. for each million it goes below this. On page 45 are given some indicator cards (Fig. 3) and the report of the tests are annexed. It may be added that the builders obtained 30,000 dols. bonus on each engine:

—	7. (Fig. 3.)		8.	
	Top.	Bottom.	Top.	Bottom.
Indicator Card Data.				
Area of high-pressure piston	706.86	678.49	706.86	678.49
,, intermediate ,,	2290.2	2261.83	2290.2	2261.83
,, low-pressure ,,	5026.5	4998.13	5026.2	4998.13
High-Pressure Cards.				
Scale of spring (nominal) ..	80	80	80	80
,, ,, (actual) ..	78.82	79.366	78.82	79.366
Admission pressure (absolute)	153.85	148.25	153.88	150.48
Cut-off ,, ,,	153.65	148.15	153.68	150.4
Release ,, ,,	44.4	41.4	43.98	41.48
Compression ,, ,,	87.35	62.65	82.68	78 49
Per cent. of cut-off	29.19	28.50	29.4	28.1
Mean effective pressure ..	55.6	54.1	55.25	53.95
Indicated horse-power ..	104.35	96.93	103.75	97.04
,, ,, (total)..	201 28		200.79	
Intermediate-Pressure Cards.				
Scale of spring (nominal) ..	20	20	20	20
,, ,, (actual) ..	19.493	19.206	19.493	19.21
Admission pressure (absolute)	43.30	43.35	44.28	43 78
Cut-off ,, ,,	38.25	37.50	38.88	38 38
Release ,, ,,	11.73	10.38	11.37	11.61
Compression ,, ,,	28.49	12.73	22.48	17.56
Per cent. of cut-off	29.25	29.00	28.5	28.5
Mean effective pressure ..	15.43	15.38	14.89	15.38
Indicated horse-power ..	93.51	92.02	90.53	92.29
,, ,, (total)..	185.53		182.82	
Low-Pressure Cards.				
Scale of spring (nominal) ..	10	10	10	10
,, ,, (actual) ..	9.87	9.795	9.87	9.795
Admission pressure (absolute)	10.27	10.61	11.03	10.83
Cut-off ,, ,,	8.425	8 97	9.06	9.17
Release ,, ,,	4.98	4.19	4.76	5.18
Compression ,, ,,	5.42	5.64	6.10	4.98
Per cent. of cut-off	52.8	52.5	45.6	45.6
Mean effective pressure ..	6.115	6.04	6.112	6 02
Indicated horse-power ..	81.48	80.42	81.53	79.79
,, ,, (total)	161.90		161.32	
Total horse-power, 3 cylinders	548.71		544.93	

Report of Duty Tests on High Service Engines Nos. 7 and 8 St. Louis Water Works.

Engine number		7	8
Date of test		June 6 & 7	June 9 & 10
Duration of test		24 hours	24 hours
Pressures.			
Steam pressure in engine-room, from cards	lb.	136.0	137.0
First receiver, from cards, ..	,,	27.3	28.5
Second receiver, from cards	,,	4.0	3.0
Vacuum, from cards	,,	13.14	13.03
Barometer	in.	29.59	29.67
Temperatures.			
Water pumped ..	deg. Fahr.	79.0	76.8
Feed water	,,	103.2	99.3
Air pump discharge ..	,,	95.0	94.6
Circulating water, in	,,	79.0	76.8
,, ,, out	,,	94.0	94.0
Exhaust	,,	115.6	113.5
Air, engine-room ..	,,	85.9	75.3
Air, outside	,,	86.6	68.3
Feed-Water and Steam.			
Total water fed to boilers ..	lb.	153,398.0	152,402.0
Water fed to boilers per hour	,,	6,391.6	6,359.0
Quality of steam at throttle,	per ct.	99.8	99.8
Total dry steam to engine ..	lb.	153,122.0	152,128.0
Dry steam to engine per hour	,,	6,380.8	6,338.7
Total water from surface condenser	lb.	133,251.0	132,227.0
Water from surface condenser per hour	lb.	5,552.0	5,509.5
Total water from jacket and second receiver	lb.	20,346.0	20,005.0
Water from jacket and second receiver per hour	lb.	847.7	833.5
Difference between boiler-room and engine-room records ..	lb.	199.0	170.0
Difference, checking from engine to boiler	lb.	88.0	4.0
Pump Data.			
Total revolutions		23,671	23,664
Revolutions per minute		16.44	16.43
Piston speed per minute ..	ft.	175.36	175.25
Displacement of plungers per revolution	gals.	424.60	424.52
Total water pumped (plunger displacement)	gals.	10,051,000	10,046,006
Plunger leakage	,,	3,000	125
Net water pumped	,,	10,048,000	10,046,000
Average discharge gauge reading	ft. el.	400.37	401.27
Average suction gauge reading	,,	106.48	107.37
Average head pumped against	ft.	293.89	293.90

SCHNEIDER-CANET 27-CENT. 30-CAL. COAST-DEFENCE GUN AND MOUNTING.

(*For Description, see Page* 41.)

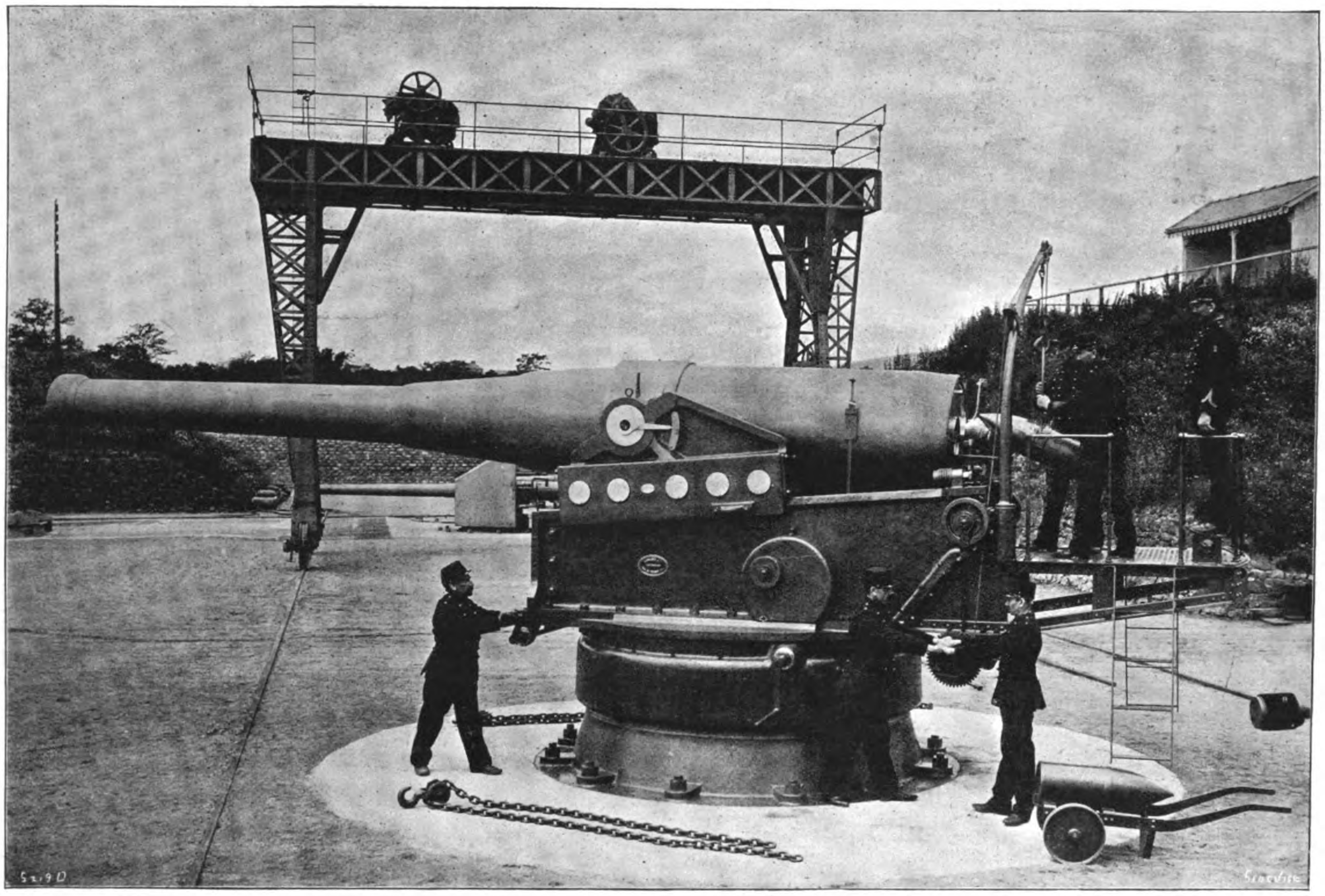


FIG. 680.

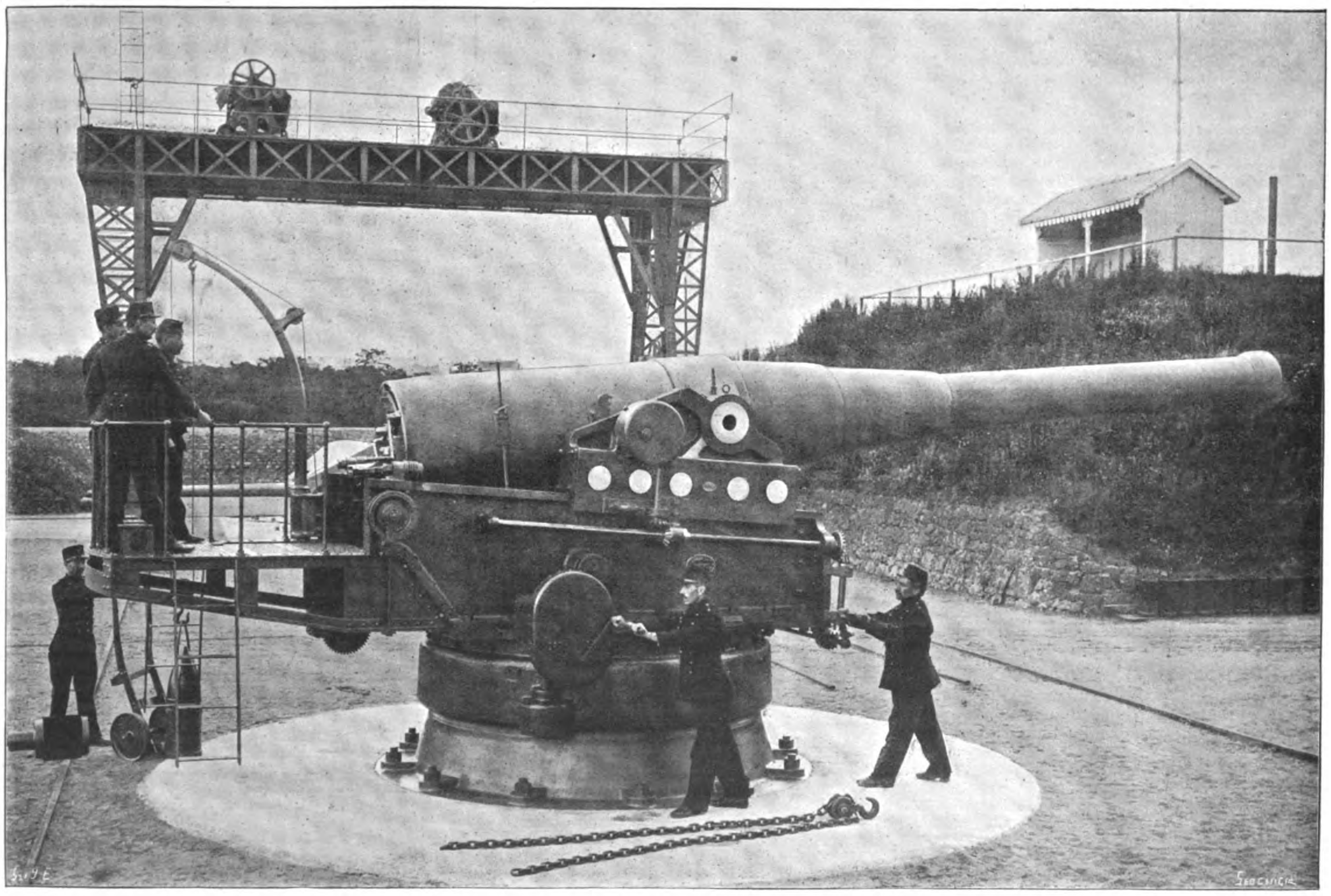


FIG. 681.

12-IN. COAST-DEFENCE GUN AND SCHNEIDER-CANET MOUNTING.

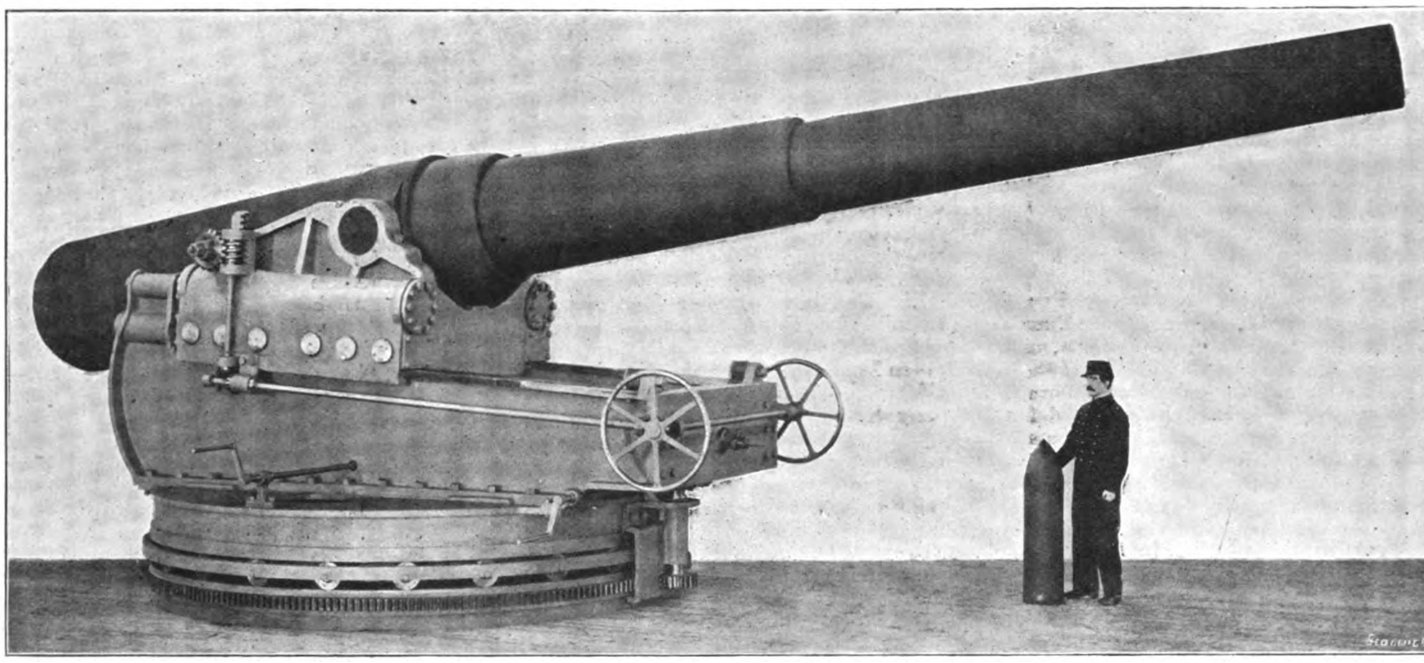
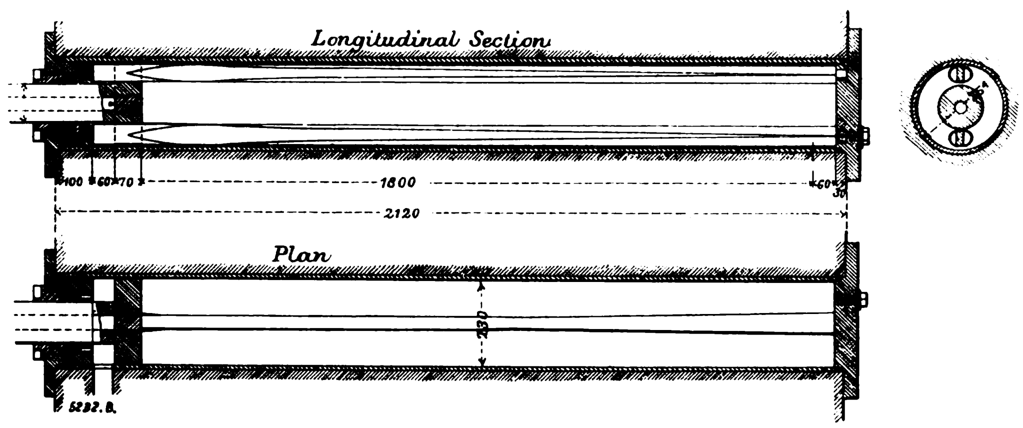


Fig. 688.



design. On an average an entirely new design appears about every three years. The castings are very smooth and perfect on account of the high grade of the iron and the superior quality of moulding sand used.

Popularity of American Stoves Abroad.—Canadian manufacturers have contracts with manufacturers in the United States to take duplicate patterns of all of their new stoves as fast as completed, to be used as patterns to make stoves from; but they have never taken a single set of patterns made in any other country. American stoves have been used as patterns in Scotland and in Germany; but there has never been a case where a manufacturer in the United States has used, or has imitated, a stove or range made in any other country. A good thing will be imitated.

Freight Rates.—Under the present prevailing conditions, goods can be freighted about as cheaply from New York, to almost any foreign market, as they can from Liverpool or London. From our lack of banking facilities, all American exporters are obliged to pay the English bankers a profit of from ½ to 1 per cent. Still, this charge does not cut much figure in the general result. Owing to the proximity of coal and iron fields, and the vast supply, we are able to produce goods made from iron and steel as cheaply, when quality is taken into account, as any nation on the face of the globe. The high wages we pay are off-set by the prices at which we can purchase our raw material, and the appliances which we use to facilitate production. When one reflects that we have been able to export to Great Britain and Europe all kinds of iron and steel materials, from pig iron up to axes and door locks, it will be seen that our position in point of cheap manufacturing is unsurpassed by that of any other manufacturing nation, and that in normal times we can beat the world in our prices, the same as we do in the quality and finish of our goods.

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

12-In. Coast-Defence Gun and Mounting.

This mounting is fitted on an elevator, and disappears in a pit for loading the gun. The disappearing action can only take place when the gun is run in, and a special device has been designed to maintain it in that position after firing, and to run it out again after it has been loaded and raised.

The mounting (Figs. 688 to 696 on the present and opposite pages) is central pivoting, with inclined slides and hydraulic recoil cylinder, the return taking place by gravity. The carriage is of cast steel, and is made to carry the gun on its trunnions; it is fitted with forged-steel rollers, which run on the slide. The slide is of cast steel, and consists of two cheeks stayed in front and strongly bolted on the bolster. The latter is of cast steel; in its centre is the pivot-housing, and underneath is a circular roller path. The transom is also of cast steel, provided with a pivot lined with gun metal, and is made with a circular racer; the transom is bolted on the elevator platform. The series of rollers placed between the bolster and the platform, consists of 24 forged-steel conical rollers, joined together by two rings. The two recoil cylinders and the cylinder for running in the gun are cast in one piece with the mounting; they are lined with gun metal. The two recoil piston-rods are fixed to two shoulders in the rear of the cheeks; the plunger for running in the gun is joined to the slide stay-piece. The recoil cylinders are made with constant resistance. During recoil, the liquid flows from the front to the rear of the piston through two openings, which are partly blocked up by two rods fixed to both ends of the cylinder. The section of these rods at various parts of their length is so designed that the free opening for the flowing of the liquid varies with the recoil speed, the resistance to the flow being constant (Figs. 689 to 691). The volume of liquid, which corresponds to that of the rods, when driven from the cylinders, flows through two pipes and a valve chest in the cylinder for running in the gun, and fills exactly the void caused by the withdrawal of the plunger. The valve chest is arranged in such a way that the liquid passes in the running-in cylinder after raising a valve, and can only return in the recoil cylinders through a vent, the opening of which is regulated by a rod which is worked from a handle placed on the side of the mounting. If the rod is driven home in the vent, the gun remains run in, and it runs out quicker the more the rod is raised. The manœuvre for running in the gun is effected by means of a small pump fitted to the bolster and worked by two handwheels on each side of the mounting. The pump draws the liquid from the recoil cylinders through a conduit in the rods, and delivers it in the running-in cylinder through a passage in the plunger.

Elevation ranges from − 7 deg. to + 20 deg. A toothed sector fitted to the gun acts in conjunction with a pinion joined through a friction cone, to an endless screw; Belleville springs allow a certain amount of play between the various parts to counteract violent shocks. The handwheels for giving the required elevation do not follow the recoil, and can act whatever be the position of the gun, by working a square shaft, on which slides a conical pinion carried by the mounting. The gun is trained through a pinion fitted to the bolster, and which engages a circular rack fixed to the transom. The pinion is worked by a set of wheels and an endless screw, the latter being driven by two cranks keyed on the same shaft and placed near the handwheels for elevating the gun. Cramps in the front and rear of the bolster clasp a ridge on the transom, and prevent the raising of the mounting.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

(By our New York Correspondent.)

(*Continued from page* 47.)

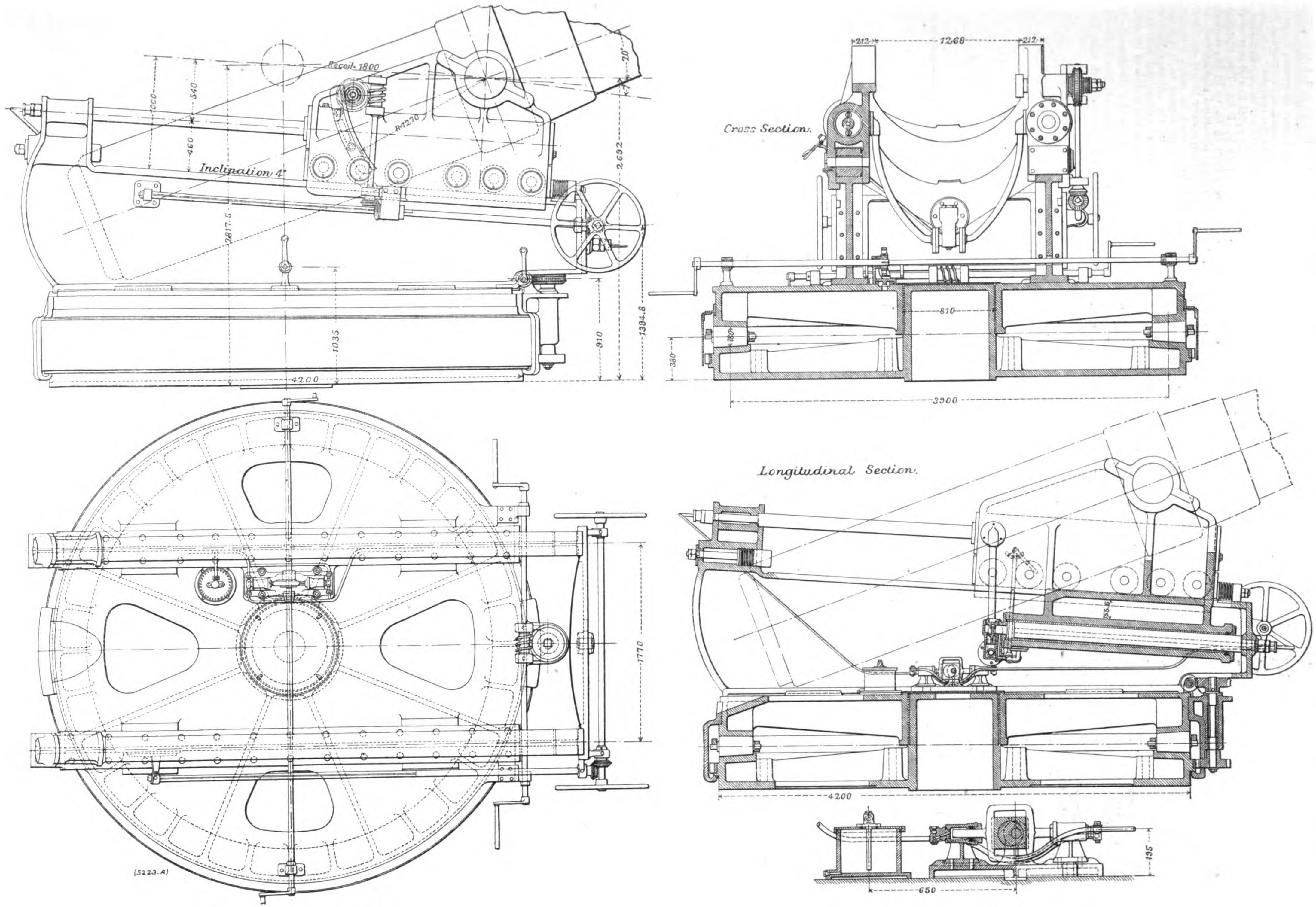
Gasoline Gas for Boiler Heating.

The next morning the session opened with a paper entitled, "Experiments on Using Gasoline Gas for Boiler Heating," by Herman Poole. The results of this are given below:

The quantity of gasoline used was 35 gallons, costing 10 cents per gallon. This generated 1000 lb. of steam at 60 lb. pressure, equivalent to 1211 lb. evaporated from, and at, 212 deg. It was intended to have a full time

12-IN. COAST-DEFENCE GUN AND SCHNEIDER-CANET MOUNTING.

(For Description, see Page 78.)



24-CENT. COAST-DEFENCE GUN WITH SCHNEIDER-CANET MOUNTING.

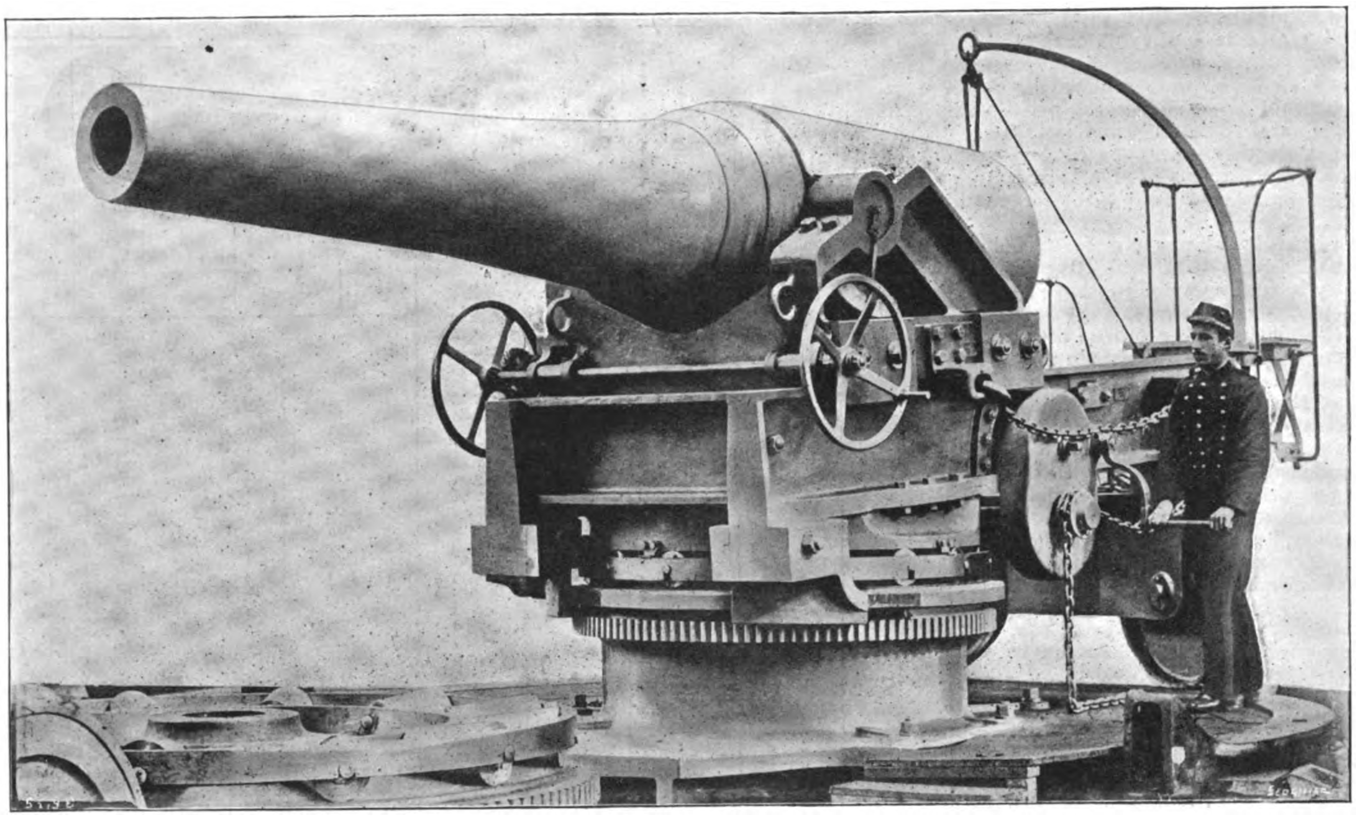


FIG. 696.

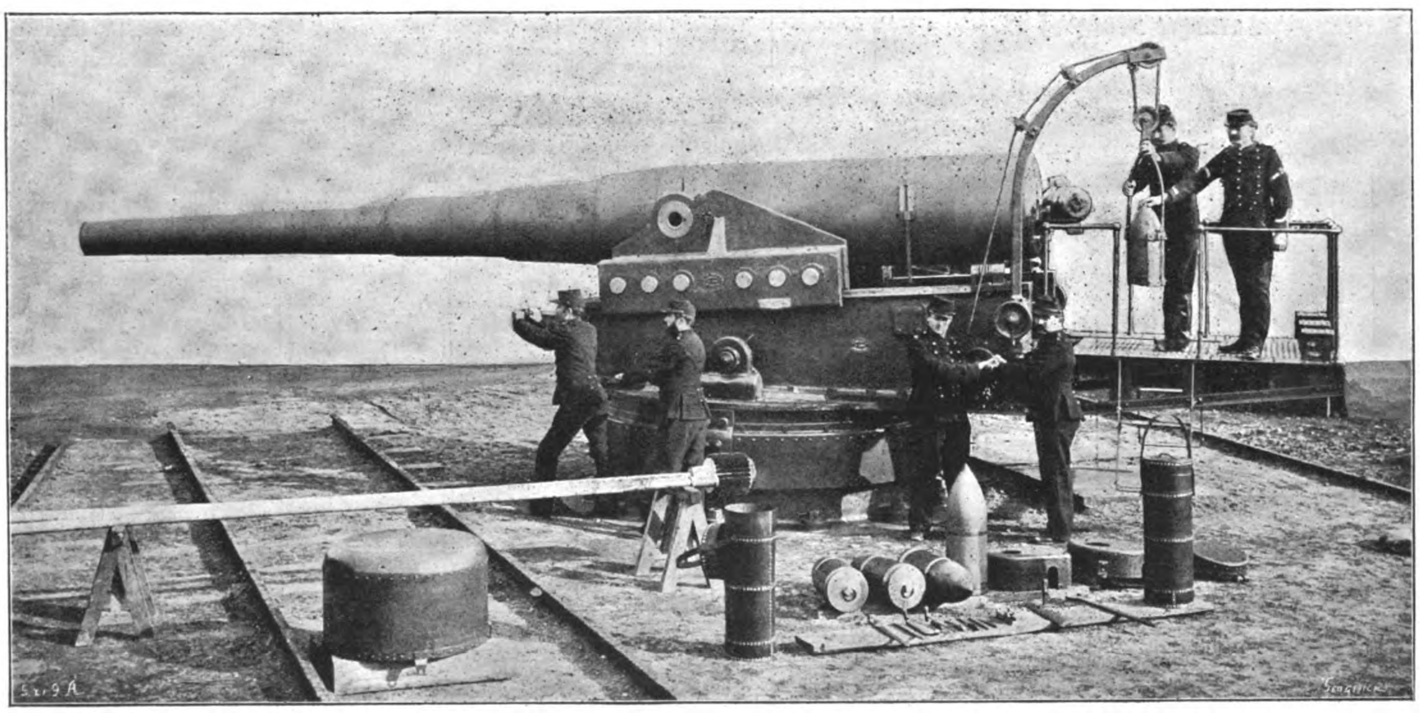


FIG. 697.

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

COAST-DEFENCE GUNS—(*continued*).

24-Centimetre (9.449-*In.*) *Coast-Defence Gun on Central Pivoted Mounting.*—(Figs. 696 and 697).—Armaments of this type have been supplied to the Chinese Government. The gun is 36 calibres in length; it is of forged and tempered steel, constructed to the requirements and specification of the French Navy; it weighs 20,300 kilogrammes (about 20 tons), and consists of a tube which runs on the whole length of the gun, and in which is screwed the breech-block; of a jacket which surrounds the tube from the rear end, to forward of the trunnion-ring; the trunnion-ring; strengthening coils that surround the jacket, and chase-coils on two-thirds of the length of the chase. The jacket and coils are placed on the cylindrical parts of the gun, the diametrical shrinkage allowance being $1\frac{1}{2}$ millimetres per metre. From the front of the jacket, the thickness of the tube is made to diminish by two steps, the non-reinforced part of the tube being in the shape of a truncated cone. The force of recoil is transmitted direct to the trunnion-ring by the jacket, the latter being made with dovetails, which secure it to the trunnion-ring and to the tube. In order to prevent sliding of the tube during firing, the bearing of the dovetails is made more secure by allowing a slight longitudinal shrinkage to the jacket and trunnion-ring.

The breech-block is on the Schneider-Canet ystem, with interrupted screw and composite obturator. All the parts can be put together and taken to pieces without the help of any special tool. The gun can be fired with percussion, or an electric, fuse. It fires ordinary shell, weighing 140 kilogrammes (309 lb.), and armour-piercing projectiles, weighing 164 kilogrammes (362 lb.). The charge consists of prismatic brown powder, and weighs 87 kilogrammes (192 lb.); the corresponding density being .94 (equals weight of powder divided by the capacity of the powder-chamber).

The mounting is central-pivoting, with hydraulic recoil and automatic return by gravity. It consists of a carriage, with slide and transom of cast steel, and a cast-iron bolster; it weighs in all 31,200 kilogrammes (31 tons). The trunnion centre is 2,200 metres (86.614 in.) above the floor level.

32-CENT. COAST-DEFENCE GUN WITH SCHNEIDER-CANET MOUNTING.

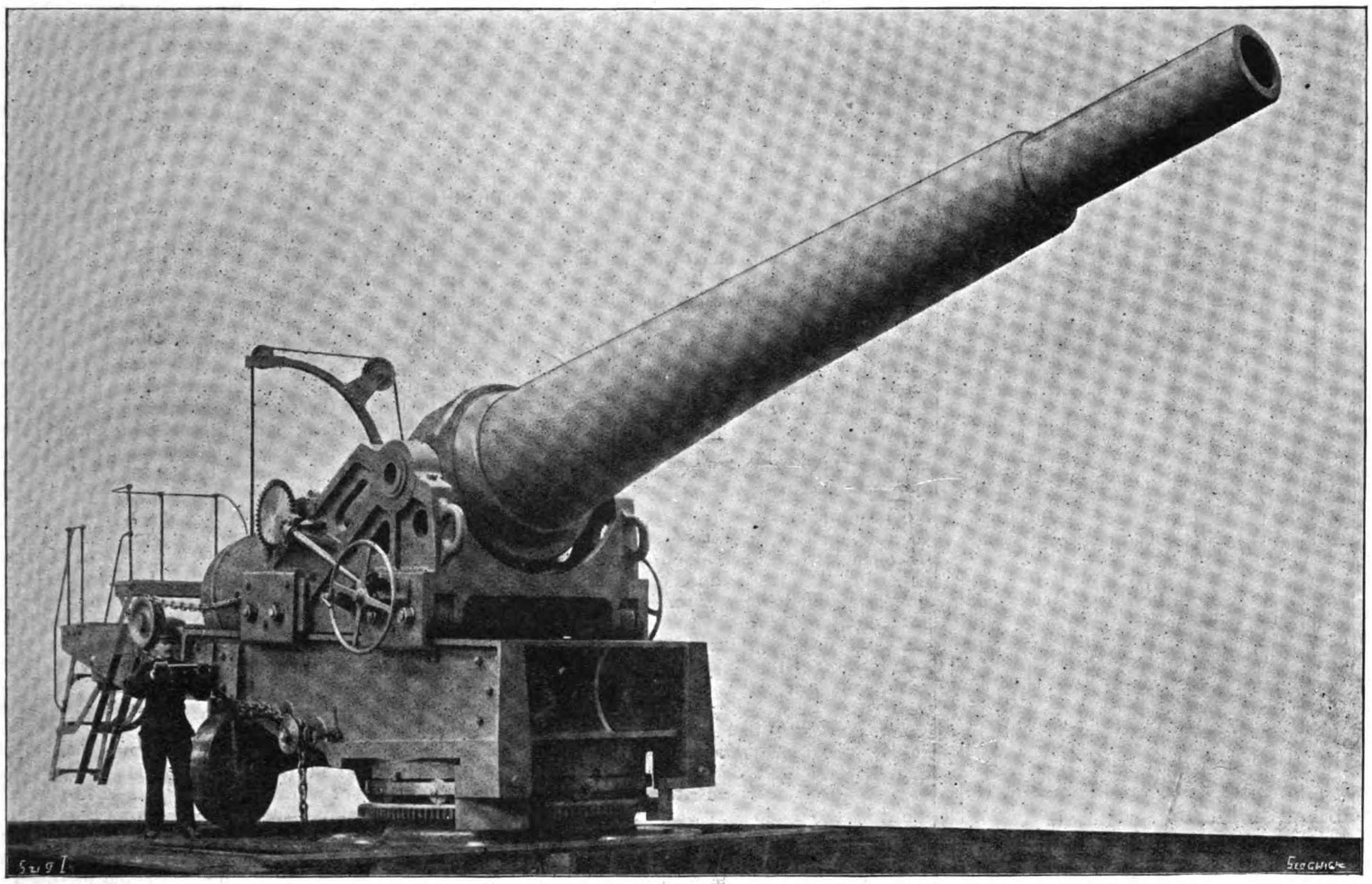


FIG. 698.

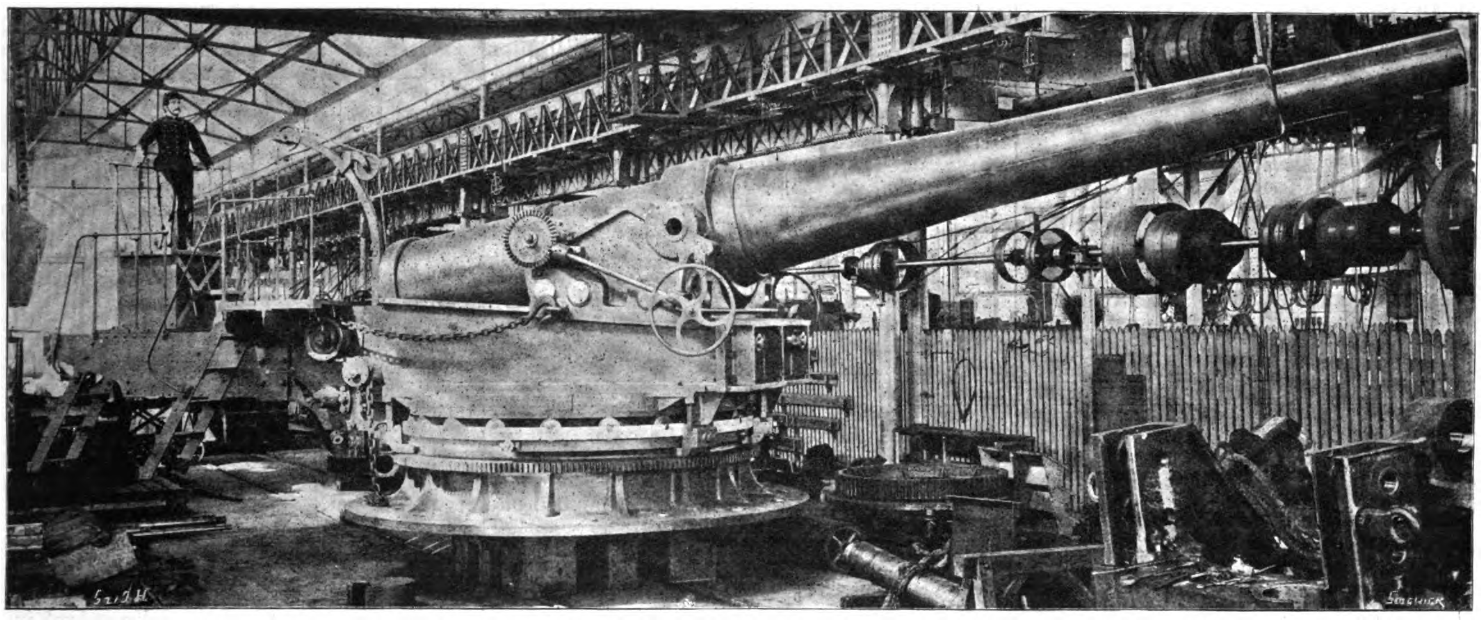


FIG. 699.

The carriage rests on the slide with the interposition of cylindrical rollers, on which it is guided in its travel, so as to prevent all deviation or raising of the system; it carries at its lower part two recoil cylinders, each with a piston fitted to the front of the slide. The slide is made with an incline of 4 deg. (7/100), and consists of two parallel cheeks with a cross-beam in front; it is joined to the transom, which turns round a pivot on a set of free rollers kept in place by rings. Cramps fixed to the transom hold a string-piece on the bolster, and prevent the raising of the slide during recoil. The bolster forms a pivot, and the string-piece above referred to serves as a circular rack for lateral training. It is bolted on wood beams to a masonry foundation, the weight of which insures the stability of the system. The range of elevation is from 7 deg. to 25 deg., and the required elevation is given by cranks working a shaft, and a set of gearing which acts on a toothed sector fitted to the gun. In the arrangement of the gearing, means are taken to insure a smooth working of the gun during elevation, as well as to prevent all shocks on the mechanism when there is preponderance of the muzzle. As the shaft on which the cranks are keyed are fitted to the slide and not to the carriage, the men need not leave the cranks when the gun is fired. For lateral training, the range runs through 360 deg., and this is obtained by cranks working a shaft and a set of gearing that engages the rack on the bolster; this same mechanism serves to run in the gun by hand-power, after disengaging a pinion to prevent the mounting from revolving, and for this a set of gearing with plate-chain transmissions is provided.

The recoil cylinders are formed for constant volume, and with loaded valves. They limit the recoil to 1 metre (39⅜ in.) maximum. During recoil, the liquid in the front part of the cylinders acts on the valve and opens it, giving a passage from the front to the rear, a small part of it flowing through two vents in the piston. When the recoil is spent, the valve closes, and the liquid in returning from the rear to the front, passes through the two openings, thus setting up a resistance which controls the running out of the gun, that takes place automatically, through the incline of the slide. The cylinders are placed at the lower part of the carriage, in order to insure the preservation of the rods and prevent losses in liquid. This causes a greater momentum in running out than would be the case were the cylinders placed above the slide; experience, however, has shown that this inconvenience is not to be feared when, as in the present instance, the stability given to the carriage is properly proportioned to the distance from the cylinders to the trunnions—a distance which has been reduced to a minimum.

The mounting is provided with the following accessory gear: a loading crane, with quick-lowering motion; a loading platform, from which the gun can be also trained, with hand-rail and steps for sighting at minus angles; elastic buffers which limit the travel of the carriage on the slide in both directions; an index for the elevation of the gun, with plates showing the direction for turning the cranks; sheet-iron covers for protecting the delicate parts of the mechanism from dust and splinters.

The average initial velocities obtained with the gun have varied between 665 and 707 metres (2182 ft. and 2316 ft.), with a powder-charge of 87 kilogrammes (192 lb.), and an armour-piercing shell weighing 164 kilogrammes (362 lb.).

24-Centimetre (9.449-In.) Coast-Defence Gun, on Muzzle-Pivoting Mounting.—The principal characteristics of this type of material are the following:

Length of gun	19 calibres
Weight „	14600 kg. (32178 lb.)
„ mounting ...	27810 „ (61293 „)
„ armour-piercing shell	144 „ (317 lb.)
Weight of prismatic brown powder	39 „ (86 lb.)
Muzzle velocity in service	470 m. (1542 ft.)
Angles of elevation ...	+ 30 — 7 deg.

The breech-block is cylindrical, with three threaded parts and three interruptions; it rests on a bracket which revolves round a vertical hinge bolt. The obturator consists of a composite elastic disc, which unites the advantages of the Broadwell ring, and those of the usual plastic obturator, while allowing the breech to be worked with great facility. It is placed between the movable head and the front surface of the breech-block. Firing is effected with a percussion fuse, by means of a movable bolt, or with an electric fuse, when the bolt is fitted with the necessary terminals for electric connections. The percussion piece is not in the centre of the vent unless the breech be completely closed, thus doing away with all risk of premature fire.

The mounting consists of the bolster, and the transom, with slide and carriage. The bolster is made with a front pivot, and is bolted on a masonry foundation. The transom rests on conical rollers. The slide is fixed on the transom, and consists of two parallel vertical cheeks stayed in front; it is carried in the rear on wheels which turn round a circular path on the platform. The gun is protected by a shield when required.

The required elevation is given by a crank which drives, through a set of pinions, an endless screw and a toothed wheel, the latter engaging direct the toothed sector fitted to the gun. For training the gun, the mechanism consists of a crank, an endless screw and a pinion, the latter engaging the circular rack of the bolster.

The hydraulic recoil cylinders are of constant volume; the plunger-rod is fitted to the slide. At the end of the recoil, the valve falls back on its seat, the liquid under pressure only flowing through small passages; the carriage runs out again smoothly under the action of gravity. In the rear of the carriage is a platform for serving the gun, and a small crane for raising the ammunition.

32-Centimetre (12.598-In.) Coast-Defence Gun, on Central Pivoting Mounting (Figs. 698 and 699).—Two types of mounting for this calibre have been built by Messrs. Schneider and Co.—namely, one in 1886 with a circular sector on which the rear of the slide rests; and one in 1888, central pivoting, and without a sector in the rear. In the 1886 type, the mounting, recoil cylinders, and bolster are of cast iron, the slide and transom of cast steel; in the 1888 pattern the recoil cylinders and bolster are of cast iron, and the mounting, slide, and transom of cast steel. In both types the mounting rests on the slide with the interposition of eight cylindrical rollers, and is guided laterally and underneath by clamps suitably placed. The recoil cylinders are placed at the lower part of the mounting, the piston-rods are joined to the front of the slide, and are supported in the rear. The slide is made with two parallel cheeks stayed in front and recessed in the transom. The transom turns round a pivot while resting on the bolster on a set of conical rollers; the latter are kept apart by two concentric rings. Clamps prevent the slide from rising during firing. The bolster forms the pivot, and is fitted with a circular rack for lateral training; it is bolted on the foundation. The required elevation is given from the front of the mounting by a transverse shaft, which transmits its motion to a set of toothed wheels, and a pinion which engages a toothed sector fitted to the gun. Lateral training is given by a vertical pinion, which engages the rack on the bolster, and is driven by a series of conical and cylindrical gearing. A front transverse shaft is provided with two toothed wheels for running in the gun by hand; for this it is necessary to disengage the bevel wheel which turns the vertical shaft for lateral training. The mounting is fitted with a charging platform and a quick-working crane for serving the gun.

HAND AND MACHINE LABOUR.

THE series of articles that have appeared from week to week in these columns during the last four months, on the subject of American Competition, have thrown much light on the causes that have contributed to make the United States not only a great manufacturing nation, but one which threatens in the near future to take a leading position in almost every form of industrial enterprise. The opinions we have published are those of men conspicuous in varied industries engaged in different parts of the States, and they show a singular, an almost monotonous unanimity, although it is to be remarked that those writers carrying the greatest weight are the least conscious of real danger befalling British trade, provided that we wish to keep it. The vast natural resources of America of course count for one of the most potent factors in her industrial success, but the great distances of the metallic deposits from the coal regions, and of both of these again, from the centres of demand, seemed even a few years ago to set insurmountable barriers to successful enterprise. The same spirit that overcame the difficulty of distance by making cheap transportation possible, has operated in the other directions required to achieve rapid and inexpensive production, until the United States has arrived at the unparalleled position she occupies to-day. The result has been attained so far, and it will be carried still farther continuously, by the same agencies of adaptability, energy, and concentration, for the prosperous path followed so far will certainly be pursued at an accelerated rate. Among the various causes of rapid output upon which all our correspondents have uniformly insisted, is the substitution of automatic machinery for hand labour, and the ever-increasing efficiency of such machines, both in the sense of turning out a larger production, and also in the simplification of devices; so that less labour, often of an unskilled kind, suffices to do the same amount of work, and thereby cheapens production. The scarceness of labour in the United States and its consequent relative high price, inconvenient as it was in the beginning of her industrial history, has proved to be a blessing in disguise, for it stimulated and encouraged invention, to the mutual advantage of capital and labour. These and most other points bearing on the problem, have been dealt fully in the series of articles we have just referred to, so that we need not insist upon them here. But it did not fall within the scope of those contributions to enter into details as to cost of production; as to the exact extent to which machinery has displaced hand labour; or how far such substitution has justified the fears of the British workman—fears that date back to the time when machinery was first employed to supplement and increase manual production. To some extent we propose to make good this deficiency, though only so far as some industries in the United States are concerned. It would be of intense interest to ourselves if we could ascertain how far, in this country, the use of machinery has increased output and reduced cost, but data on this subject are not available. We know, of course, that vast progress has been made here during the last half century; but we also know that to a large extent the use of labour-saving machinery is restricted, and hand labour is still employed where mechanical means could be substituted to the benefit of all concerned. The actual facts on this point belong to the secrets of different industries; but it is certain that British manufacturers are in ignorance of the exact means at the disposal of American competitors, both as regards increase of output and reduction of cost; such means varying with the extent to which machinery has replaced hand labour.

That a large amount of such information is available, is due to the recent publication in Washington of a remarkable report by the Commissioner of Labour; a report that has required several years to compile, and has involved an almost incredible amount of research, and unusual co-operation on the part of manufacturers. It was in 1894 that Congress directed the Commissioner of Labour to undertake this investigation. The object was to ascertain "the effect of the use of machinery upon labour and the cost of production, the relative productive power of hand and machine labour, the cost of manual and machine power as they are used in the productive industries, and the effect upon wages of the use of machinery operated by women and children; and, further, whether changes in the creative cost of products are due to a lack or a surplus of labour, or to the introduction of power machinery." It is difficult to imagine a more difficult undertaking than this, nor one that would prove of more benefit to the industrial world at large, provided that it could be well completed. That the Commissioner of Labour, Mr. Carroll D. Wright, has succeeded will be evident from the information we are able to gather from his report, and place before our readers in some sense as supplementary to the series of articles on "American Competition."

The task before the Commissioner of Labour was briefly as follows:

(*a*) To select a sufficient number of old-established and representative industries, the controllers of which were able and willing to afford the necessary information.

(*b*) To ascertain and classify the various processes involved in the industry for the production of a given product, both under the old methods of hand labour, and the most modern machinery appliances.

(*c*) To apply the results to a sufficient number of the objects so produced, to arrive at fair averages under the old and new conditions.

(*d*) To ascertain and report on the material and moral effect the change had produced upon the working classes so largely affected by the introduction of machinery.

(*e*) To determine how far the use of machinery had improved or deteriorated the manufactured product, had affected its price, and stimulated or retarded its sale.

The statistics of no fewer than 88 main industries, and 672 branches of these, have been gathered and tabulated in the report, and for each the following information is fully given, for hand and mechanical processes:

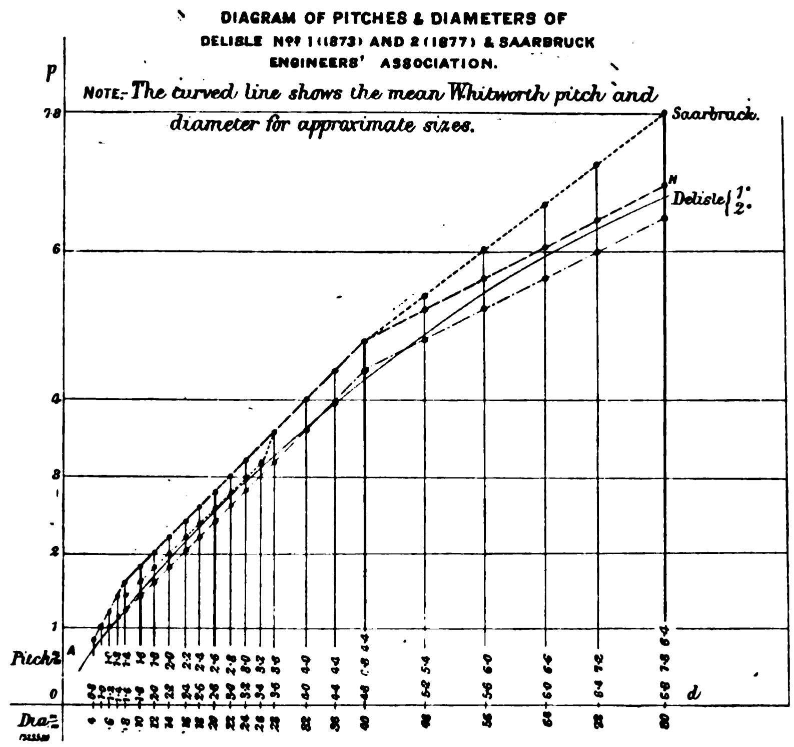
1. The names of the operations in the production of the work done, in their natural order.
2. The machine, implement, or tool used in each operation.
3. The motive power used in each operation.
4. The number of persons necessary on one machine for each operation.
5. The number and sex of employés engaged in each operation.
6. The name of the occupation pursued by each employé in each operation.
7. The age of each employé engaged in each operation.
8. The time consumed by each employé in each operation.
9. The rate of pay for each employé in each operation.
10. The labour cost of each operation.

As this information is given for 672 industries, and as the number of operations of most of them is large—in the machine methods of making watch movements, the number is no less than 1088—some idea may be gathered of the amount of labour that has been expended. Unfortunately no data have been collected on the comparative costs of workshops and plant under the primitive and modern conditions, but it could not be expected that manufacturers would supply the latter information, as doing so, would have been equivalent to disclosing the total cost of production and, inferentially, profits realised.

It is obviously out of the question for us to deal screws, and the designers gave a different proportion to the former to secure a finer pitch.

16. *The Reuleaux System.*—This system is very similar to the three last named, and does not possess any apparent advantage over either. The profile corresponds to that of Delisle No. 2 (Fig. 11).

Fig. 12.



Each different diameter d determines the corresponding pitch p according to the following formula:

$$p = .4 + .1\,d \text{ for } d = 4 \text{ to } 40 \text{ mm.}$$
$$p = 2.0 + .06\,d \;,,\; d = 40 \;,,\; 80 \;,,$$

From these values the series is worked out in Table XI. (see preceding page):

(*To be continued.*)

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

MORTARS FOR COAST DEFENCE.

27-*Centimetre* (10.630-*In.*) *Coast-Defence Mortar.*—Coast-defence mortars of 10.630-in. calibre have been built in large numbers (Fig. 700, page 146). The following are some leading dimensions:

Weight of mortar ...	... 5,750 kilogs. (1,267 lb.)
,, mounting	... 19,160 ,, (42,228 ,,)
,, projectile	... 250 ,, (551 ,,)
Angles of elevation ...	... −0 deg. + 60 deg.
Training	... through 270 deg.
Muzzle velocity, with black powder	... 275 m. (902 ft.)

The 10.630-in. mortar illustrated is placed on a mounting, the general arrangements of which are similar to those of the mounting for the same calibre of coast-defence guns already described. In the mortar, however, the height of the trunnions being very much less than in the 10.630-in. guns, the platform for loading and training is not required; the bolster is fitted with the circular rack and pivot housing, for the pivot on the lower part of the slide. In the lateral training mechanism, the helicoidal wheel cast in one piece with the grooved pulley on which the chain turns, is set in motion by an endless screw fixed to a shaft on which are keyed the two working cranks. The elevating mechanism consists of a toothed sector fitted to the mortar, and an endless screw; on the end of the shaft which carries the latter is keyed a square pinion driven by another pinion on the shaft of which is keyed the working crank.

30-*Centimetre* (11.811-*In.*) *Muzzle-Loading Rifled Mortar*, 1883 *Pattern, on Coast-Defence Mounting* (Fig. 701).—Mountings of this pattern were built by Messrs. Schneider and Co. in 1889. They are arranged so as to allow an elevation of from −5 to + 70 deg., and lateral training through 200 deg. The mounting is built up of steel plates and angles; on the top in front are the trunnion supports, while underneath are two cast-steel cases each containing seven cylindrical rollers, which revolve on the slide. The necessary guiding is secured on the sides and underneath by four clamps of forged steel. A cast-iron recoil cylinder is recessed in the lower part of the mounting, to which it is strongly bolted; the piston-rod is joined to the front and to the rear of the slide. The slide consists of two I-beams stayed together in front and in the rear. The slide is fitted, in a line with the mounting trunnions, with a strengthening piece forming a transom. In the rear there is a stay-plate, with two supporting rollers for the mounting trail. The slide is built up of steel plates and angles. The mounting and slide rest in front on a bolster, and in the rear on a circular segment with the interposition of coned rollers. The bolster rollers and the rear segment are of cast iron, and rest on oak beams imbedded in the foundation.

The gun is elevated from the front of the mounting by means of a transverse shaft, which works a toothed sector keyed on the left-hand trunnion of the mortar. It is trained from the rear of the slide; a transverse shaft works the pinion which engages the rack of the circular sector, through conical and cylindrical toothed wheels. On the slide is fitted a crane for serving the mortar with ammunition.

Quick-Firing Coast-Defence Guns.—A certain number of points selected for coast defence, and especially "armour-piercing coast batteries," have to be armed with guns of high power and flat trajectories, permitting a rapid concentration of fire against a target. It is important in many cases that coast-defence batteries should be in a position to compete thoroughly, under conditions approximately equal, with quick-firing naval guns, while it is necessary to take into consideration the ease with which modern fleets can perform their evolutions. A special class of Schneider-Canet quick-firing guns contains a complete series of calibres, from 37 millimetres (1.456 in.) to 24 centimetres (9.449 in.), for carrying out this programme to the best advantage. This class of *matériel* has been adopted for regular service by various Governments, especially Russia and Japan, the two latter countries having acquired the right to reproduce the types in their own arsenals. As a rule, these guns are similar to those used on board ship, as regards construction and breech-closing device, but they are frequently of longer bore in order to obtain higher muzzle velocities and flatter trajectories. The mountings are also similar to naval mountings, but as coast-defence guns have to fire under great angles, both positive and negative, the mounting is either placed upon a concrete base or upon a cone built up of plate and angles. As the guns of this class are similar, except in dimensions, to the naval guns already described, we shall select for the following descriptions a few only of the most interesting types that embody particular devices, and are placed up on special mountings.

12-*Centimetre* (4.724-*In.*) 26-*Calibre Quick-Firing Coast-Defence Gun* (Fig. 702, page 147).—This has been adopted for regular service in Japanese coast defences. The programme that had to be fulfilled according to the Japanese Artillery stipulations, stated that the gun should be of medium power (muzzle velocity 600 metres only = 1968 ft.), quickly trained and fired by a limited number of men. In connection with this order, the Japanese Government established competitive trials, in which the Schneider-Canet ordnance obtained the first rank, and was definitely adopted. The following are some leading data:

Weight of gun ...	... 1620 kilogs. (3570 lb.)
Length of gun ...	... 3.120 m. (10 ft. 2 $\frac{13}{16}$ in.)
Weight of mounting	... 2780 kilogs. (6127 lb.)
,, base ...	... 1800 ,, (3967 ,,)
,, shield ...	... 1500 ,, (3306 ,,)
Maximum angles of elevation	... − 7 deg. + 20 deg.
Training	... through 140 deg.
Weight of projectile	... 18 kilogs. (40 lb.)
Weight of powder charge, French smokeless powder	2.8 ,, (6 ,,)
Muzzle velocity ...	... 560 m. (1837 ft.)

The mounting is fitted with a shield which protects the working parts and the gunners. The mounting consists of four main parts, namely: The built-up base, in the shape of a truncated cone, stayed inside and bolted to the firing platform, the loading platform being in the rear; the bolster, fitted to the base and provided with roller balls, the central pivot of the bolster being joined by ribs to the circular ring; the slide which rests on the bolster on the balls and consists of two cheeks made practically vertical, the latter being provided with under trunnion plates strengthened in the middle by stays, the cheeks joined together by a stiff plate; the gun carriage, which consists of a cast-steel jacket, in one piece with which is cast the lower part of the hydraulic recoil cylinder; the trunnions are in the front part of the jacket; while inside, gun-metal rings at both ends serve to guide the gun during recoil. At its lower part, over a part of its length, the carriage is made with a gap forming two slide paths to guide the butt end, which draws the recoil piston-rod with it. A transverse bar with buffer is placed in front to check the travel of the gun when it runs out again.

The recoil cylinder is on the Schneider-Canet system, with central counter-rod. It acts as follows: During recoil the gun draws along with it the recoil piston, its rear surface presses on the glycerine in the cylinder, and forces it to flow through the annular vent cut round the central rod and through the lateral vents cut round the piston. The glycerine flows to the front part, the valve which establishes a communication between the two ends of the cylinder being raised. The inside capacity of the cylinder decreasing by a quantity equal to the volume of the rod which penetrates it, the corresponding excess of liquid moves the bottom of the cylinder which acts as a plunger, this moves the transverse bar and presses down the recuperating springs. When the recoil is spent, the springs in relaxing drive back the transverse bar and the cylinder bottom, thus forcing the glycerine to resume its former position; but as the valve is closed, it can only flow through the narrow vent in the valve seat, the gun returning therefore slowly and without shocks. The training gear both for vertical and horizontal angles is of the ordinary type, and so need not be described.

12-*Centimetre* (4.724-*In.*) 40-*Calibre Quick-Firing Coast-Defence Gun.*—This gun is on the same system as the preceding one, but is of a much greater power.

Weight of gun ...	... 2650 kilogs. (5840 lb.)
,, mounting	... 4130 ,, (9102 ,,)
,, base ...	... 1850 ,, (4077 ,,)
,, shield ...	... 1650 ,, (3636 ,,)
Elevation	... − 10 deg. + 15 deg.
Training	... through 360 deg.
Weight of projectile	... 21 kilogs. (46 lb.)
Muzzle velocity ...	... 650 m. (2132 ft.)

The mounting is provided with a platform and consists of five main parts:

(*a*) The base, of plates and angles, is invariably bolted on the firing platform; it contains the roller path and supports the firing platform. At its lower part are eight recesses containing rounds of ammunition for insuring rapid firing.

(*b*) The circular bolster with pivot.

SCHNEIDER-CANET MORTARS AND COAST-DEFENCE MOUNTINGS.

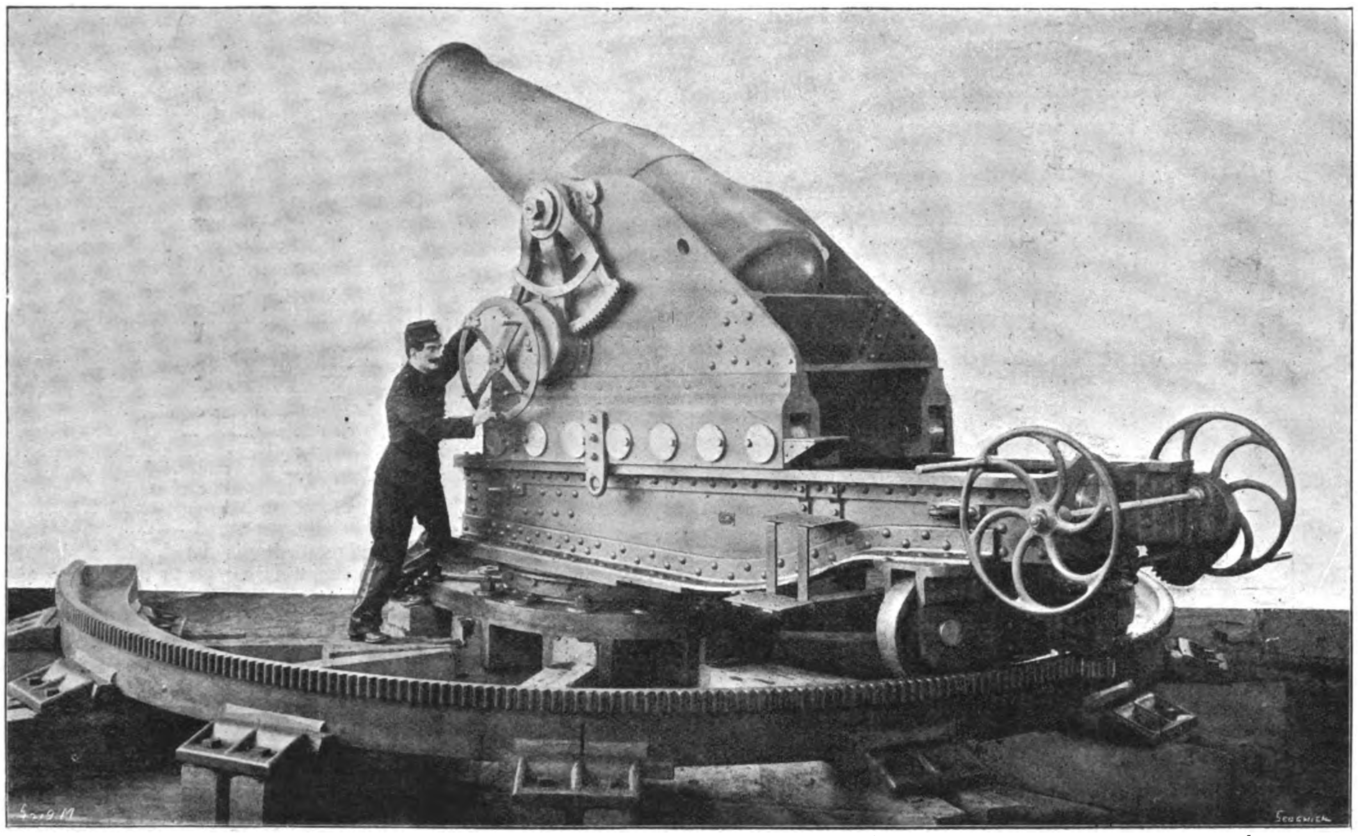


FIG. 701. 30-CENTIMETRE MUZZLE-LOADING MORTAR AND COAST-DEFENCE MOUNTING.

(*c*) The slide which rests on the bolster on balls; it consists of two cheeks stayed together and fitted with the trunnion plates.

(*d*) The loading platform on the rear of the slide; it bears on the base with the interposition of rollers.

(*e*) The carriage which carries the gun; this is made with two trunnions that rest in the slide, and is on the same type as the one for the preceding gun, as also are the hydraulic recoil cylinder and the recuperator.

6-*In. 50-Calibre Quick-Firing Coast-Defence Guns* (Fig. 703).—Guns of this type have been supplied to the Russian Government.

Weight of gun ...	... 6,230 kilogs.	(13,731 lb.)
,, mounting	... 10,400 ,,	(22,921 ,,)
,, base ...	... 3,180 ,,	(7,008 ,,)
,, shield ...	... 1,720 ,,	(3,791 ,,)
Elevation	... −10 deg. + 30 deg.	
Training	... through 360 deg.	
Weight of projectile	... 43 kilogs. (95 lb.)	
Muzzle velocity ...	... 720 m. (2362 ft.)	

The mounting consists of the following main parts:

(*a*) The base, built up of plates and angles, in the shape of a cone, strengthened by gusset plates; it is bolted on the firing platform, by means of a circular soleplate.

(*b*) The bolster which rests on the cone and is provided with rollers to facilitate rotation. The bolster is fitted also with the pivot and the circular rack for lateral training.

(*c*) The slide consists of two cheeks with trunnion plates for the carriage trunnions; they are strengthened in front by a rib and are joined at their lower part by a plate of suitable shape in which fits the bolster pivot.

(*d*) The gun carriage consists of a fixed part and of a movable one which follows the recoil. The fixed part contains two lateral string beams, a front and a rear collar, and a hydraulic recoil piston. The string beams contain the trunnions, and are bolted at their two ends on the collars. The front collar is provided with a plastic ring, which forms a buffer for the mounting jacket when the gun runs out again. The rear collar is lined inside with gun-metal bushes; it is continued at its lower part, and forms a butt, to which is joined the recoil piston. The movable part contains a jacket which remains joined to the gun in front by tongues and grooves, and in the rear by two half-rings placed in a groove of the gun; a recoil cylinder cast in one piece with it; two lateral slide shoes, forming clamps which hold on the string beams and support the gun during recoil.

The arrangements of the recoil cylinder and recuperator are the same as those for the 12-centimetre guns, except that the recoil piston-rod is jointed in the rear, and does not follow the recoil. In the case of the present mounting the cylinder is drawn by the gun, the piston remaining fixed. Moreover, the set of recuperator springs is divided into two parts, and consists of Belleville rings.

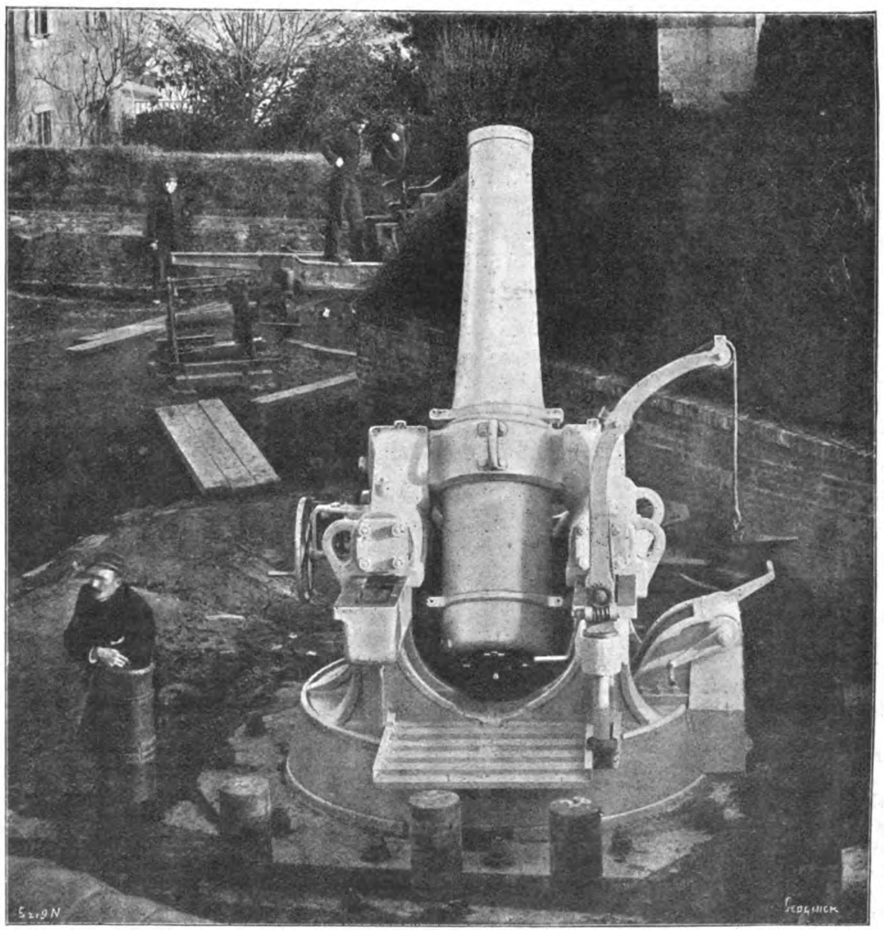


FIG. 700. 27-CENTIMETRE MORTAR AND COAST-DEFENCE CARRIAGE.

SCHNEIDER-CANET QUICK-FIRING GUNS FOR COAST DEFENCE.

(*For Description, see Page* 145.)

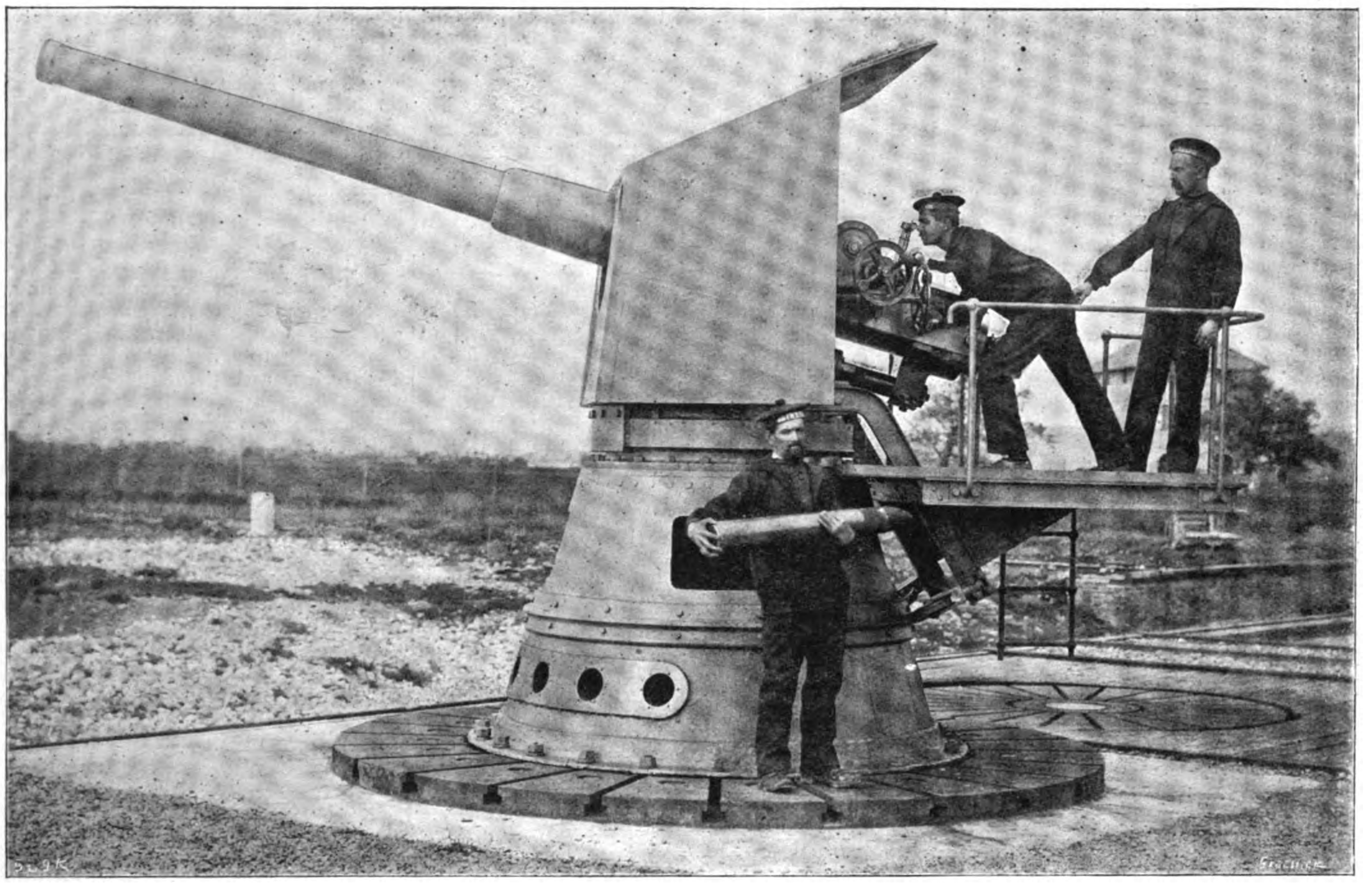


FIG. 702. 12-CENTIMETRE 26-CALIBRE QUICK-FIRING GUN AND COAST-DEFENCE MOUNTING.

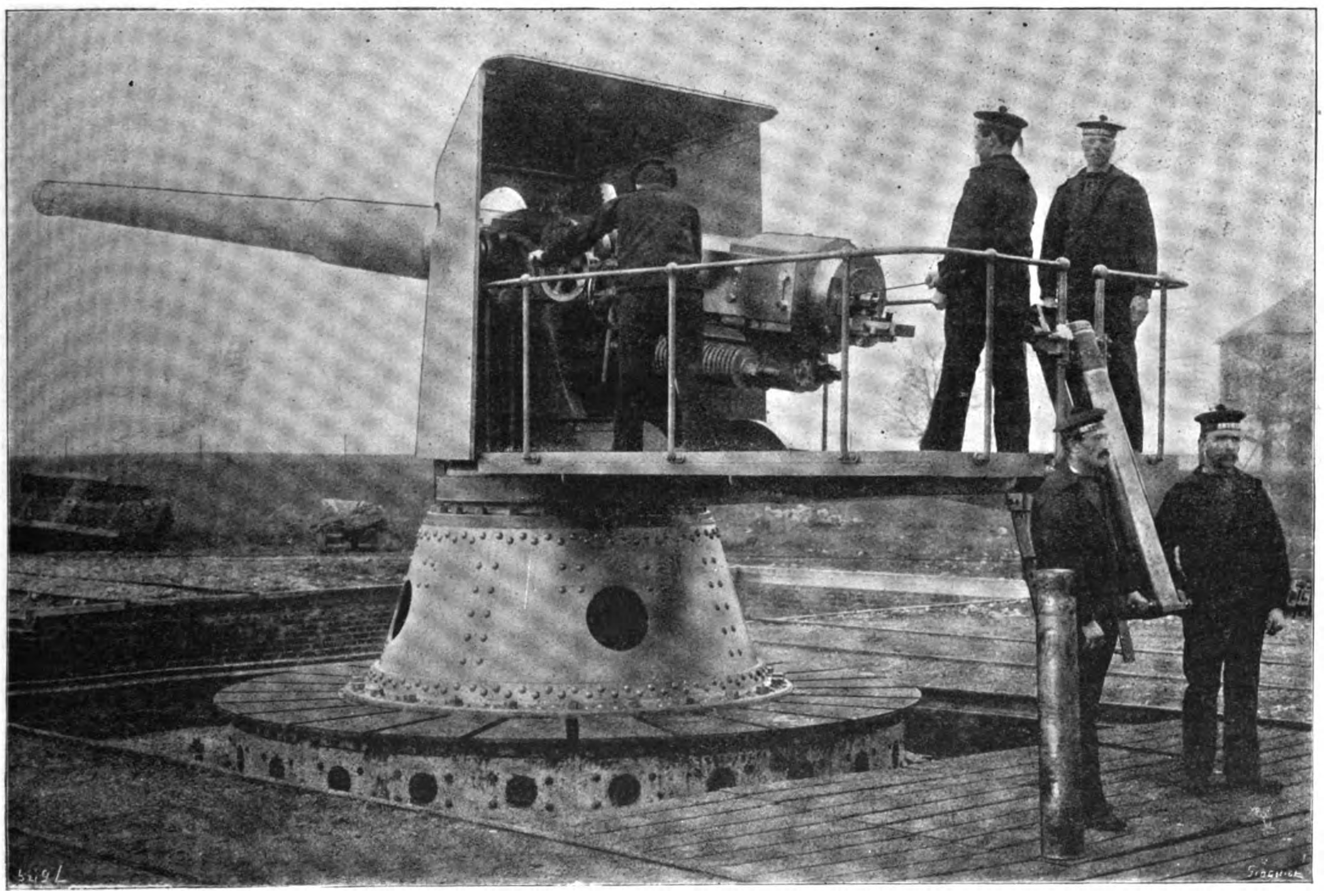


FIG. 703. 6 IN. 50-CALIBRE QUICK-FIRING GUN AND COAST-DEFENCE MOUNTING.

The slide is continued in the rear by a loading platform. A shield of suitable shape and dimensions protects the whole mechanism.

THE INSTITUTION OF MECHANICAL ENGINEERS.

The fifty-third annual general meeting of this Institution was held on Friday evening of last week, January 26, at the Institution's House, Storey's Gate, St. James's Park. In the absence of the President, Sir William H. White, who was prevented from attending, the chair was taken by Sir Edward H. Carbutt.

After the minutes of the last meeting had been brought forward, the secretary proceeded to read

The Annual Report of the Council.

From this it appeared that the number of names in all classes on the roll of the Institution was, at the end of 1899, 2922, as compared with 2684 at the end of the previous year, showing a net gain of 238. The losses of membership during the past year were slightly in excess of the average. On the other hand, 57 more new members were added to the Institution than during the previous year, and 112 more than in the year 1897. Attention is called to the fact that early in the year the council took steps to put before engineer officers of the Royal Navy the advantages attaching to membership of the Institution. It is satisfactory to know that this action has resulted in many of these officers becoming members, and it is anticipated more will join. Amongst members who have died during the past year may be mentioned Sir Douglas Galton, who had served on the Council since 1888, and had been a Vice-President for eight years; Mr. Jeremiah Head, who had been a member of Council for 25 years, during which time he was a Vice-President for four years and President in 1885-6; Mr. William Laird, who had been a member of Council for 12 years; and Mr. Peter Rothwell Jackson, who was an original member of the Institution.

Turning to the accounts, we find that the revenue for the year 1889 was 8777*l*. 4s. 5d., while the expenditure was 9230*l*. 16s., leaving an excess of expenditure over revenue of 453*l*. 11s. 7d. The total investments and other assets amount to 69,084*l*. 8s. 10d. If from this is deducted 25,000*l*. of debentures, and the total remaining liabilities, 3588*l*. 19s. 11d., the capital of the Institution amounts to 40,495*l*. 8s. 11d. The past year, it is pointed out, was the first in which the Institution occupied its own house, and an increase in the expenditure was inevitable. Certain expenses of a special character had also to be incurred in connection with the opening of the new house. Under these exceptional circumstances the financial result for the year is considered satisfactory.

The work of the Research Committee is next referred to. The report of the Alloys Committee, presented by Sir William C. Roberts-Austen, is mentioned. This report, and the discussion which followed its reading, have been fully dealt with in our columns in connection with the February meeting of the Institution. Sir William Roberts-Austen is now at work on the effect of annealing and tempering on the properties of steel, a subject which will form the principal part of the next report. Professor Burstall hopes to present the Report of the Gas Engine Research Committee, which is under the chairmanship of Dr. Kennedy, early in the present year. Professor Beare is also proceeding with the investigation of the value of the steam jacket; while Professor Capper promises his first report on the compound steam-jacketed condensing engine at King's College, London, as soon as the investigations he is making are sufficiently advanced, which will be shortly.

Reference is next made to the Summer Meeting held in Plymouth last year, and to the formal opening of the new house.

Sir Edward Carbutt, in moving the adoption of the report, remarked that he might be permitted to say how hard the Council worked, for, as a Past-President, he was not called upon for such active exertions as other members of the Council. The Research Committees were carrying out most valuable work, which could not fail to make its mark on engineering science. He attached importance to students joining the Institution, and he hoped young men would come forward to take advantage of the chances offered to them of increasing their technical knowledge, and fitting themselves for upholding the position of this great engineering country amongst the nations of the world. Mr. E. P. Martin seconded the resolution; and the chairman having invited members to make any remarks they thought fit, but no response being given to his invitation, the motion was put to the meeting and carried unanimously.

The result of the ballot for President and members of the Council was next announced. The Council was fortunate in being able to persuade Sir William White to accept another term of office in spite of the heavy official duties that press upon him in the onerous position he occupies under Government. He will therefore remain President for the present year. The three Vice-Presidents elected were Messrs. J. A. F. Aspinall, E. P. Martin, and J. H. Wicksteed. The members of Council elected were Messrs. H. Chapman, H. A. Ivatt, H. D. Marshall, S. R. Platt, and J. I. Thornycroft.

Water Meters.

There was one paper down for reading and discussion, this being a contribution by Mr. William Schönheyder, entitled "Water Meters of the Present Day, with Special Reference to Small Flows and Waste in Dribbles." This paper we commence to print in full in our present issue, and may therefore at once proceed to the discussion which followed its reading.

Mr. Schönheyder wished to add a few words of explanation before other members spoke. He said that a great many difficulties had to be overcome before he had been able to bring the meter to its present state as described in the paper and illustrated by the models on the table. These difficulties had been entirely due to material and not to design. For instance, the piston cups had first been made of leather, but this was found not to be suitable, and after many trials he had adopted a soft vulcanite, the composition and mode of manufacture of which was known only to the makers who supplied it. Again, the crank spindle, which was of gun-metal, was apt to seize, until he bushed the hole through which it worked with vulcanite, and that cured the defect. The pin of the valve also wore away somewhat rapidly when it was running metal to metal with the crank; this was due to working dry on account of air accumulating in the top of the meter. He had got over this also by the use of vulcanite. In the counter-plate, where the pinion spindle passes through, there was also trouble through seizing, but here again a vulcanite bushing cured the defect. The speaker referred to the different-sized meters on the platform, which showed the range of the device. The cylinders of some were of vulcanite, which was a useful material for hard water. Two meters were also exhibited in operation, the counter gear being taken off so that the action could be seen. The author gave an illustration showing with how small a head the meters could be driven. One meter had registered 267,000 gallons per hour, and was now quite correct at 450 gallons and 20 gallons per hour. This meter had been tested by the Southwark and Vauxhall Water Company, who had not thought it necessary to go lower; the author had, however, tested the same meter to 5 gallons per hour. It had been in work for two and a half years in the service of the Vauxhall Company, and was still as good as when new. A ½-in. meter had been in use at his house for four years; the valve was still bright and perfectly tight, and the meter registered correctly down to as little as 2 gallons per hour.

Mr. Charles Hawksley, who rose at the invitation of the President, said he was willing to obey orders, but he came as a learner rather than a speaker. He had not an intimate personal knowledge of the details of this meter. He knew that each type of water meter had its own advantages and defects according to the special situation in which it was placed. It was of very great importance to water companies to be able to register small flows, for much of the water used passed away in this manner; not to be able to register small quantities appeared to him very like a shopkeeper having no small weights, so that he had to give away everything weighing only ounces. This was more especially the case in regard to waste. As to low-pressure meters, he knew the Parkinson had given good results during many years of its existence, but it would not transmit pressures. Another point was that many meters would perform excellently well when new, but would not measure small quantities when somewhat worn, the valves perhaps becoming defective. Some meters would work excellently in one position, but when transferred to another district would cease to give satisfaction, a fact no doubt largely due to the nature of the water dealt with, whether hard or soft. Rust from pipes was a source of trouble in the use of meters in soft water districts.

Professor Unwin complimented the author on the design of his meter and the patience he had exhibited in investigating the cause of error. There was one passage, however, to which he would take exception. In speaking of the Venturi meter the author said in his paper: "it must, of course, not be used below its rated capacity." The statement was, perhaps, accurate, but he thought was somewhat misleading. All meters had limits of capacity, but while most meters had maximum and minimum limits the Venturi had only a minimum, below which it would not register—or rather below which it would not give a registration which could be read. The minimum velocity of flow he believed at which records were obtained was half a foot per second; the speaker had found it extraordinarily accurate in dealing with water mains. He referred to the frequent use of vulcanite by the author, and pointed out the extraordinary durability of lignum vitæ as a bearing surface for metal when well lubricated with water.

Mr. P. Bright, of the firm of Tylor and Co., said that the author had given a very fair paper in describing different types of meter. He regretted, however, that Mr. Schönheyder had not communicated with his firm, as they would have been pleased to have given him particulars of a Tylor meter more modern than the one illustrated by the author in his wall diagram, for this had not been made for eleven years, and the fan shown had not been used for sixteen years. The speaker would bear out what Professor Unwin had said as to the durability of lignum vitæ. The author had said that the plan suggested for use with the inferential meter did not appear to him successful in registering small flows as well as large ones. Mr. Bright would point out that these meters could be made small enough to register the slightest dribble, they had at work such meters which would show a flow of 2 or 3 gallons per hour, but had a capacity up to 120 and 130 gallons per hour. As they were generally used with ball valves, however, the registering of sluggish flows was not so much a matter of consequence; in connection with this matter he would point out the discrepancy that often existed in the capacity of ball valves, those registered at ½ in. being frequently made with a ¼ in. way. The price of the meter was a very important consideration. Inferential meters could be supplied for 30s., which would serve for 342 people if a constant supply of water were used. Questions of original cost, and of cost of maintenance, should both be considered in connection with these matters. He agreed that working metal to metal did not give very good results; Lord Kelvin's now well-known tap was much improved by having a vulcanite valve added.

Mr. W. B. Bryan, of the East London Water Works, said that he was much interested in water meters, as his company supplied through meters water to the value of 150,000*l*. a year. He was responsible for the meters used for this purpose, and he thought there was room for several different types; a positive meter was not suitable for large supplies of, say, 300,000 gallons a day, and for those quantities the inferential meter must be used, and it registered with sufficient accuracy. On the other hand, for domestic supplies the positive meter was necessary. It had the disadvantage of sometimes stopping, and then they received indignant letters from consumers asking why their water had been arbitrarily cut off. That was the disadvantage of the meter from the customer's point of view, but from the supplier's point of view it had this advantage that when it stopped registering it stopped supplying. The expense of installing meters was the great drawback, and to use Mr. Schönheyder's beautiful device to a large extent would involve a very great outlay. As bearing upon this question, he would state that the East London Company's customers included 80,000 renters who paid less than 3d. per week, and 40,000 at 1d. per week; that did not leave much margin to pay interest on the cost of meters. They had 210,000 houses in their district, so that to put in meters would cost over one million sterling. Abroad things were on a different footing; the example of Berlin where meters are used, had been brought forward as an object lesson to be copied, but there the houses were big, being subdivided into flats or tenements, the average being 60 persons per house. In Vienna

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

Disappearing Guns and Carriages.

Classified under this general heading are those guns which, when fired, oscillate round movable supports, and thus are caused to disappear, either to be run out again immediately, or only when the operations of reloading and training have been completed. Although mountings of this type are used indifferently for coast defences and for garrison armament, and also in cases on board ship for mortars and howitzers, it has been found preferable to classify this material separately, and to give the following general data concerning the principal types manufactured and put in service by Messrs. Schneider and Co. As in preceding articles, the principal types only, and those which are of representative calibres, have been selected for description. A special interest attaches itself to this class of ordnance at the present time, when a number of Schneider-Canet guns, mounted on disappearing carriages, have been brought into the field against us in South Africa.

75-*Millimetre* (2.952-*In.*) *Guns on Lever Mountings.*—These are used with advantage for the armament of light-draught boats, and were described at the commencement of this series; they are simply mentioned here to make the present section complete. With this mounting the gun does not remain run down; but it rises up again immediately for reloading and training, the lever being short enough to enable the breech to be freely worked.

90-*Millimetre* (3.543-*In.*) *Gun on Disappearing Carriage, for Coast Defence and Garrison Armament* (Figs. 704 to 707, page 214).—This type is of reduced weight, and, considering its calibre, is of great mobility. It has been designed specially with a view to be easily carried on wheels, and to form the movable armament in a series of distinct positions communicating with each other by a single road; it is, in fact, a highly mobile gun of position. A limited number of such guns is sufficient, as we have found lately, to defend a largely extended front. The various parts are so arranged that, according to circumstances, firing can be effected while the carriage stands on its wheels, or after placing the gun on a fixed mounting provided in advance at suitable places.

Weight of gun	530 kilogs. (1168 lb.)
,, carriage	1200 kilogs. (2645 lb.)
,, projectile ...	8 kilogs. (17 lb.)
Muzzle velocity	460 m. (1508 ft.)
Extent of lateral range when the gun is placed on fixed bolsters	360 deg.

The carriage consists of the rising and falling arms, the slide, the coupled wheels with bolster, or the coupled wheels with limber, as the case may be. The arms are formed of two cheeks which carry the trunnion bearings at their top part; in these the gun trunnions are placed. The arms turn round an axle sheathed with india-rubber for deadening as much as possible all shocks on the bolster during firing. The arms end below in two extensions connected by a rod on which is jointed the head of the recoil piston-rod. The slide is of plate-iron and angles, and consists of two lateral supports, in which are placed the lever pivots; the supports are joined below on a circular platform, the latter being of the same dimensions as the top of the bolster, to which it is fixed by a hinged clamp, to prevent shifting. The wheel axle runs through the slide; a roller in a jointed frame is provided, as shown in Figs. 704 and 706, and it can take either of the two positions shown. The slide also carries the fixed platform for training the gun, and the jointed platform for loading it; the latter is arranged to fold down when the position of the gun is shifted; it is also fitted with the recoil cylinder shaft. The recoil cylinder is fitted with the central counter-rod, of the standard type. The bolster or fixed mounting is of cast steel, and is made with a horizontal ring for bolting it to the foundation; this ring is continued by a spherical part ending at the top in another ring on which is placed the lower portion of the slide.

A toothed sector, fixed to the gun and worked by differential gearing and by a pinion on a friction cone, is used for elevating; the mechanism is driven by a handwheel carried on the left-hand cheek. The toothed sector is made long enough to place the gun in a suitable position for transporting it. Lateral training is obtained by hand action on the rear of the slide; a pointer fitted on the hinged clamp travels over a scale on the bolster, and shows the angle through which the gun has been trained laterally.

When the gun is on the fixed mounting as shown in Figs. 704 and 705, placing in battery is effected by setting the carriage in such a position that the front wheels come opposite two grooves cut in the rim of the bolster (Fig. 704); in this position, the whole system rests on the top surface of the bolster, and the wheels can turn freely round on their axle. The grooves are made perpendicular to the mean firing axis. When the carriage is so placed, and when the bolt is removed which holds the recoil piston-rod to the arms, a shoulder bar is put in the spokes of the wheel, and is made to bear underneath the arms. The wheels are then turned by means of two winches placed on the limber axle and driven by levers, thus causing the cheeks to oscillate and run out the gun. When this is done, the gun is ready for firing, and the junction between the beam and the recoil piston-rod is re-established. The running down of the gun is effected by an inverse operation, the winch ropes being used only to regulate the lowering motion of the gun. When it is required to fire the gun away from the platform, the limber axle is joined to the slide, and the wheels are wedged by shoe-brakes to limit recoil; in the latter case, the roller is brought up against the lower surface of the slide.

12-*Centimetre* (4.724-*In.*) *Gun on Disappearing Carriage.*

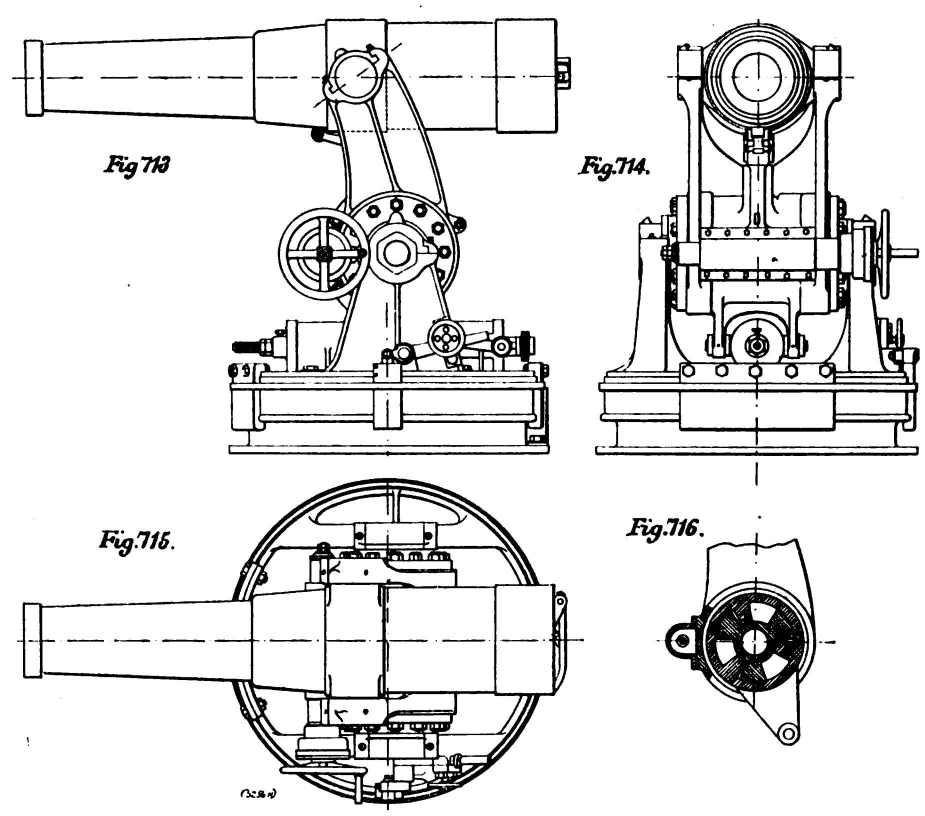
Weight of gun	1400 kilogs. (3086 lb.)
,, carriage	4000 ,, (8818 ,,)
,, projectile ...	21 ,, (46 ,,)
Muzzle velocity	500 m. (1639 ft.)
Training	through 360 deg.
Elevation	+ 15 deg. – 5 deg.

This carriage consists of the swinging beam, the revolving platform, and a bolster.

The beam is formed of two vertical cheeks firmly stayed together, and which end at the top in trunnion plates that carry the gun trunnions. The beam pivots round an axis carried by the revolving platform and ends at the lower part in two arms, which act through jointed rods on the head of the recoil piston-rod. The revolving portion is circular in shape, made of cast steel, and has at its top the two brackets which carry the beam trunnions; it rests on a set of rollers on the bolster, and contains the following parts:

(*a*) The hydraulic recoil cylinder in the piston of which are cut vents of varying sections. The piston-rod is jointed on a slide shoe, which travels between two horizontal gun-metal slides, and is fixed by a horizontal shaft to the two jointed rods, the other ends of which are fitted to the arms at the lower part of the beam.

(*b*) The spring recuperator, consisting of four cylinders placed in pairs on each side of the carriage, parallel with the recoil cylinder, and in which work plunger pistons loaded with Belleville springs. The first cylinder near the front contains the plunger, and the second one, which is longer, holds the recuperator springs. The arms are fitted loose on the axle that carries the beam, and the ends of these are joined to the lower end of the rods which support the chase of the gun. The gun thus forms the fourth side of a jointed parallelogram. A series of clamps joins the revolving platform to the bolster to prevent the shifting of the system. The bolster is provided with a ring in which are placed the foundation bolts, and besides the roller path it contains a central pivot cased in the revolving platform; the bolster rests mainly on an iron bedplate embedded in a concrete foundation.



15-Centimetre Howitzer on Central-Pivoted Disappearing Carriage with Circular Brake.

The required elevation is given by acting on a vertical handwheel on the front of the platform, the shaft of the handwheel having an endless screw which engages a toothed wheel keyed on a shaft perpendicular to the carriage cheeks, and driven by two cones. At each end of the latter shaft is keyed a pinion which engages a toothed sector that forms part of one of the arms fitted loose on the beam axle. Under these conditions the jointed rods give to the gun, by acting on the handwheel, the required incline, which can be measured by the levelling instrument placed on the top part of one of the arms. Lateral training is obtained direct, by hand, by means of levers fitted to the platform, and is measured with a pointer which travels on a scale marked on the bolster.

When the gun is fired, it is thrown to the rear, being held parallel by the two rods, and it draws along with it the beam which pivots round its axis. In this motion the pieces on the lower end of the beam act on the recoil piston and bring it forward. A certain quantity of liquid is thus driven from the recoil cylinder, and flows to the lateral cylinders of the recuperator, through a tube on which is a loaded valve; it drives the plungers to the rear, and causes the sets of springs to be pressed down. When recoil is spent, the valve falls back on its seat, and the gun remains run down; it is then loaded afresh. To run it up again, it is sufficient to re-establish a communication between the lateral cylinders and the bottom of the recoil cylinder, and this is obtained by means of a valve worked by a handle placed outside the valve-box. The liquid driven by the relaxing of the Belleville springs, acts on the large surface of the piston, and runs up the gun again at a speed that can be regulated at will by controlling the opening of the valve.

All the parts forming this mounting are very simple, and are of easy access for inspection and removal.

15-*Centimetre* (5.905-*In.*) *Howitzer on Mounting with Circular Brake* (Figs. 713 to 716, page 212):

Weight of howitzer... ...	820 kilogs. (1807 lb.)
,, mounting ...	2200 ,, (4848 ,,
,, projectile ...	32 ,, (70 ,,)
Muzzle velocity with black powder	300 m. (984 ft.)
Angle of elevation	from −0 deg. + 60 deg.
Training	through 360 deg.

The gun is of the Schneider-Canet type already described, with tube, trunnion jacket, and wedge coil. The breech-block has helicoidal segments and works with one operation. The mounting has been designed specially for plunging fire, and comprises a bolster, with slide and beam. The top part of the bolster forms a roller path; its outside rim ends in a ring for the bolting of the system to the firing platform. The slide rests on the bolster on a set of rollers; two clamps, one in front and one in the rear, prevent the raising of the system. The beam consists of two cast-steel cheeks strengthened with ribs and ending at their lower part in two trunnions carried in two blocks cast in one piece with the slide; the gun trunnions fit in trunnion plates at the top part of the beam. The position of the gun is regulated by two rollers fitted on a rod jointed with the beam. The rod is supported at a point in a line with a roller nearest the breech by a piston lodged in the beam and made to bear on a spring. Owing to this arrangement, the beam, in oscillating, draws the gun with it smoothly and without any great shocks. The oscillating motion is limited by a special type of brake, styled the Schneider-Canet circular brake; it consists of a shaft (Fig. 716) made with three ribs parallel with its centre line and placed in the blocks of the slide, in which it is held by two nuts. Round this shaft is a cylindrical jacket of gun-metal, the inner surface of which is made with three ribs of the same shape as the preceding ones. This jacket is almost entirely surrounded by the drum of the beam, the trunnions of which rest also in the blocks of the slide. The gun-metal jacket is made at its lower part with two lugs, to which are fitted the rods of the recuperator cross-bar; this bar bears on a set of Belleville springs lodged in a horizontal cylinder bolted on the slide. A sliding piece which travels on the screw of the elevating mechanism, goes through a groove on the drum, its end being held in a helicoidal groove made on the circumference of the jacket. When the mounting is in battery the liquid is in the spaces between the pallets on the shaft and those on the jacket; when the gun is fired, its oscillation round the beam trunnions, causes the beam to pivot, the jacket being drawn with it. The liquid then escapes through the openings between the central shaft and the extreme edges of the jacket pallets. The openings are made of a suitable section, in order to insure a practically constant pressure in the recoil cylinder during the whole time recoil lasts.

The gun is trained by acting direct on a lateral lever, which is carried on the bolster. The smaller arm of the lever forms a jaw which holds the rim of the slide and the ring of the bolster to fix the mounting. When the gun has to be trained it is only necessary to raise the lever to disengage the jaw. A scale is traced round the circumference of the slide.

The drum of the beam is provided in front with a semi-cylindrical box with an axle formed of an endless screw worked through differential gearing, on which the wheel acts for elevating the gun. When the wheel is turned, the slide which moves on the endless screw is displaced in a direction corresponding with the rotation and travels on the helicoidal slide of the jacket, the latter remaining fixed on its axle. Owing to this motion, the beam and with it the gun, take an incline which corresponds with the number of revolutions of the wheel. A scale marked on the left trunnion of the beam completes the elevating mechanism.

When fired, the gun falls to the rear by turning round the beam trunnions, and the hydraulic cylinder begins immediately to work, deadening part of the recoil force, this force being made use of to compel the liquid to flow between the extreme edges of the pallets and the opposite wall. At the same time, the two lugs on the jackets cause the sets of springs of the recuperator to be pressed down. When the recoil is spent, the springs relax and run the system out again. All this takes place automatically and without any shocks.

15-*Centimetre* (5.905-*In*) *Mortar on Beam Mounting*:

Weight of gun	440 kilogs. (970 lb.)
,, mounting ...	1800 ,, (3967 ,,)
,, projectile ...	32 ,, (70 ,,)
Muzzle velocity	200 m. (656 ft.)
Elevation	from 0 deg. to + 60 deg.
Training	through 360 deg.

This mortar is of similar construction to that of the howitzer just described. The mounting has been designed specially for plunging fire. It consists of the following main parts, a bolster with slide and beam. The bolster is of the same type as the preceding one. The slide rests on a set of rollers, and is held in place by two clamps that bear on a rim of the bolster, thus insuring the stability of the system, and preventing its raising when the gun fired. The beam consists of two arms, strengthened with ribs, and in which the gun trunnions are fitted; it turns round a shaft carried in two blocks cast in one piece with the slide. Between the shaft and the beam are placed india-rubber sleeves for deadening the shock produced when the gun is fired. The beam arms are continued below the shaft for making connections of the movable recoil cylinders. The piston is fixed and its rod is jointed on the slide. A set of springs surrounds this rod inside the cylinder and forms the recuperator for running out the gun. The hydraulic recoil is of the type with central counter-rod already described. Two rods hold the chase of the gun, one being jointed on a collar fitted to the gun, the other pivoting round the beam axle.

Lateral training is obtained by working the system direct by means of a lever similar to the one for the 15-centimetre howitzer. When the gun is trained in the position required, the lever is let go and the jaws with which it is fitted hold fast the platform. For elevating the gun, a lever is provided which works in a socket in one piece with the rod that pivots round the beam axle; the chase of the gun is thus acted upon direct to obtain the required incline, a screw holding fast the gun when it is in firing position. A scale is marked on the left-hand trunnion plate.

155-*Millimetre* (6.102-*In.*) *and* 120-*Millimetre* (4.724-*In.*) *Howitzers, on Double-Brake Mountings* (Figs. 717 to 723, page 215).—These types have been supplied in large numbers to the Russian, Danish, and other Governments.

	155-Millimetre.	120-Millimetre.
Weight of gun ...	1100 kilogs. (2425 lb.)	520 kilogs. (1146 lb.)
Weight of mounting	3000 kilogs. (6612 lb.)	2300 kilogs. (5071 lb.)
Weight of projectile	40 kilogs. (88 lb.)	20 kilogs. (44 lb.)
Muzzle velocity ...	300 m. (984 ft.)	300 m. (984 ft.)
Elevation	−5 deg. + 60 deg.	−5 deg. + 60 deg.
Training, through...	360 deg.	360 deg.

The howitzer is of the Schneider-Canet type, already described. The breech-closing mechanism works generally in two actions. The mounting has been specially designed for effecting plunging fire with guns of high power, while reducing as much as possible the shocks caused by the firing, and is characterised by the combination of two distinct hydraulic recoil cylinders. One acts parallel with the direction of the guides of the oscillating slide, and counteracts, therefore, the force of traction developed by the gun trunnions; while the other serves to deaden the effects of shocks which, in this kind of ordnance, would reach sometimes considerable proportions. Part of the force developed during recoil is taken up by a spring recuperator; it is given back afterwards to insure the automatic running out of the gun. The mounting contains the following main parts: The carriage, the slide, the recoil cylinders and recuperator, and the bolster. The carriage supports the gun by its trunnions; it consists of a gun-metal cradle, and contains the two traction recoil cylinders. The carriage travels during recoil and return on the oscillating guides, to which it is clamped, to prevent its shifting during firing. The piston-rods are fixed in the front of the guides, and their section is such that the resistance given during recoil to the flowing of the liquid remains practically constant. The slide is of cast steel, and consists of a movable part, with two oscillating guides, which carry the slide-shoes of the carriage, and of the fixed frame, formed of two vertical cheeks strengthened by ribs and firmly stayed together. These cheeks are joined at their lower part by a circular platform, in the thickness of which is made the racer for the friction balls. The centre part of the platform constitutes the vertical cylinder in which fits the fixed pivot of the carriage bolster; its circumference is provided with clamps that prevent the shifting of the system. A horizontal shaft is placed at the top part of the cheeks, round which the movable slides oscillate. The percussion recoil cylinder contains a piston, the rod of which is jointed at its top part to the middle cross-piece that joins together the oscillating guides. When the piston descends, the liquid driven by it acts on a movable plunger that bears on a cross-piece loaded with two sets of Belleville springs; this takes place when, under the action of firing, the oscillating slide turns down on its horizontal axis. When recoil is spent, and the motion of the guides ends, the recuperator springs relax, and cause the system to rise at a moderate speed; and when the two guides have resumed their normal incline, the carriage resumes the firing position, under the action of gravity. The carriage can also be fixed in any position by means similar to those described for the 15-centimetre howitzers and mortars, namely, by jointed jaws on the rim of the lower platform. A groove is cut round the circumference of the bolster, to form a roller-path for the balls; its central part forms the vertical pivot round which the movable slide revolves. The bolster is provided also with a ring for bolting it to the foundation.

Lateral training is obtained by acting direct on the system by means of levers that work in sockets forming part of the platform. The position can be regulated during firing, either by sighting a distant point or by means of the scale on the bolster. In certain cases the required elevation can be given by acting direct on one of the gun trunnions with a square-studded lever; a screw brake serves to fix the gun when it has been given the required angle. For measuring this the sight scale is used, with movable slide. In cases of masked firing, a mirror placed in front of the sight objective, allows the regulating of the gun on an objective chosen at the side. Several pieces of ordnance of this type built at the Havre Works, are fitted also with a special elevating gear, which comprises a crank, a set of conical pinions, and an endless screw, working a toothed wheel that acts on the left trunnion of the howitzer.

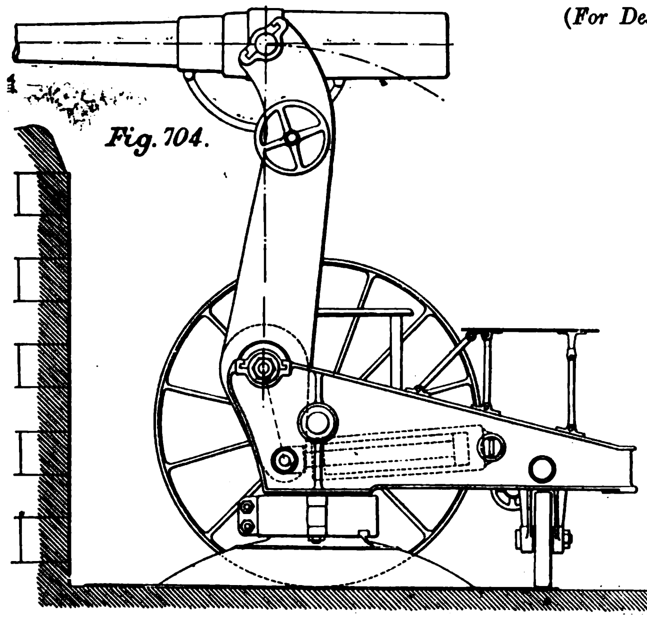
THE PARIS INTERNATIONAL EXHIBITION.

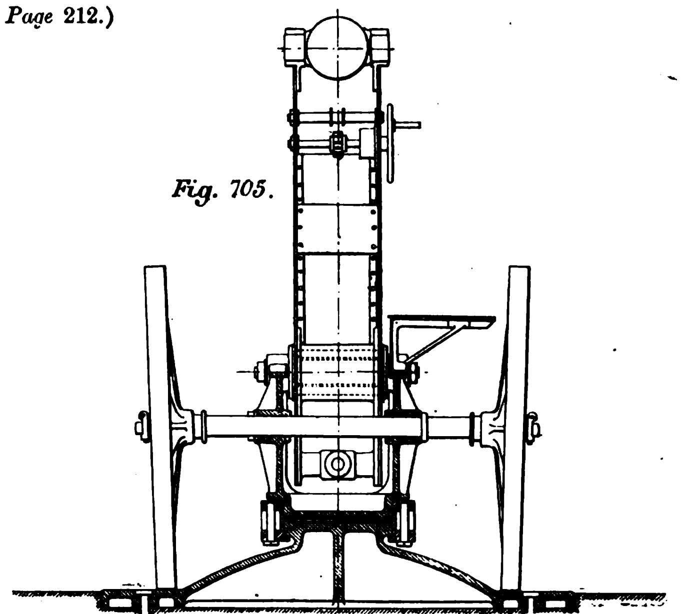
THE LARGER FINE ART PALACE.

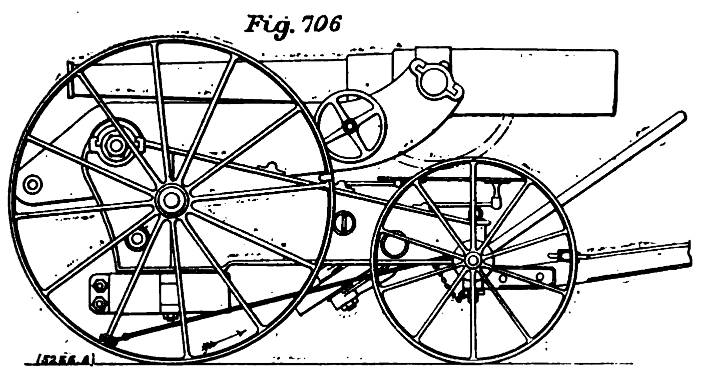
We have said in a recent article that the smaller Fine Art building, erected on the new avenue leading to the Alexander III. Bridge, will be universally admired for its successful design; we do not think that the larger building on the opposite side of the avenue will be so generally approved. Now that it is practically completed an idea can be obtained of its appearance, which is well rendered in the illustration on page 222, taken from a photograph, which also shows the actual condition of the works. From this picture it will be seen that the criticism we ventured upon some time ago, when the various competitive designs were exhibited, has been justified. It is an unfortunate combination of a classic, though not clearly defined architectural style, with the very modern and always unsightly device of a metal-covered arched roof. To complete the bizarre effect, a vast dome of admirable design is placed in the centre of the building and dominates the whole. It is, as it were, a fine steel structure enclosed within a classic monument; two utterly incongruous designs, though each of themselves excellently devised. We shall see later that not only is the metal structure interesting as a piece of construction, but that it is unusually elegant in appearance. In the same way the classic portion of the work is worthy of its site; it is only the blend of modern and ancient art that offends the eye. We regret that we cannot at present publish detailed drawings of the steelwork; such drawings are not to be obtained now that everyone inte-

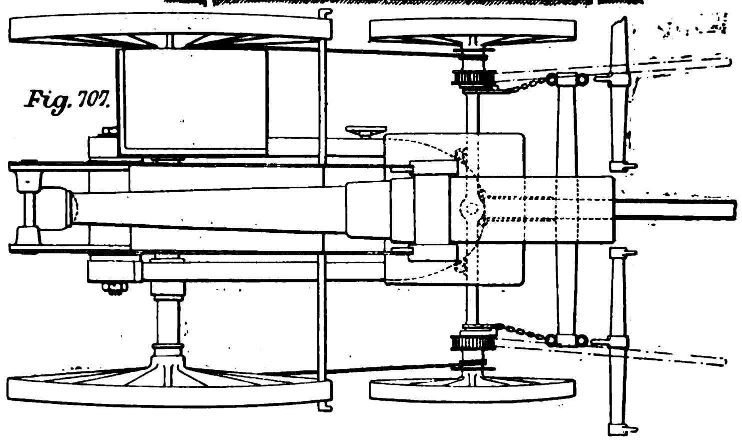
SCHNEIDER-CANET GUNS AND DISAPPEARING CARRIAGES.

(*For Description, see Page* 212.)

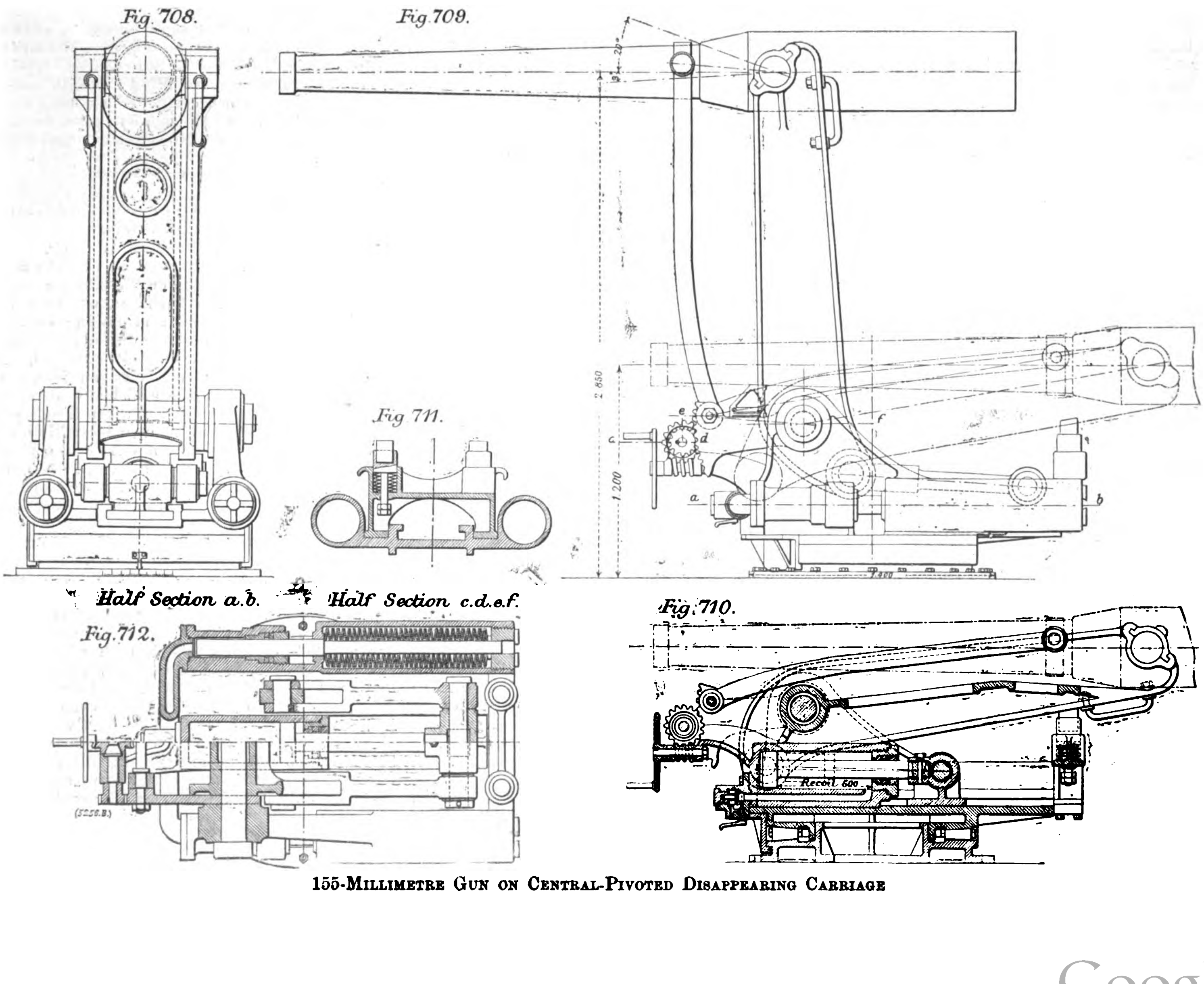








90-Millimetre Gun on Disappearing Carriage for Mobile or Fixed Service.



155-Millimetre Gun on Central-Pivoted Disappearing Carriage

SCHNEIDER-CANET 15-CENTIMETRE HOWITZER ON DISAPPEARING CARRIAGE.

(*For Description, see Page 212.*)

Fig. 717.

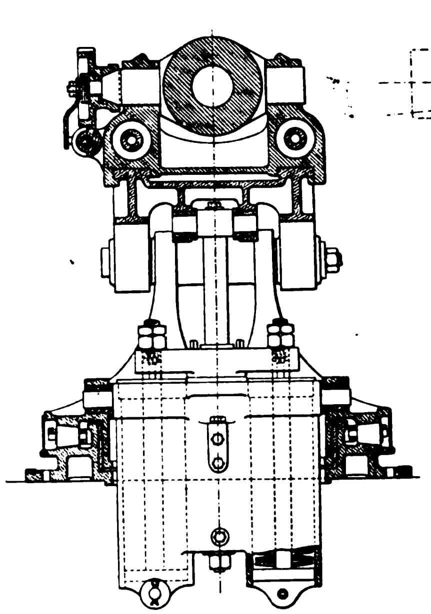


Fig. 718.

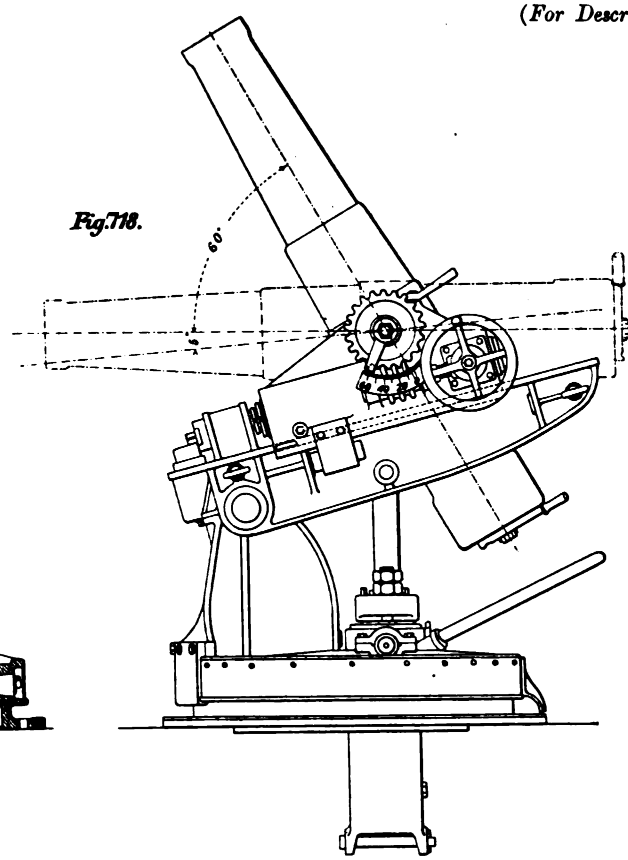


Fig. 719.

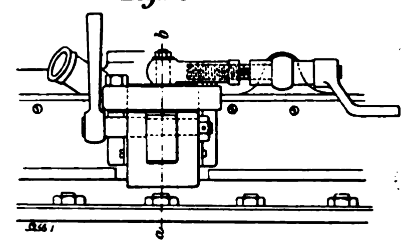


Fig. 720.

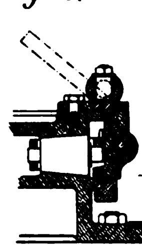
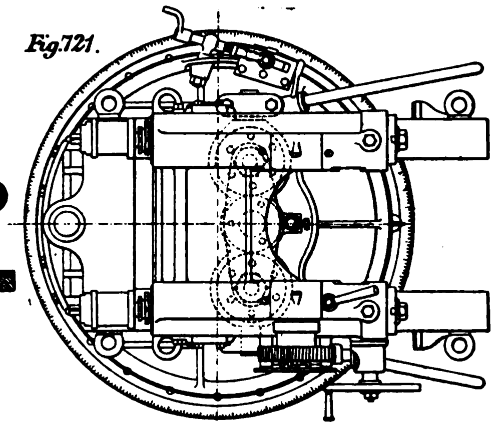


Fig. 721.



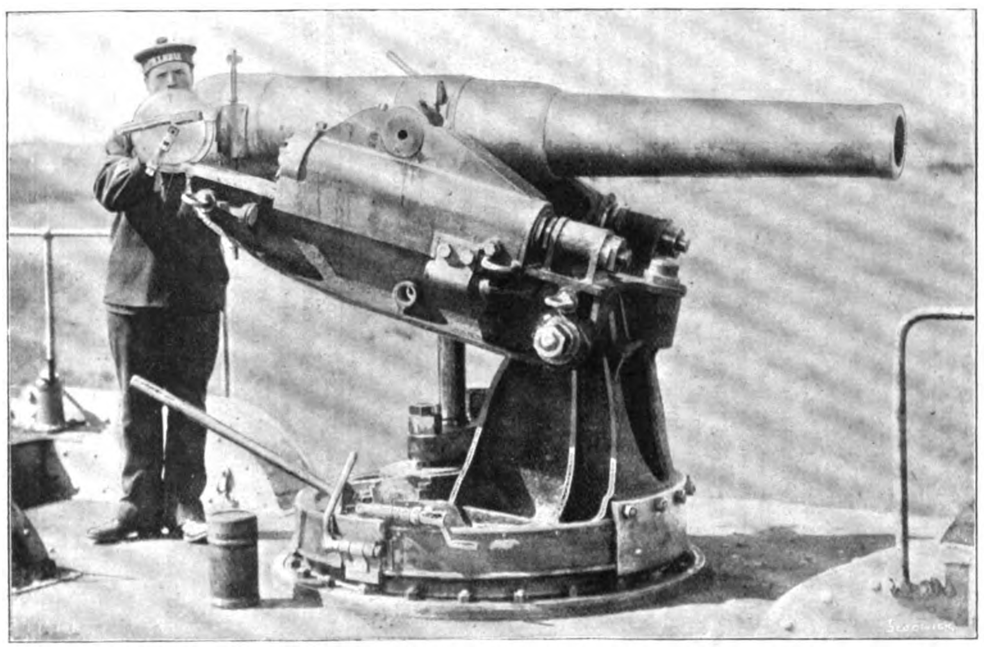


FIG. 722.

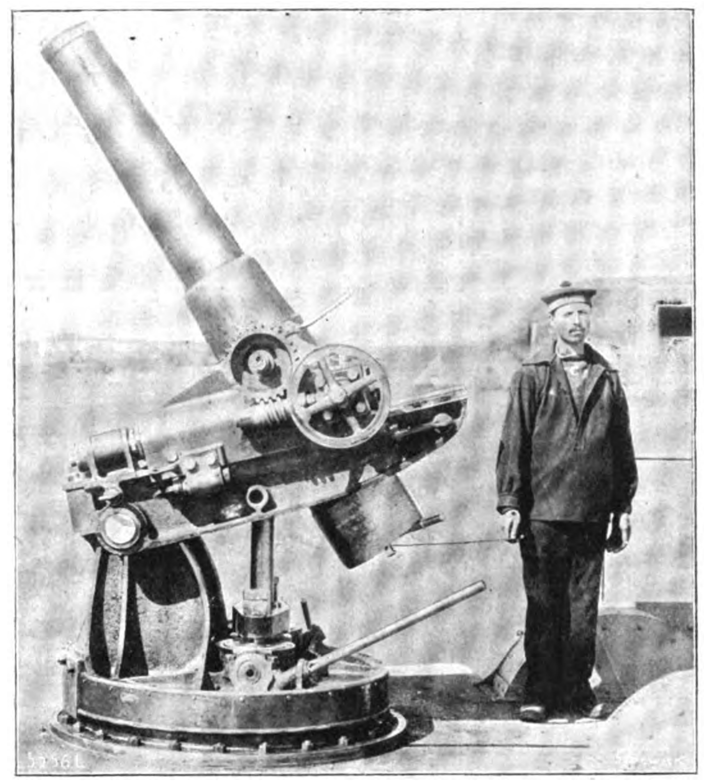


FIG. 723.

the current, amounting to some 40 amperes at the commencement gradually fell off to about 30 amperes when the battery was fully charged. That is, when the battery charge is low, and this rotary converter is thrown on in series with the 500-volt line, it automatically regulates its own excitation so that, while giving 30 volts and 40 amperes at first, it finished up with 200 volts and 30 amperes. Its shunt coils are excited from its own commutator, hence at gradually increasing voltage.

Its series winding is connected to act in opposition to the shunt winding. This negative series winding was at first put on to protect the rotary from the effect of sudden variations of voltage on this 500-volt circuit. Thus if the line voltage suddenly rose to 520 volts, the addition of the rotary voltage sent a much heavier current into the battery; a negative series winding tended to equalise the resultant voltage in spite of line variations, and proved to contribute very markedly to the automatic regulation of current and voltage to the varying requirements during the process of charging the storage battery.

In Fig. 43 is given a diagram of its connections.

An alternative scheme to that of a small auxiliary rotary converter, and, perhaps, on the whole, the best arrangement of all, consists in the addition of a small continuous-current machine on an extension of the shaft of the main rotary converter. If its fields are excited in series with the load, and its commutator connected in series with that of the main rotary converter, the combined set may be adjusted to over-compound to any desired extent. Fig. 44 gives a diagram of this scheme.

A great disadvantage of both these last schemes is that the commutator of the auxiliary machine carrying the main current must have substantially as great a radiating surface as the main commutator, and hence is expensive. The commutator losses are also doubled.

Still another interesting arrangement for giving an adjustable ratio of conversion of voltage is that illustrated in Fig. 45, wherein a small synchronous motor is directly connected on the shaft of the rotary, which requires no collector rings; those of the synchronous motor serving for the set. The synchronous motor has a separate field system by varying the excitation of which the percentage of the voltage consumed in the synchronous motor is varied, and consequently also the total ratio of conversion.

(To be continued.)

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

GUNS ON DISAPPEARING CARRIAGES—(*Concluded*).

15-*Centimetre* (5.905-*In.*) 26-*Calibre Gun, on Disappearing Carriage* (Figs. 724 and 725).—

Weight of gun	2750 kilogs. (6,061 lb.)
„ mounting ...	6500 „ (14,326 „)
„ projectile ...	35 „ (77 lb.)
Muzzle velocity with black powder	520 m. (1706 ft.)
Elevation	+ 15 deg. – 5 deg.
Training, through	360 deg.

The gun is a general type of Schneider-Canet ordnance for garrison armament. The breech-block opens in three actions, and is fitted with a plastic obturator. The bedplate is provided with a roller-path, the balls of which are maintained at a fixed distance apart by a circular plate-ring, in which are cut a series of hollows. It is fitted with a circular disc for fixing it to the foundations. The slide consists mainly of two vertical brackets, joined at their lower part by a circular platform which revolves on a set of balls on the bedplate. A clamp holds the rim of the latter and the front of the slide, preventing all shifting when the gun is fired. The beam, in which the gun trunnions are placed, consists of two cheeks stayed together at the top; it is movable round a horizontal axis formed by two hollow drums, which oscillate in vertical brackets fixed on the platform of the slide. The gun is, moveover, supported in front of its trunnions by two jointed rods on a collar placed near the wedge coil. The rods oscillate at their lower part on a shaft supported by two sliding shoes, which fit in circular grooves made in the front of the slide brackets. Two smaller rods join the shoes to these arms; these are in a line with the cheeks, below the drums. The hydraulic recoil cylinder is movable; it is placed horizontally between the brackets, and is pro-

SCHNEIDER-CANET DISAPPEARING CARRIAGES.

Fig 724.

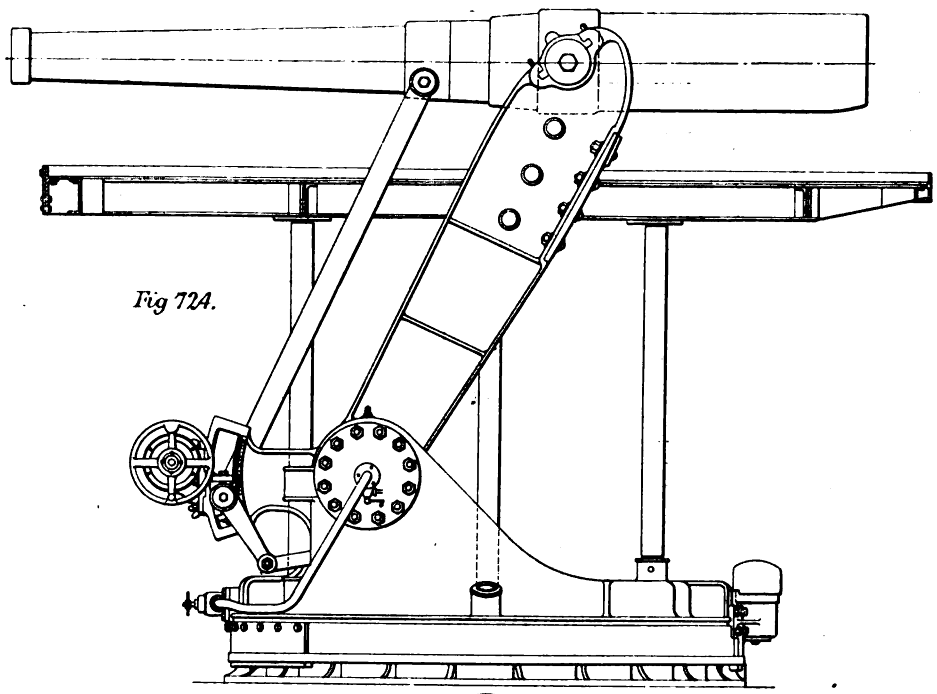
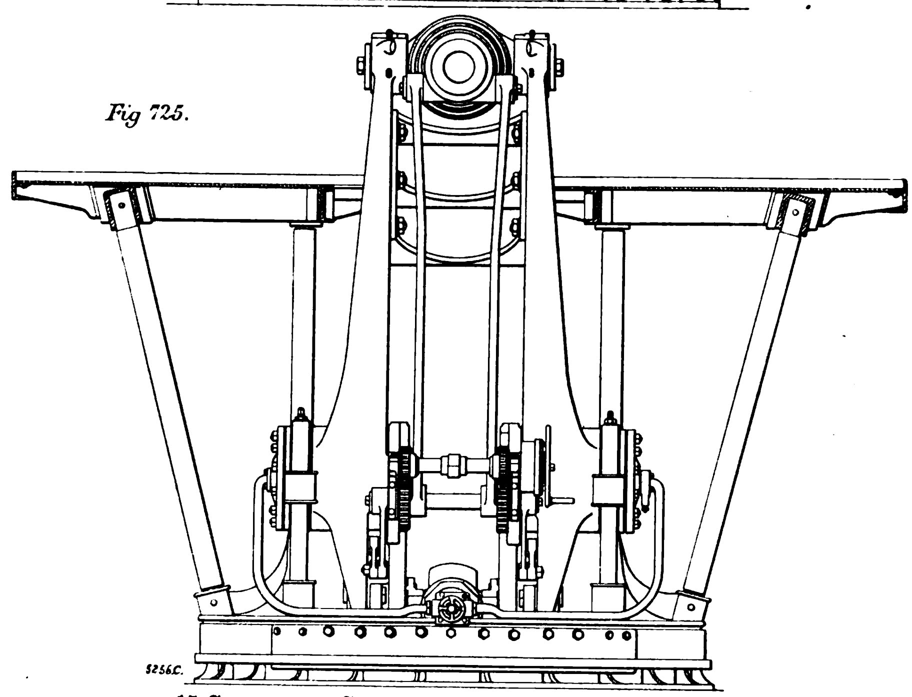
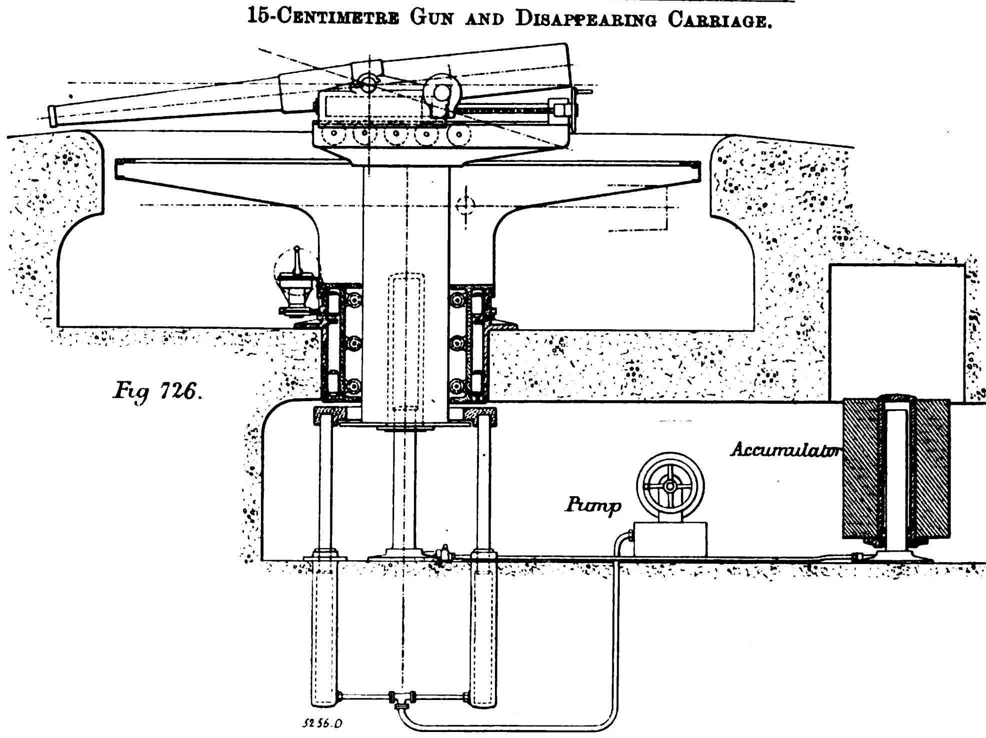


Fig 725.



15-CENTIMETRE GUN AND DISAPPEARING CARRIAGE.

Fig 726.



24 CENTIMETRE SCHNEIDER-CANET GUN AND DISAPPEARING CARRIAGE.

27-CENTIMETRE SCHNEIDER-CANET GUN AND DISAPPEARING CARRIAGE.

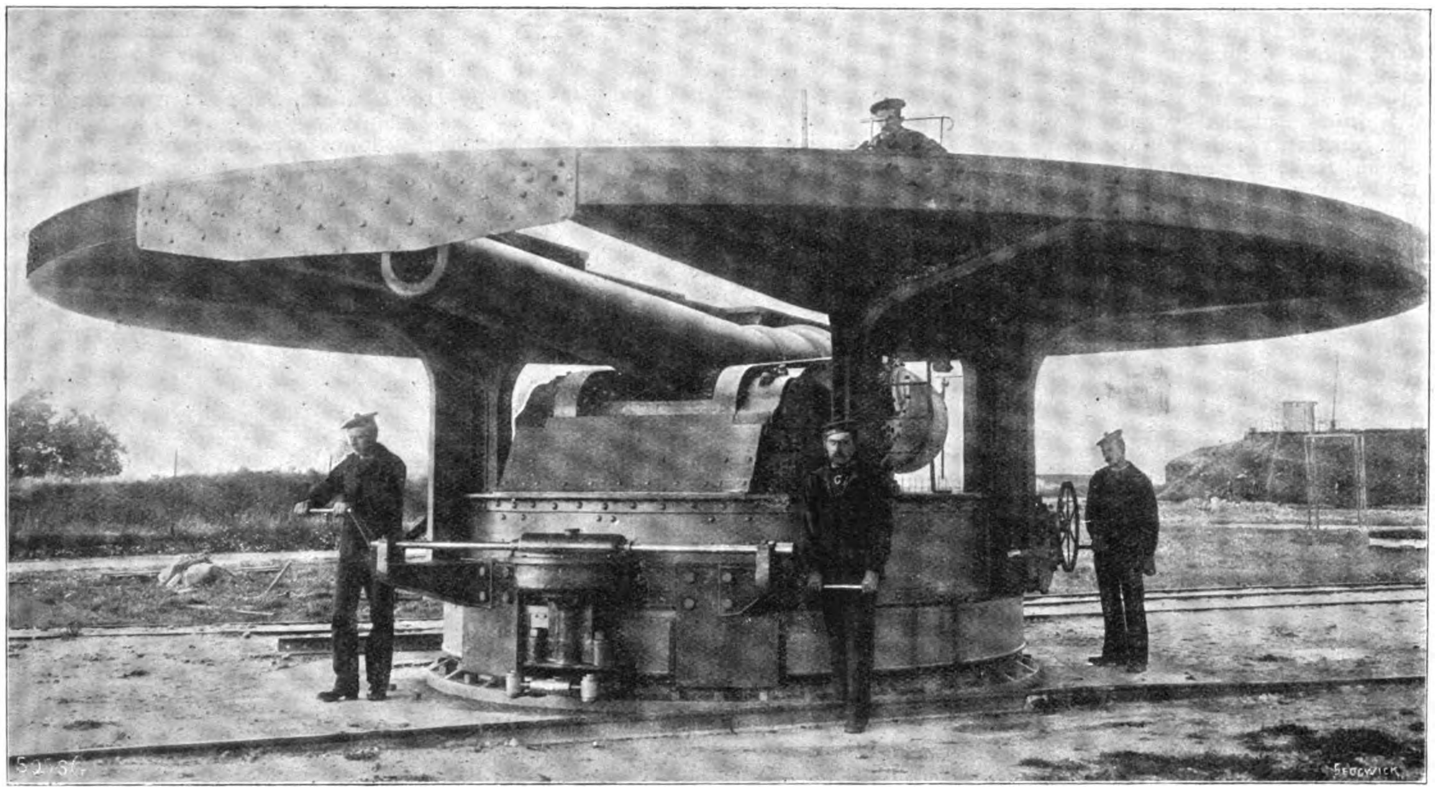


FIG. 728.

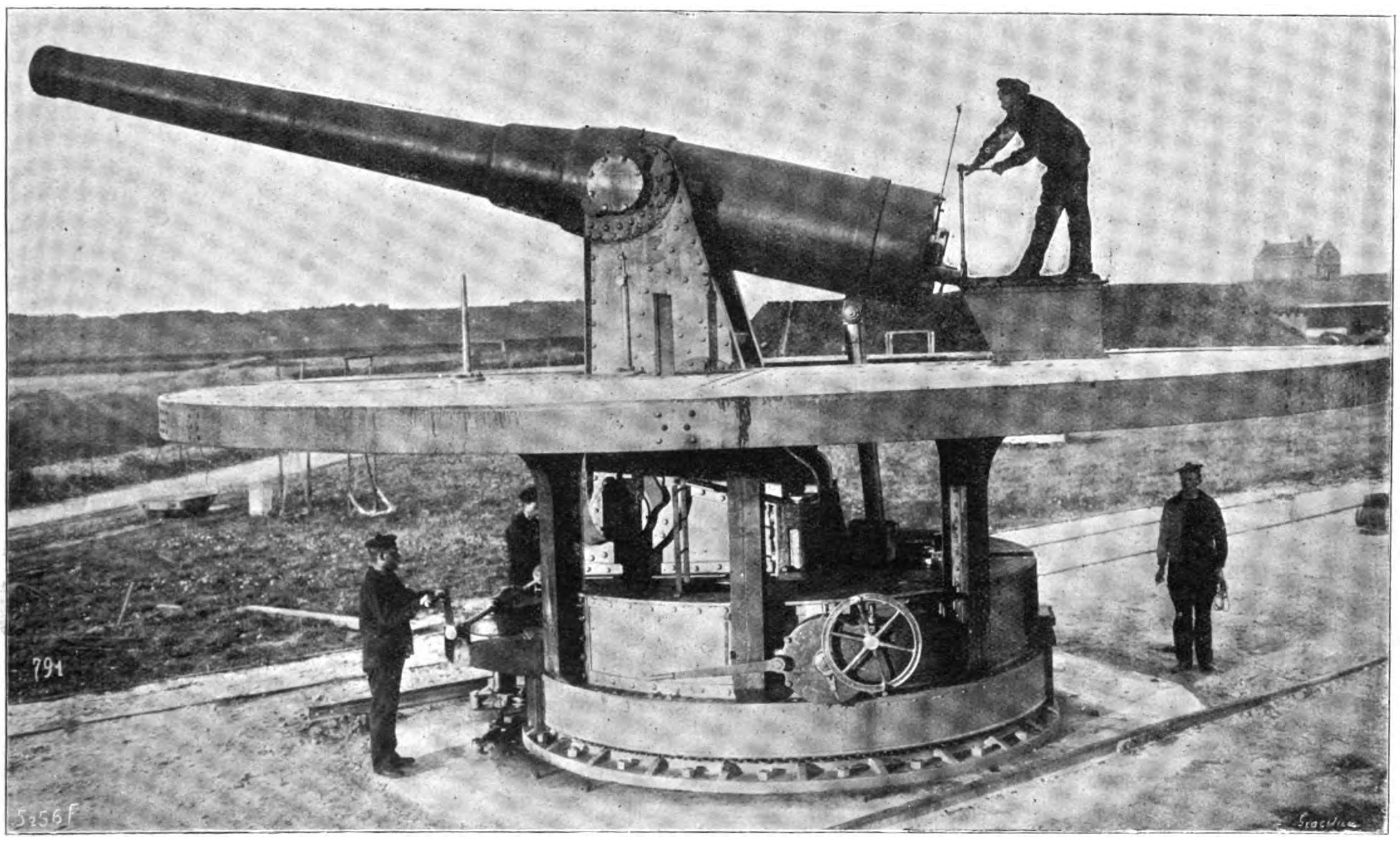


FIG. 729.

vided in front and in the rear with two cross-bars that travel in gun-metal guides fitted to the slide. The piston remains fixed; it consists of a cylindrical rod hollowed out along its length, the central counter-rod being held on the bottom of the recoil cylinder. The recuperator is formed of two hollow drums, round which the beam turns. The bottom of each drum is in communication with the recoil cylinder through a pipe fitted with a loaded valve. In the valve seat are two narrow vents which cross at right angles; these openings can be closed wholly or in part by a conical-pointed rod worked by a screw. This establishes a direct passage, the area of which can be made to vary at will, though the valve be fallen back on its seat. The other end of the drums can be put in connection with an air compressor, worked by hand or by power; a movable airtight diaphragm is put in both cylinders, between the liquid from the recoil cylinder, and the compressed air delivered by the compressor.

When the gun is run up and ready for firing, the pointed regulating rod is screwed down, closing the vents. Then, when the gun is fired, the recoil causes the beam to turn round the drums, and the arms fitted to the lower part of the beam cheeks are driven forward, drawing with them the recoil cylinder in which the piston enters. Pressure is thus exercised on the liquid which flows through the opening that remains free between the counter-rod and the central port hole in the piston; it raises the loaded valve, and enters the two drums, driving before it the airtight diaphragms above referred to, which act on the compressed air and increase its pressure. This continues as long as the gun has run completely down. An elastic buffer is placed in the rear of the slide, to deaden the shock, should the motion of the system exceed in any way the extent calculated for a normal oscillation. When the gun is run down, the loaded valve falls back on its seat, and cuts off communication between the recuperator drums and the hydraulic recoil cylinder; the gun then remains run down, and can be reloaded and reset. For running it up again the pointed rod is unscrewed by means of a handwheel; the liquid under pressure can thus flow back to the recoil cylinder; this resumes its former position, drawing with it the arms at the lower part of the beam. The running up of the gun can therefore be controlled at will. For rapid firing, the firing device can be arranged to act automatically when the gun has run up in battery, the only stoppage in the action being that for loading and training.

For lateral training it is sufficient to act direct by traction on the movable slide, with the help of one or more levers placed on the circumference of the platform; a scale enables the position of the gun to be noted and maintained. The required elevation is obtained by working the rods jointed on the gun ring; to this effect the slide-shoes, in which is fitted the shaft that joins the two rods at their lower part, extend over the guides in two brackets. A shaft on which two pinions are keyed goes through the two brackets. The pinions gear in circular racks, cut in the outside surface of the fixed guides. The system is worked by a handwheel driving the shaft which carries the two pinions. A scale is cut on the outside ledge of the guides. The gun can be set to a given angle of elevation, either when it is run down or when it is in firing position.

A horizontal shield, carried on columns attached to the slide, protects the various parts of the mounting. It is made with a longitudinal opening to admit the passage of the gun.

24-Centimetre (9.448-In.) Gun on Disappearing Carriage with Counterweight (Fig. 726, page 244).—This type, though working automatically, can be driven by a steam motor or by electric transmission. It contains only mechanical parts and a counterweight, compressed air not being resorted to.

Weight of gun ...	... 22,200 kilogs. (48,942 lb.)
" mounting	...124,000 " (273,370 ")
" projectile	... 150 " (331 ")
Muzzle velocity ...	... 820 metres (2,688 ft.)
Elevation	... − 6 deg. + 15 deg.
Training, through ...	... 360 deg.

The gun is built throughout of steel, and is of a standard Schneider-Canet coast-defence type. The mounting is formed of the following main parts:

(*a*) The carriage proper, which carries the gun in its movements of recoil and return.

(*b*) The slide, on which the carriage travels; this slide disappears after each round, and runs the gun up again in a firing position.

(*c*) The movable platform, which transmits to the system the lateral training displacements. The platform remains fixed during the disappearing motion of the gun.

(*d*) The bedplate, which carries the whole installation and rests on the foundation.

The carriage proper consists of a cradle; it contains the two lateral recoil cylinders and an intermediate recuperator placed in the centre line of the system and at the lower part. It is provided with trunnion-plates, in which the gun rests. The lower surface of each of the cylinders forms a slide-shoe, and is provided with a clamp that holds the edges of the slide guides. The recoil cylinders are on the Schneider-Canet system, with central counter-rods. The recuperator communicates with the cylinders through two branched pipes and a valve-chest; it contains a piston, which, on recoil, is driven by the liquid that flows from the recoil cylinder, and presses down two sets of springs parallel with the centre line of the mounting. The slide is formed of two vertical cheeks, the top part of which constitutes horizontal slides, in which are fitted friction rollers of the type previously described, to facilitate the travel of the cradle. The slide is continued at its lower part by a cylindrical sleeve made of plates, inside which is the hydraulic cylinder used for raising the mounting and regulating the disappearing action. The vertical motion of the sleeve is guided by a set of horizontal rollers mounted on the vertical pivot of the movable platform. The movable platform carries the horizontal shield and also the lateral training mechanism. It is circular, and its lower face bears on a series of friction balls; it is fitted with a vertical ring to which are attached the centring rollers of the sleeve. The platform is guided in its rotary motion by a second series of rollers, the vertical axes of which are fitted to the cylinder that forms part of the cast-iron bedplate which carries the whole of the system; this bedplate contains a ring that bears on the foundation, and through which run the foundation bolts. Its top part is made with a groove that forms a path for the friction balls. It is strengthened by a series of radiating ribs. Its lower part ends in a vertical cylinder, which rests direct against the cemented wall of the pit and carries the axles of the guiding rollers of the movable platform. The pit itself communicates with a larged-sized room that contains part of the hydraulic mechanism and the counterweight. The room is joined to the battery communications through an underground passage. The fixed plunger piston that works in the hydraulic cylinder, is drilled for its whole length and parallel with its centre line; the conduit thus established, communicates through a tube fitted with regulating valves, with an hydraulic accumulator designed for storing a power slightly above that required for counterbalancing the weight of the movable mounting during running up and down. The cast-iron counterweight consists of a large-diameter ring guided in its action by a set of horizontal rollers on vertical guides; at a given moment, it can rest completely on a bedplate bolted on the lower part of the movable sleeve and then the weight of the whole arrangement is sufficient to act against the resisting power of the accumulator. The counterweight can be raised independently of the sleeve by three plunger pistons contained in vertical hydraulic cylinders, worked simultaneously by the forcing pump. These hydraulic cylinders are embedded in the foundation.

The required elevation is given the gun by a handwheel placed in the rear of the left-hand cheek of the slide. The transmission contains a set of square toothed-wheels, an endless screw and differential gearing, working a square pinion that engages the toothed sector fitted on the left side of the gun. Lateral training is obtained with the help of a mechanism similar to that described further on with the 27-centimetre (10.630 in.) gun mountings. The plate-chain that surrounds part

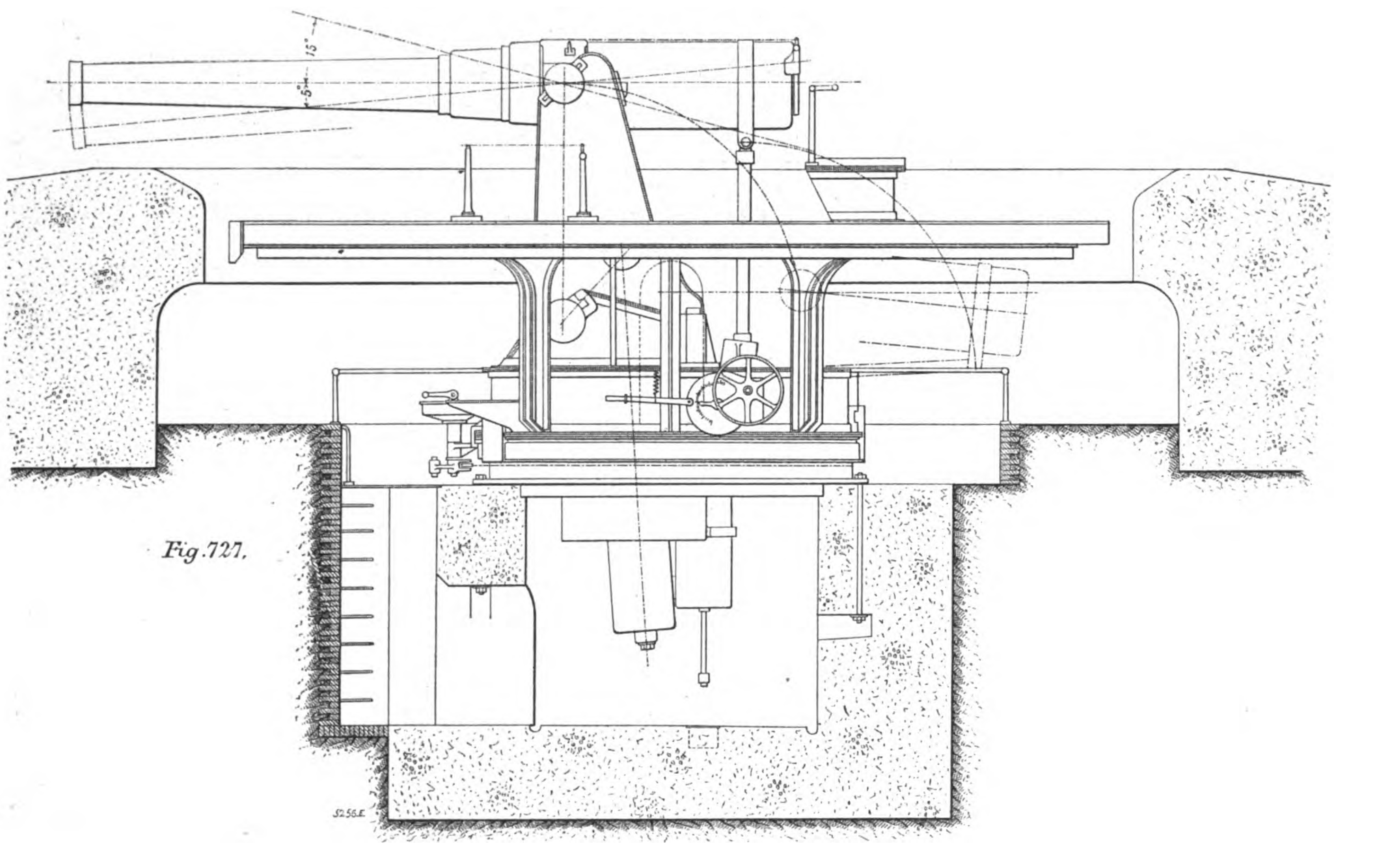


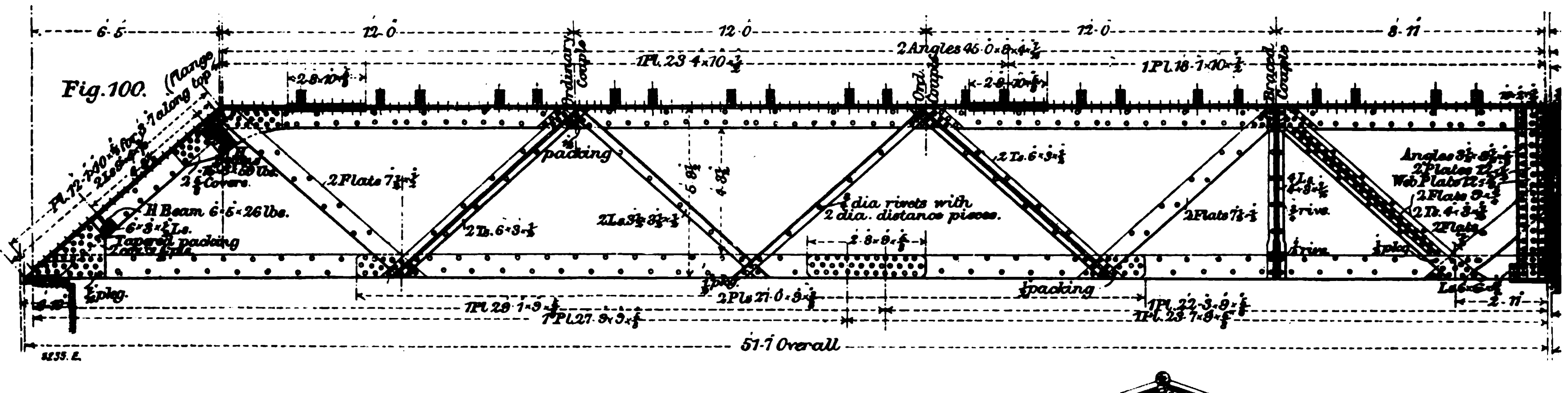
Fig. 727.

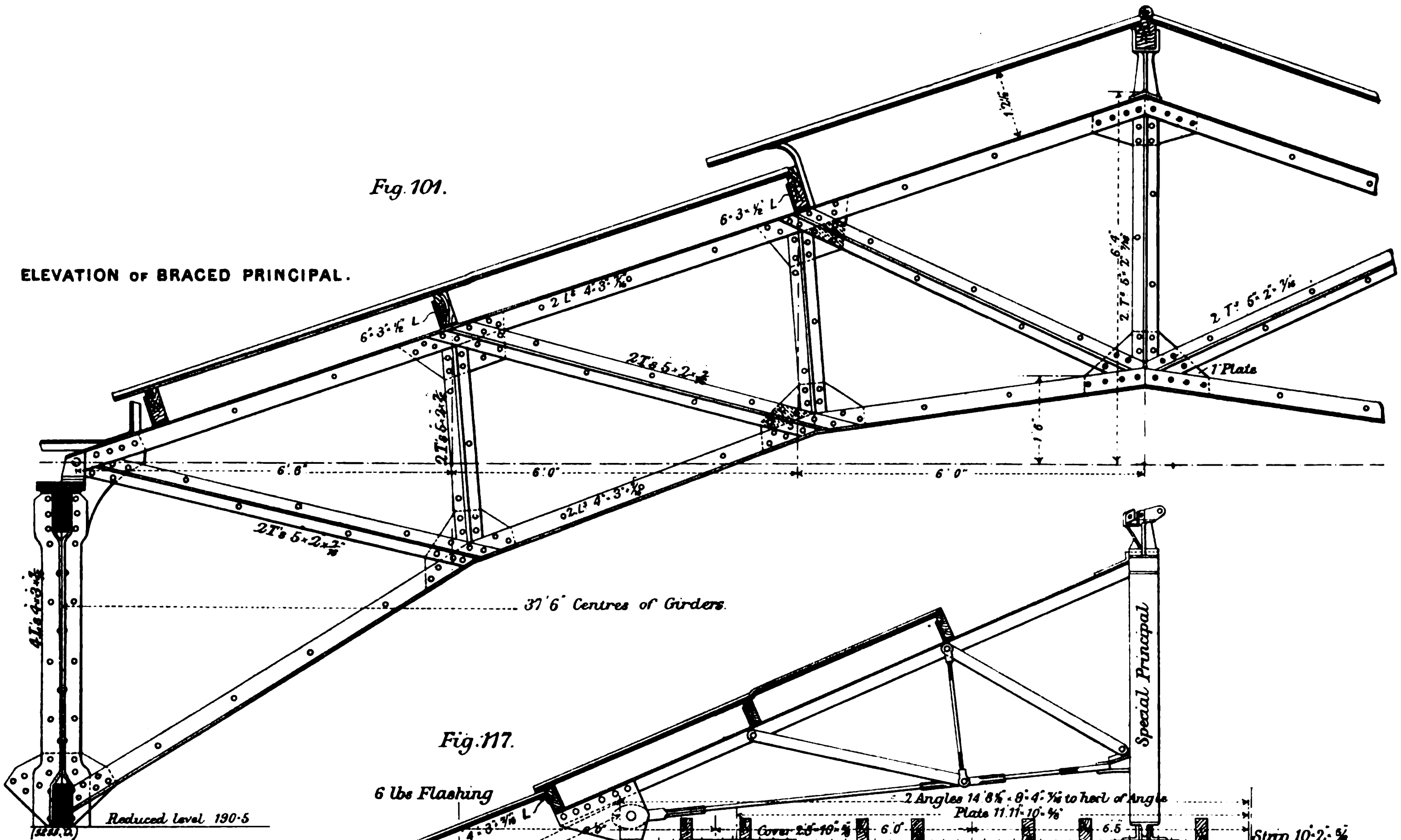
27-Centimetre Schneider-Canet Gun and Disappearing Carriage.

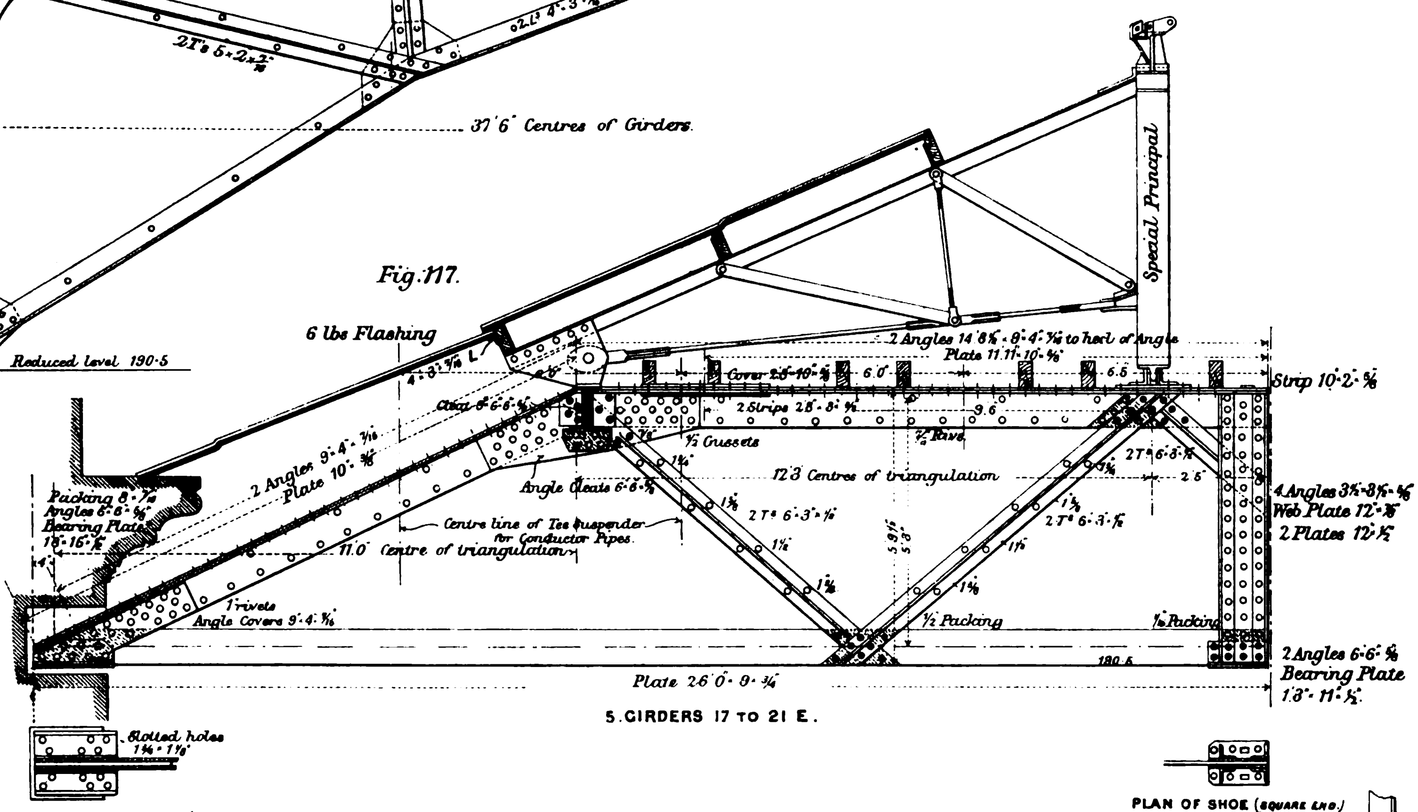
THE WAVERLEY STATION AT EDINBURGH OF TI

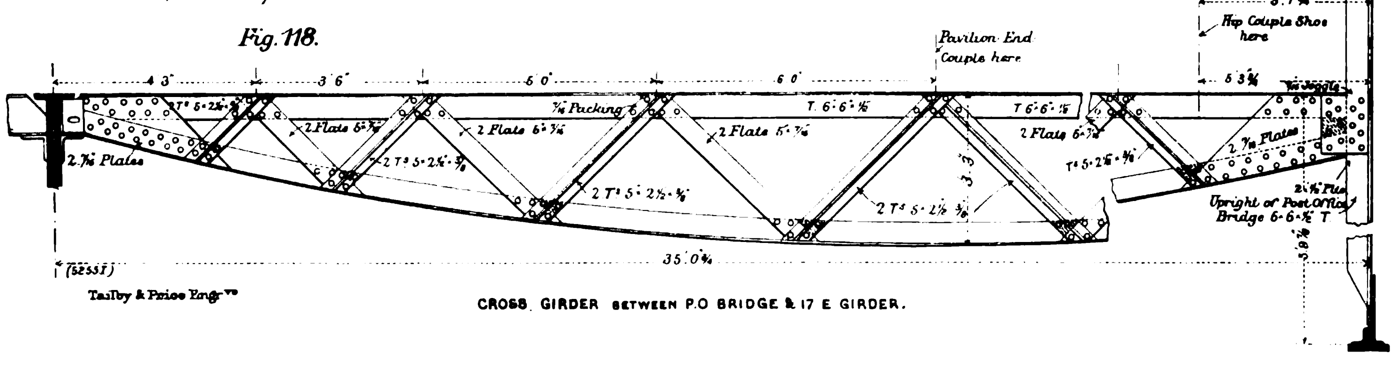
MESSRS. BLYTH AND WESTLAND, EDINBURGH, ENGINEERS; MES

(For Descriptio





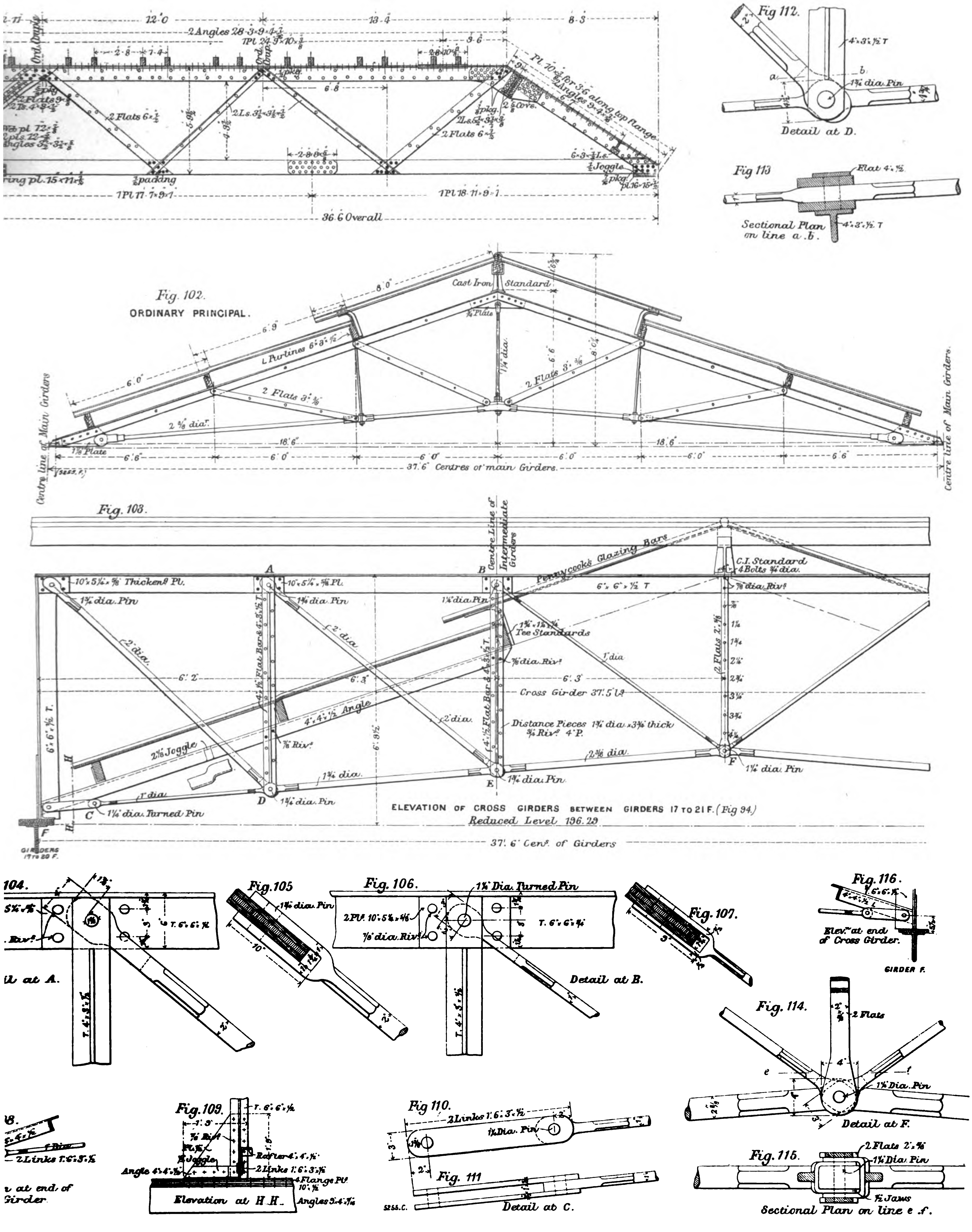




E NORTH BRITISH RAILWAY; DETAILS OF ROOF.

S. P. AND W. MACLELLAN, LIMITED, GLASGOW, CONTRACTORS.

see *Page* 247.)



of the circumference of the movable platform, is driven by a spurwheel keyed on a vertical shaft, which goes through a chest containing the driving-mechanism. The gun can be trained direct from the platform with the help of a crank or through a chain transmission worked by a gunner standing on the shield.

When the gun is in battery, the cast-iron counter-weight rests on the lower collar. On firing, when the carriage recoils, it travels on the slide rollers, and the recoil cylinder acts in the same way as that for the types described above. When the recoil is spent, the valve that establishes communication between the recoil cylinder and the recuperator, closes and maintains the gun run in. At the same time, the valve which establishes a communication between the main vertical hydraulic cylinder and the accumulator, opens automatically, allows the flowing out of the liquid and the gun runs down. It is then reloaded and reset in position. This effected, and the communication with the accumulator remaining cut off, the ring that forms an additional counterweight is raised by means of the forcing pump and the three plunger pistons, to a height that varies according to the angle of elevation under which firing is to be effected. Communication between the hydraulic cylinder and the accumulator is then re-established and the gun runs up in battery under the action of the accumulator alone. The system is then fixed, and the hydraulic cylinders being turned on the exhaust, the additional counterweight descends, and rests afresh on the caisson collar. A valve placed on the conduit in the thickness of the valve-chest, then re-establishes communication from the recoil cylinders to the recuperator, which, in relaxing, place the gun in a firing position.

A circular track, formed of I-bars, is placed below the shield, and allows the working of tackle, the chain of which carries the box for raising the projectile to the breech.

This type of ordnance is simple in design; it contains safety devices that insure a regular succession in the various manœuvres, and it is most suitable for open coast-defence batteries that are so exposed they cannot be protected by artificial means. In the course of firing, a single set of motors is required for manœuvring the additional counterweight, the accumulators being charged before firing commences. The motors are preferably electric motors, and can be driven by underground cables. This type of mounting can be used in conjunction with the largest-calibre guns.

27-Centimetre (10.630-*In.*) *28-Calibre Gun and Disappearing Carriage* (Figs. 728 and 729, page 245).—This type of gun and mounting has been supplied to the Japan War Department for defence of Tokio Bay, and to other Governments.

Weight of gun ...	...21,720 kilogs. (47,870 lb.)
„ mounting	...61,300 „ (135,105 „)
„ projectile	... 216 „ (476 „)
Muzzle velocity	580 m. (1903 ft.)
Elevation	−5 deg. to + 15 deg.
Training, through	360 deg.

The gun is on the Schneider-Canet system, 28 calibres in length, strengthened by a rear jacket and a set of coils. The breech-block seating is cut in the tube itself. The breech-block is the same as that for 27 centimetre coast-defence guns; it can be fitted with two metallic cup obturators of different diameter, the second one acting as a spare one for the first in case of need. The mounting consists of the beam, the slide, platform, and the bedplate.

The beam is built up of plates, and consists of two cheeks joined by stay bars, and one of these is fitted at its top end with a gun-metal butt to limit the vertical elevation of the gun; the other is provided with a square which, when the gun has run completely down can connect with the platform and hold the gun down, during the necessary operations for laying and loading it. The beam is fitted:

(*a*) At its lower part, with an axis formed of two trunnions that are carried direct by the brackets of the slide platform.

(*b*) At its top part with cast-steel trunnion plates.

(*c*) With a cross-piece, to which is joined the top of the recoil piston-rod. Both cheeks are, moreover, fitted at their top part with an elastic buffer which can rest, when the gun is completely run down, on buffers on the platform. The slide platform consists mainly of a plate caisson and two vertical brackets fitted with the trunnion-plates for the beam trunnions. It contains all the parts of the mounting, namely: The recoil cylinder, air recuperator, setting mechanism, pump for running down the gun, and it rests on a set of rollers on the bolster. It is fitted also with uprights on which is held the horizontal shield, circular in shape, and in which is cut a longitudinal opening through which the gun passes in running up and down. The recoil cylinder oscillates round the trunnions carried on the flooring, in two fixed brackets; the flooring is joined to the plate caisson, and is cut out in a suitable way to allow the recoil cylinder free travel in its oscillating movements. The recuperator is in the rear, and is fitted with a collar bolted on the slide platform. Communication between the recoil cylinder and the recuperator is insured through a pipe which ends on one side at the lower part of the recuperator, and, on the other, on a valve chest. The hydraulic piston-rod is joined to the beam by a cross-piece with trunnions, the central counter-rod is fixed to the bottom of the recoil cylinder. The air recuperator contains an airtight diaphragm that divides it into two parts—the top division containing compressed air and the lower one, the liquid brought from the recoil cylinder. Through this diaphragm passes a rod provided with a butt to limit its travel. An air-pipe allows the top division to be put in communication with the pressure pump, to run up the gun before firing, should the recuperator have been exhausted.

When the gun is fired, it draws back the beam which turns on its trunnions to the rear, the hydraulic piston descends in the recoil cylinder and drives the liquid into the bottom of the recuperator; the movable diaphragm is displaced and compresses the air of the top compartment. When the beam falls back, the air pressure becomes sufficiently high to balance the system, and the valve between the recoil cylinder and the recuperator falls on its seat. During the time the gun runs down, the elevating rod that supports the breech end, keeps the gun practically in a horizontal position, and when the motion ceases the gun is placed exactly in the required position for reloading. The breech is then opened, the projectile and charge are introduced and the fuse made ready; the gun being given afterwards the required elevation and lateral training, with the help of the scales and marks provided for this purpose. For running up the gun again, the clamp that holds the beam to the slide is removed and communication is re-established between the recoil cylinder and the recuperator by means of a special lever; the compressed air expands and drives before it the diaphragm which forces the liquid to return in the recoil cylinder, where it acts on the piston. The gun runs up progressively with a speed in relation to the space left free for the flowing of the liquid; it can be lowered when necessary, with the help of a hand-pump, which serves to force the liquid from the recoil cylinder to the lower compartment of the recuperator.

The gun is given the required elevation by working the rod that supports the breech-end of the gun. The rod is jointed at its top part in a ring in the breech-end of the gun and on its lower end, on the elevating sector worked by a pinion keyed on the working shaft, the latter extending outside the shaft in a box fitted with the working mechanism. This mechanism consists of a set of pinions and endless screws driven by the shaft of the elevating handwheel. A pointer that travels along a scale shows the exact angle of the gun to the horizontal. Lateral training is given by a chain which surrounds the circumference of the bolster and passes round a pulley keyed on a vertical shaft; tension blocks serve to guide the chain. The cranked horizontal shaft drives the chain pulley and produces the lateral displacements of the slide by tension on the fixed ends of the chain. A scale on the platform marks the extent of the lateral displacements. In normal service the gun is trained when it is run down and loaded. As it may be necessary, however, to rectify the setting of the gun from time to time, when it is run up in battery, the shield is fitted with a special platform for sighting the gun on the target.

The whole of the mechanism above described rests on rollers on the bedplate, which is bolted on the foundation. When a position has been chosen, the top of the foundation is made with a layer of concrete on which is placed an iron foundation plate. These arrangements vary according to the nature of the subsoil.

From the number and diversity of types that we have noticed, it will be seen that the Schneider-Canet system contains mountings which can fulfil all the conditions required in service, from those for 75 millimetres (2.952-in.), guns, weighing 100 kilogrammes (2 cwt.) to those for the largest calibres. This section is of special interest, owing to the numerous unsuccessful attempts that have been made in several countries in the adoption of ordnance of this type. The designing of disappearing gun carriages, and their practical working, is a problem difficult to solve, at all events for large-calibre guns. The perfection to which the various types of Schneider-Canet ordnance of this nature have been brought means, therefore, a large amount of calculation, trials, and tests of all kinds, carried through a number of years.

THE WAVERLEY STATION, EDINBURGH.

(*Continued from page* 9.)

IN continuation of our illustrations of the Waverley Station at Edinburgh, of the North British Railway Company—that used in connection with the East Coast route from London—we reproduce on our two-page plate, and on pages 248 and 249, drawings of the roof, some of the details of which are specially interesting in view of the fact that the station buildings, as well as footbridges, break the general line of the roof, and that the principals have had to be designed to suit the adjacence of buildings along the north side of the site of the station, as shown on the roofing plan, Fig. 94, page 248.

It may be said generally that the roof is of parallel lattice-girder type, carried on columns at intervals of from 50 ft. to 80 ft., while the girders are 37 ft. 6 in. apart. The engineers unfortunately were limited for headroom, the Act of Parliament authorising the erection of the old station having a clause inserted, at the instance of the proprietors of contiguous buildings, limiting the height to 42 ft. above rail level; and this again rendered short spans necessary owing to the desirability of making the depth of girder as small as possible, so as to get a large headroom over the platforms. The superstructure is carried by triangular principals resting on the top of the main girders.

The columns carrying these girders are illustrated on page 248 by Figs. 95 to 99. They are founded on concrete bases with granite blocks, the average depth being 4 ft. below the rail level. The columns are of cast iron, 12 in. in diameter at the top and 19 in. at the bottom, the shafts being fluted, and the capitals and octagonal base highly ornamented. They were cast on end by the Widnes Foundry Company. The average thickness of the metal is 2 in., but the base is 2½ in. and they are secured to the granite bed blocks by 1½ lewis bolts. The arrangement for disposing of surface water from the roof through the columns is shown in Fig. 99.

The roof girders are 6 ft. deep, of the lattice type. A representative girder is shown on the two-page plate (Fig. 100). The bottom boom is built up of flat plates as shown. The girders are otherwise of the usual construction, extending over a maximum width of 370 ft., in six spans supported on the station walls, and on intermediate columns. Expansion joints at varying distances apart are formed at alternate columns—the usual slotted holes. The girders are spaced 37 ft. 6 in. apart, and in the length of the station there are 32 lines of such girders, the area roofed in being 11½ acres. The main roof girders were not made continuous as the general foundations were found to be soft, so that settlement was regarded as a not improbable contingency to be guarded against. Nor could continuous girders be erected with equal facility. Generally the girders were either brought to the ground whole or in two pieces, jointed in the ground where necessary, lifted by a crane into position, and then tied by the couples when in place. Some of the girders at the north-western corner were built on a large travelling stage, as was the Post Office footbridge. This bridge is also above the roof and has glazed roof and sides with oak floor: but in our next article we hope to illustrate and describe its connection with the roof generally.

The principals are, as a matter of course, 37 ft. 6 in. span, and are placed at 12 ft. intervals. One of