Italian Coast-Defence Ordnance

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ITALIAN COAST-DEFENCE ORDNANCE.

CHANGES FROM 1885 TO 1888.

(From *Rivista di Artiglieria e Genio*, of December, 1888. Translation by
A. ROBERTS, Esq.)

Information on Studies and Experiments.

Coast Matériel.

THE principal innovations introduced in our coast matériel from 1885 to the present year, 1888, will be found briefly summarized in the present chapter, which, after referring to the more important studies and experiments carried out, and to the modifications and adoptions introduced, gives the actual condition of our coast matériel.

At the end of the chapter will be found a short *résumé* of the studies and experiments in regard to this matériel which are still being pursued.

45, 32, and 24-centimetre Guns, Carriages (17·72, 12·64, and 9·45-inch), and Platforms; 24-cm. (9·45-inch) Howitzer, Carriage, and Platform.—No modifications worth mentioning have been introduced as regards the 45, 32, and 24-cm. guns, carriages, or platforms, nor in the 24-cm. howitzer, either as regards carriage, platform, or other gear; what modifications there were being limited to the removal of such slight defects of construction as were counselled by the long and extensive practical experience gained at the Naval Gunnery Schools.

40-cm. A.R.C. Gun, B.L. (15½-inch Hooped and Rifled B.L. Steel Gun).—The limited power of the 32 and 24-cm. guns against the armour of ships of modern construction led to the purchase from Krupp of four 40-cm. steel guns intended for the defence of the fortress of Spezia.

These guns, which were at first intended to be placed in couples within two revolving turrets, were subsequently disposed of differently.

Two of them will be installed in a revolving iron turret faced with chilled cast-iron plates (Grüson), the mechanism and substructure of which will be furnished by Armstrong.

One of these proof plates satisfies the requisite amount of resistance to the impact of 43-cm. (17-inch) tempered steel projectiles, which strike it with an energy of 48,436 foot-tons.

The other two guns will be placed on two floating pontoons, which are also to be constructed by the Armstrong firm.

The ammunition for these guns consists of tempered steel shot, supplied by Krupp's firm, and of chilled cast-iron shot from the Genoa foundry.

These steel or cast-iron projectiles, when empty, weigh 910 kilog. (2,006 lbs.), and have a bursting charge of 10½ kilog. (23 lbs. 2½ ozs.) of fine powder.

These projectiles will be fired with brown prismatic powder, supplied from the Fossano powder mills; this powder, during repeated trials carried out at the Muggiano practising grounds with the 43-cm. naval gun, has proved itself able to compare advantageously with the best prismatic powders of Dünberg, Cologne, or of Rübeland; the results obtained from a charge of 375 kilog. (826½ lbs.), firing a projectile of 908 kilog. (2,028 lbs.), being equal

to an initial velocity of 565 metres (1,854 feet), with a mean pressure (crushers) of less than 1,900 atmospheres (12½ tons).

The charge, divided into six cartridges, will be about 340 kilog. (749½ lbs.), the posterior cartridge in order to facilitate ignition will have its centre made up of grains of black prismatic powder with a hole through the centre.

16-cm. G.R.C. Gun (6-29-inch Hooped and Rifled Iron Gun).—In consequence of the absolute want of power of the 16-cm. G.R.C. gun as a coast gun, it was determined to remove these guns entirely from the armament of fortresses and to utilize them for conversion into 21-cm. B.L. G.R.C. howitzers.

Matériel for 28-cm. (11-inch) Howitzers.—The essential innovations introduced in the matériel for 28-cm. howitzers issued and in construction are two, viz. :—

1. Reduction of the gun-carriage so as to allow fire up to 75° elevation.
2. Abolition of the platform elevating gear and application of the system of disc springs.

The first modification sprang from the adoption of firing with high angles of elevation, of which we shall speak further on. In order to obtain this it was absolutely necessary to cut down the middle transom of the carriage and to raise the horizontal part of the fore transom.

The second modification was rendered desirable on account of the inconveniences experienced in practice from the elevating gear.

With this modification the platform is supported by four cast-iron rollers, which run on the platform rails, two being placed in front and two behind, in framings or casings, which support a guide rod which traverses the side framing, fixed to the platform, containing six disc springs.

The application of the disc springs to the platform has rendered the service of the 28-cm. howitzer much less fatiguing, and has also led to the great advantage of being able to diminish the number of men to serve it.

Disappearing Gun-carriage with Hydro-pneumatic Platform (Armstrong) for 28-cm. Howitzer (11-inch).—Although our gun carriage and platform for the 28-cm. howitzer leaves little to be desired as regards facility in serving or resistance, yet, in consequence of researches made by the Armstrong firm, experiments were made with disappearing carriages fitted with hydro-pneumatic platforms, which allow a vertical angle of fire of from 45° to 75°, and a horizontal all round fire (360°).

These carriages having given satisfactory results after being experimented with, and account being taken of the important advantages resulting from the large horizontal arc of training which they allow, of their comparatively simple method of fixing, and of their taking up less space in battery than the ordinary carriage and platform, they were introduced into the Service (see *Giornale d'Artiglieria e Genio*, A.D. 1888, p. 334) particularly for placing in batteries designed for indirect laying.

The disappearing carriage weighs about 8 quintals (15½ cwt.), and is formed of two blocks united by a transom, on each of which is a trunnion-hole with a capsquare joined by bolts.

The hydro-pneumatic platform weighs about 9½ quintals (18·7 cwt.), and consists of two brackets (or cheeks) with two polished surfaces, on which the carriage runs.

The brackets rest on a system of girders braced by transoms, and at the back end of the brackets are fixed the cylinders, within which the cylinder-rods work.

On the upper surface of each cylinder is a buffer, formed of several layers of felt and grease, pressed between two discs, through which bolts are passed. The upper disc serves as a brake for the recoil of the carriage.

The platform is supported by fourteen rollers, and has the turning gear

fixed to the left of it; this gear is worked by a hand-wheel, and allows, when the shaft and pinion which work on the toothed arc fixed on the guide are set in motion, of the whole being revolved.

The elevation of the howitzer is effected by the elevating gear, which is worked by two fly-wheels, one on either side of the platform.

The recoil of the piece is checked, and the automatic recoil in battery effected, by means of the hydro-pneumatic brakes, which consist of two cylinders which are fixed to the brackets; each cylinder is divided into two chambers. One, by means of its piston, bears the weight of the piece on recoil, whilst the other, which contains glycerine and air, communicates with the first through the recoil valve and the lifting valve. The glycerine and air chamber can be got at directly by a screw tap, which is fitted with a leather ring.

The cylinders communicate with each other by means of three tubes; the first connects the two recoil presses underneath, the second, which also passes underneath, connects the two elevating presses, and the third, a thinner one, is on top of the elevating presses.

The upper end of the recoil press is fitted with a collar, hermetically closed, and a filling tap is screwed on to the communication tube of the elevating press.

The glycerine and compressed air chambers are filled by the aid of an air pump, which compresses the air to a pressure of about 89 atmospheres (1,303 lbs.).

The platform base (or substructure) consists essentially of a track secured to cramps embedded in a concrete basement. The fourteen rollers which support the platform rest on and travel over this track; the toothed arcs, by means of which the complete rotation of the system is rendered possible, are fixed within the inner circumference of this track.

The operation of charging the cylinders of the carriages to the required pressure by the air pump only, or of re-establishing the pressure when diminished, whilst firing is going on, by loss, escape of air or glycerine, by the bursting of the communicating tubes between the hydro-pneumatic cylinders, or by deformity of the valve, &c., is long and fatiguing, and requires about three hours for each carriage.

In order, therefore, to obviate such a grave inconvenience, every battery, in addition to tubes and spare valves, is supplied with compressed air cylinders of the Nordenfelt type (one for each piece) by means of which air can be easily introduced into the hydro-pneumatic cylinders of the carriages by simply connecting them together; an operation which takes from four to five minutes to effect.

The Nordenfelt cylinders are charged either by a steam engine suitable for the purpose where there are many batteries, or, in isolated batteries, by means of a hand-pump, and they are always kept ready charged in the battery so as to be available on every occasion.

Ammunition.

No innovations have been made as regards projectiles, but substantial alterations have been introduced in regard to fuzes and powder.

Fuzes.—In 1885 a percussion fuze was designed for projectiles loaded from the base which was to serve both for 32 and 24-cm. (12·6-inch and 9½-inch) shot as well as for the 28-cm. (11-inch) shell—a small lead tube filled with a mixture (for delay) being used with the latter in order to ensure the bursting of the shell being delayed until penetration had ceased.

This fuze, which had consequently to be used both when firing with heavy charges from guns, *i.e.*, with high initial velocities—and when firing with

reduced charges from howitzers, *i.e.*, with low initial velocities—was of somewhat complicated construction. Nevertheless it was adopted in 1886, under the name of "Percussion fuze for 32 and 24-cm. shot" (*v. Giornale d'Artiglieria e Genio*, A.D. 1886, p. 19).

Subsequently a more simple percussion fuze having been designed for the 15-cm. (6 inch) shot, its use was extended to those for coast defence; a new fuze was thus introduced for siege and coast projectiles (*Spoletta per palla d'assedio e da costa*, 45, 40, 32, 24 and 15-cm.),¹ and the employment of the original fuze for 32 and 24-cm. projectiles (delay) was limited to the 28-cm. shell, and as such took the percussion fuze for 28-cm. shell—*Spoletta a percussione per granata da 28* (*v. Giornale d'Artiglieria e Genio*, A.D. 1887, p. 590, and 1888, p. 123).

Meanwhile a percussion fuze—for shells loaded from the head, of the type M. 1880, but much more sensitive, was designed for use at first in short guns with reduced charges: this fuze, which has a delay tang, is styled Percussion fuze M. 1885 (*Spoletta a percussione*, M. 1885) and was adopted in 1886 for the 21-cm. shell and for the 24-cm. mine shell—*Granata mina* (see *Giornale d'Artiglieria e Genio*, A.D. 1886, p. 1893, and 1887, p. 578).

The increased sensitiveness of this fuze was obtained, 1st, by increasing the weight of the screw plug of the percussion cap carrier by introducing into its head molten and compressed lead; 2nd, by increasing the weight of the pellet. With these modifications the action of the fuze was assured, whether at the moment of discharge, or on graze under the most unfavourable conditions.

Thereupon, in order to simplify the employment of the various fuzes in use, experiments were undertaken to ascertain whether difficulties would not occur in using the fuze M. 1885, with its sensitive priming when firing, and especially when handling loaded 32 and 24-cm. shell.

The experimental trials, however, carried out with the 15-cm. (5-inch) gun, with 20 lbs. charges, proved the possibility of using without danger the fuze (M. 1885) even when firing 32 and 24-cm. guns.

The trials for ascertaining the safety in the handling of the fuze consisted in finding out from what height it was necessary to drop 32 and 24-cm. shells to set the fuze in action. The result of these trials demonstrated the practical safety of fuze M. 1885; but by an excess of prudence it was laid down that the priming of the shell should only be inserted when the shell was actually on the loading plate.

Thereupon the use of this fuze (without safety pin) was extended to the 32 and 24-cm. shells (see *Giornale d'Artiglieria e Genio*, A.D. 1888, p. 413).

Powder for 24-cm. (9½-inch) Guns.—It having been ascertained that large grain powder, N. 2 (cubes), after absorbing moisture loses a good deal of its ballistic power, suitable experiments were made with powder not artificially moistened, but kept for a winter in the powder magazine at the Cirié Camp, and also with powder artificially moistened to 1·5 per cent., and then dried in the sun.

The results obtained when fired from a long 24-cm. gun are shown below (p. 245).

The deduction from these results is that cubical powder after absorbing moisture, even in moderately small quantities, becomes undoubtedly unserviceable for the purpose for which it is destined; for if it is used without drying, its ballistic power is excessively lessened, whilst if it is dried, even in the sun, its quick burning attains absolutely inadmissible proportions, changing the internal structure of the grain and consequently altering the slow combustion character of the powder.

¹ Vide *Giornale d'Artiglieria e Genio*, A.D. 1887, p. 567.

Powder not Artificially Moistened.

Number of rounds.	Weight of projectile.	Charge.	Mean velocity at 50 metres from muzzle.	Mean pressure.		Distance between base of projectile and section at the breech.
				Rodman.	Crushers.	
4	lbs. 322	lbs. 61½	feet. 1316	tons. 12·09	tons. 12·095	inches. 42·244

The initial velocity from firing table is 1,427 feet.

Powder Artificially Moistened to 1·5 per cent., and then Sun Dried.

1	322	61½	1433	21·11 ¹	21·81	42·4
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¹ High pressure.

In consequence of this state of things it was ordered that cubical powder was never to be sun dried (see *Giornale d'Artiglieria e Genio*, A.D. 1885, p. 22, &c.), and that the charge for the 24-cm. guns should be raised to 30 kilog. (66·13 lbs.), so that the additional 2 kilog. should compensate for the diminution in ballistic power of the damp powder; at the same time, however, it was decided gradually to substitute progressive powder for cubical powder.

Experiments having proved that a charge of 68·34 lbs. of progressive powder, No. 2 (the same as employed for the 32-cm. gun), fired from the long and short 24-cm. guns gave initial velocities differing but slightly from those produced by 66·14 lbs. of cubical powder, with internal pressures much lower than the maxima allowed for the said powder, progressive powder was adopted for the 24-cm. guns as well, and suitable bags were prepared accordingly (see *Giornale d'Artiglieria e Genio*, A.D. 1885, pp. 210 and 211).

The substitution of progressive for cubical powder is now completed.

Incendiary Charge for 24-cm. Shell-mines (Granata-mina) and 28-cm. Shells.—In view of the indifferent results obtained from the carcass composition in cylinders employed in the incendiary charges of shells, suitable experiments were made with various incendiary substances, and for this purpose small incendiary cylinders (*cilindretti incendiari*), similar to the French, were at last adopted and employed for the loading of 24-cm. shell-mines (*granata-mina*) and 28-cm. shells.

Loaded in this manner the 24-cm. shell-mine contains 12·56 lbs. of powder and 94 small cylinders, and the 28-cm. shell 62·83 lbs. of powder and 111 small cylinders.

Gun-cotton Charge for the 28-cm. Shell and for the 24-cm. Shell-mine.—Meanwhile studies and experiments were being indefatigably pursued on explosives of a yet more powerful nature than powder for use in the bursting charges of projectiles. These researches led to the adoption of gun-cotton in grains for the 28-cm. shell and for the 24-cm. shell-mine (see *Giornale d'Artiglieria e Genio*, A.D. 1887, p. 567).

This gun-cotton was obtained in bulk from the firm of Wolff at Walsrode.

The gun-cotton which forms the bursting charge of these shells is moist, i.e., it contains from 18 to 22 per cent. of water, and is dressed into prisms of the following dimensions:—

Minimum .. $12 \times 12 \times 22$ mm. = $0.472 \times 0.472 \times 0.866$ inches.
 Maximum.. $14 \times 14 \times 24$ „ = $0.551 \times 0.551 \times 0.945$ „

The 24-cm. shell-mine is loaded with about $16\frac{1}{2}$ lbs. and the 28-cm. shell with about 17.63 lbs. of this kind of wet gun-cotton.

Paraffin mixed with vegetable wax (Carnauba wax) is employed to keep the bursting charge in proper position.

Small cylinders (or pellets) of dry gun-cotton, i.e., containing only from 1 to 2 per cent. of moisture, are employed to cause the explosion of the wet gun-cotton.

The fuze used for the 24-cm. shell-mine is the 1885 pattern, with an appendix screwed to the body intended to receive the head of the fulminating cap.

The appendix is threaded externally, so as to allow the case (an empty steel cylinder), which contains the pellets of dry gun-cotton, to be screwed on to it.

These pellets have a diameter of about 24 mm. (0.95 inch) and a length of about 50 mm. (1.97 inches). They are covered with paraffined paper, and five of them form the loading of the case: the top one is perforated to make room for the cap.

The cap causes the explosion of the dry gun-cotton, which in its turn explodes the wet prismatic cotton; it contains 1 g. ($15\frac{1}{2}$ grains) of fulminate of mercury, covered with a layer of pressed powder, so as to give a slight delay in the explosion of the projectile.

The 28-cm. shell fuze (without delay), fitted with appendix, cap, and case, similar to that used for the 24-cm. shell-mine, is employed for the 28-cm. shell. The pellets have a diameter of 30 mm. (1.14 inch), and three of them form the loading of the case.

Laying and Firing. Range-finders.

The continuous improvements introduced in regard to the horizontal armour of ships made it incumbent to have recourse to high-angle fire, in order to penetrate the deck armour of ships and to inflict damage on their vital parts.

After a long series of experiments, it was decided to adopt with the 28-cm. howitzer vertical fire of from 45° to 62° , experience having shown that when fired with angles in excess of 62° and up to 75° , the accuracy of the fire sensibly diminished, in consequence of the disturbing effect produced by the air on the flight of the projectile.

The firing tables, within penetrating range, are calculated for 14 charges of 11 lbs., $12\frac{1}{2}$ lbs., 13.22 lbs., 14.33 lbs., 15.43 lbs., 17 lbs., $18\frac{1}{2}$ lbs., 20.94 lbs., 23.15 lbs., 26 lbs., and 28.8 lbs. of large grain powder No. 1, and 31.97 lbs., 40.12 lbs., and 44 lbs. of progressive powder No. 1; the first eleven being contained in a cloth bag as reduced charges for the 28-cm. howitzer, and the others in a cloth bag for the 28-cm. howitzer.

The firing tables, both for the 28 and the 24-cm. howitzers, have been calculated for batteries on the sea level: suitable tables being worked out and lithographed for batteries placed at varying height above the sea.

With a view to protecting the gun detachments and matériel in the batteries, numerous experiments were made in the indirect laying of coast howitzers, and a system of indirect laying by means of rails and graphometers was adopted; at the same time, every suitable arrangement was made for signalling from outside to the battery the necessary data for laying and firing the guns. With this system, which certainly has many opponents, although

¹ This diameter is liable to alteration in consequence of experiments which are now being made.

the laying and firing of coast howitzers is somewhat complicated, the advantageous employment of disappearing carriages and hydro-pneumatic platforms is rendered possible; and it is also possible to have even low-placed coast batteries under good conditions, both as regards service of personnel and matériel, as well as resistance to the enemy's fire.

The proposals of Captain Braccialini as to the introduction of certain modifications in the Amici vertical base range-finder having been accepted, the alteration of these into vertical base range-finders, 1886 pattern (Braccialini), was quickly taken in hand (see *Giornale d'Artiglieria e Genio*, A.D. 1886, p. 437).

The effect of these modifications has been to make the range-finder more accurate, and also to simplify its employment. By the first half of 1889 all the Amici telemeters will have been altered.

A series of comparative trials between horizontal base range-finders designed by Captain Braccialini and those of Madsen and Goarault of Trommelin having been carried out, the coast range-finder with horizontal base, 1886 pattern (Braccialini), was adopted (see *Giornale d'Artiglieria e Genio*, A.D. 1888, p. 17), and the low-lying coast batteries are already provided with them.

On the proposal of Major Sollier, R.A., and Captain Braccialini, R.A., experiments were made at Spezia with "telegoniometers" to direct fire from stations outside the batteries, and to concentrate the fire of several batteries on the same object.

This important problem was satisfactorily solved, and "telegoniometers" with direct sighting (*telegoniometria a visione diretta*) were adopted (see *Giornale d'Artiglieria e Genio*, A.D. 1888, p. 281) as subsidiaries to the battery range-finders; and telegonomic stations, bearing on the same point on the water, were established for directing the fire from groups of batteries.

Another invention, of no great importance, but very useful in practice for training the troops in serving the coast batteries, is the adoption of reduced coast fire (*tiro ridotto*), evidently on the Morris tube principle.

The reduced fire from 24 and 32-cm. guns and from 28-cm. howitzers is carried out by introducing a small 7-cm. (2½-inch) cannon into the bore of the gun and firing from it a 2½-inch unringed shell loaded with sand.

For guns, the cartridge used contains 1·87 lbs. of large grain No. 1 powder, and the gun is laid as if for ordinary firing, except that suitable volutes have to be used for the automatic tangent sights, and range tables specially drawn up for this method of firing.

For the 28-cm. howitzer seven charges were used, viz.: 5·29 ozs., 6 ozs., 7·05 ozs., 7·94 ozs., 8·82 ozs., 9·7 ozs., and 11·46 ozs. of fine grain powder No. 2; and for the 24-cm. howitzer five, viz.: 5·29 ozs., 6 ozs., 7·05 ozs., 8·82 ozs., and 11·46 ozs. of the same kind of powder.

The firing tables are worked out for the several batteries from 1,500 to 3,700 metres for the 28-cm. howitzer, and from 1,400 to 3,800 metres for the 24-cm. howitzer.

It results, therefore, from what we have said, that at the end of 1888 our coast matériel consists of—

- 45-cm. G.R.C.¹ B.L. guns.
- 40-cm. A.R.C.² B.L. guns.
- 32-cm. G.R.C. B.L. guns.
- 24-cm. G.R.C. B.L. guns, long and short.
- 28-cm. G.R.C. B.L. howitzers.
- 24-cm. G.R.C. B.L. howitzers.

The principal data in connection with this matériel are reproduced in the following tables A, B, C.

¹ G.R.C. = hooped and rifled cast-iron gun.

² A.R.C. = hooped and rifled steel gun.

Table A.

Gun.	45-cm. G.R.C. B.L. gun.	45-cm. G.R.C. B.L. gun.	32-cm. G.R.C. B.L. gun.	28-cm. G.R.C. B.L. howitzer.	Long 24-cm. G.R.C. B.L. gun.	Short 24-cm. G.R.C. B.L. gun.	24-cm. G.R.C. B.L. converted howitzer.
Calibre.....	17.72	15.75	12.64	11.02	9.45	9.45	9.45
Furnace charge.....	72.83	..	35.43	11.81	18.01	16.73	5.91 ¹
Weight of casting.....	66.38	..	31.49	10.12	15.67	13.79	5.07 ¹
body.....	47.19	..	21.3	6.01	11.11	9.14	2.72 ¹
hoops.....	50.63	..	15.75	4.35	6.1	5.8	1.47
Weight of gun { breech-piece.....	19.68 ²	..	7.32	4.29	3.6	3.6	3.25
swinging tray.....	441	..	412.26 ³	22.6 ³	63.93 ²	63.93 ²	61.73 ²
total.....	99.11	119	37.6	10.62	17.42	15.16	4.40
Preponderance (breech closed).....	74.8	7	17.32	44 lbs.	Nil.	Nil.	-55 to + 55 lbs.
Cost { materials { hoops.....	4,248	..	1,040	276	360	360	243
labour.....	1,044	..	420	204	280	216.8	48 ³
total.....	2,000	..	300	200	240	240	72 ³
Cost per kilogram of gun.....	7.202	36,800 ⁴	1,760	680	880	816.8	1.95
number of grooves.....	1.81	7.60	1.15	1.56	1.24	1.37	56
twist in feet.....	64	92	48	64	24	24	24.10
Rifling from right to left.....	88.58 {	65.61 ⁵	76.28	32.15	49.21 ⁴	49.21 ⁴	24.10
inclination of grooves.....	2° 59' 10"	32.8 ¹	2° 59' 50"	5° 7' 50"	50.37	50.37	3° 53' 50"
width.....	0.574	0.36	0.51	0.39	2° 52' 40"	2° 52' 40"	0.37
depth.....	0.093	0.078	0.12	0.07	0.82 to 0.63	0.82 to 0.63	0.07
Distance between base of projectile and section at breech.....	83.3	92.9	69	28	41.5	41.5	20.5
Space allowance in the distance of the projectile {	+0.31	..	+0.23	+0.10	+0.19	+0.19	+0.19
from section at breech.....	-0.31	..	-0.23	-0.10	-0.19	-0.19	-0.19

Table A—continued.

Gun.	45-cm. G.R.C. B.L. gun.	45-cm. G.R.C. B.L. gun.	32-cm. G.R.C. B.L. gun.	28-cm. G.R.C. B.L. howitzer.	Long 24-cm. G.R.C. B.L. gun.	Short 24-cm. G.R.C. B.L. gun.	24-cm. G.R.C. B.L. converted howitzer.
Capacity of powder chamber	17,454	23,434	7,128	1,511	1,977	1,977	549
Breech system	screw steel expansion ring	wedge	Sc.S.E.R.	Sc.S.E.R.	Sc.S.E.R.	Sc.S.E.R.	Sc.S.E.R.
Length {	370	500 ³	252	100	208	167	85 5
bore, exclusive of socket for expanding gas	20.9	..	19.9	9	22	17.6	9
check ring	64.17	73.8	49.7	14.5	39.4	39.4	6.7
bore in calibres	393.7	551.2	270	112.7	222.7	181.9	9.9
powder chamber, not including the cone, ..	22.2	35	21.4	10.2	23.5	19.2	10.47
total from muzzle to breech	3	3 ¹⁰	2	2	2	2	1
total in calibres	13.82	..	7.28	5.12	5.12	5.12	2.53
Number of layers of hoops	27.4	23.8	18.7	13.58	14.56	14.56	8.48
Thickness of breech coil	..	..	..	..	..	..	..
Total thickness of walls at breech	..	..	..	..	..	..	..

¹ For a 22-cm. M.L. howitzer.² With small obturating ring.³ Cost of conversion. The total cost of the converted howitzer is 348l.⁴ For the restricting and directing slides.⁵ At breech.⁶ At muzzle. The final twist is constant for a length of 26 inches from the muzzle.⁷ Has no preponderance, as it has no trunnions.⁸ Exclusive of custom-house dues, but including cost of transport.⁹ Length measured from front face of wedge.¹⁰ Only the layers over the breech lining are counted: the A-tube is also hooped as far as the muzzle.

Table B.

Ammunition and firing data.	45-cm. G.R.C. B.L. gun.	45-cm. G.R.C. B.L. gun.	32-cm. G.R.C. B.L. gun.	28-cm. G.R.C. B.L. howitzer.	Long 24-cm. G.R.C. B.L. gun.	Short 24-cm. G.R.C. B.L. gun.	24-cm. G.R.C. B.L. converted howitzer.
Weight of { Shell ready for firing lbs. projectile { Shot ready for firing "	.. 2204·6	.. 2,028 cast iron or steel 53·6 cast iron 50·4 steel	602 764	447 chilled iron ..	277 331 cast iron	277 331 cast iron	262 shell-mine
Total length of shell and shot inches (not including handling rings and fuze)	49·3		30·3 34·3	31·8 ..	23·2 26	23·2 26	20·4
Bursting { Shell (fino grain pow- charge { der) lbs. Shot (fino grain pow- der) "	.. 20·7 ..	.. 23·1 ..	30·6 8·8 M. 1885	20·9 ¹ .. For 28-cm. shell ..	9·9 3·7 M. 1885	9·9 3·7 M. 1885	17·6 ¹ M. 1885 with tang
Percussion fuze { Shot Gun charge lbs.	For siege and coast shot 485 Progressive for 45-cm.	For siege and coast shot 749·5 Fossano brown pris- matic	For siege and coast shot 187·4 Progressivo No. 2	For 28-cm. shell .. 11 to 44 Large grain No. 1 for charges not > 32 lbs. Progressivo No. 1 if > 32 lbs.	For siege and coast shot 68·3 Progressivo No. 2	For siege and coast shot 178·6 Progressivo No. 2	6·3 to 11·7 Large grain No. 1
Quality of powder.....							

¹ For the incendiary and gun-cotton charges see previous statement.

Table B—continued.

Ammunition and firing data.	45 cm. G.R.C. B.L. gun.	45 cm. G.R.C. B.L. gun.	32 cm. G.R.C. B.L. gun.	28 cm. G.R.C. B.L. howitzer.	Long 24 cm. G.R.C. B.L. gun.	Short 24 cm. G.R.C. B.L. gun.	24 cm. G.R.C. B.L. converted howitzer.
Density of charge	0.77	0.85	0.73	0.807 for charges > 32 lbs.	0.925	0.925	0.59 for charge > 456 to 758
Initial velocity { Shell..... feet Velocity { Shot..... " "	..	..	..	..	1,542	1,476	456 to 758
at 1,000 { Shell at 1,000 metres " "	1,450	1,804	1,398	..	1,427	1,378	
and 2,000 { " " " "	..	..	1,230	..	1,316	1,276	
metres { Shot at 1,000 " " "	1,385	..	1,316	..	1,148	1,145	
(1,094 { " " " "	1,296	1,575	1,200	..	1,256	1,230	
and 2,187 { " " " "	..	at 2,500 m.	..	..	1,152	1,132	
yards) { " " " "	..	..	..	..	..	..	
Total energy { Shell..... ft. tons	32,859	46,136	10,736	..	4,575	4,194	
at muzzle { Shot..... " "	..	..	11,414	..	4,682	4,366	
Total initial energy per cm. of	232	367	115	..	62	59	
circumference of shot..... " "	..	..	8,037	..	0,261	3,155	
Energy { Shell at 1,000 m. " "	..	..	6,229	..	2,231	2,541	
at 1,000 { " " " "	28,751	..	9,186	..	3,629	3,481	
and 2,000 { Shot at 1,000 m. " "	25,190	35,325	7,053	..	3,051	2,948	
metres { " " " "	..	at 2,500 m.	..	..	..	..	
Energy per cm. { at 1,000 m. " "	203.5	..	92	..	49	47	
of circumference { at 2,000 m. " "	178	263	76.6	..	41	40	
of shot { " " " "	..	distance not stated	..	..	9,843	9,843	5,140
Maximum range of shell fire..... yds.	..	..	8,749	8,858	..	..	..

Table D—continued.

Ammunition and firing data.	45-cm. G.R.C. B.L. gun.	45-cm. G.R.O. B.L. gun.	32-cm. G.R.C. B.L. gun.	28-cm. G.R.C.B.L. howitzer.	Long 24-cm. G.R.C. B.L. gun.	Short 24-cm. G.R.C. B.L. gun.	24-cm. G.R.C.B.L. converted howitzer.
Maximum range { Pounding . . . yds. for shot { Perforating . . . "	8,740 2,187	10,390 ¹ 10,390 ¹ (sic)	8,749 2,187		9,843 2,187	9,843 2,187	
Thickness of { at 1,000 metres inches iron plating { (1,001 yds.) pierced by { at 1,500 metres shot { (1,640 yds.)	.. 21.26	.. 16.93 at 2,500 m. (2,734 yds.)	.. 13 78	..	9.45	9.45	

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¹ Allowed by gun-carriage.

Table C.

Carriages.	45-cm. G.R.C. B.L. gun.	40-cm. G.R.C. B.L. gun.	32-cm. G.R.C. B.L. gun.	29-cm. G.R.C. B.L. howitzer.	Long 24-cm. G.R.C. B.L. gun.	Short 24-cm. G.R.C. B.L. gun.	Converted 24-cm. G.R.C. B.L. howitzer.
Defensive barbette with box sides. Centre pivot platform and three cylin- ders.	Armstrong's hydraulic system for revolving turret.	Defensive barbette. No. 7 front pivoting plat- form, two cylinder brakes.	Defensive, with box sides. No. 13 central pivot platform, brake with one cylinder only.	Defensivo pivoting platform with one cylinder only.	High ¹ Plat- form No. 1.	Low ¹ Plat- form No. 5.	Defensive, Platform No. 12 front pivoting, two bow-compres- sor friction brakes, one breecching. 70
Height of axis of piece inches	135·8	126	74·6	74·6	109·5	96·8	
Genouillere.	102·4	103·4	..	..	90·5	78·75	
Vertical arc of fire degrees	+20—6°	+30—6°	+75—5°	+75—5°	+32—8°	+20—15°	+41·5—10°
Weight of gun carriage cwt.	322·8	109·2½	101·37	101·37	54·13	55·11	18·89
Weight of platform.... tons	29·03½	14·86½	8·02½	8·02½	6·186	5·0	2·795
Platform base	Metal on square with granite bot- tom.	Metal with two tracks on granite.	Metal and wood for up- per part of circumfer- ence, lower parts in gra- nite.	Metal and wood for up- per part of circumfer- ence, lower parts in gra- nite.	Metal with lower part in masonry and sector.	Metal, con- verted from the masonry and granite platform of 22-cm. gun.	
Cost of carriage and platform	2,392½. 1876, p. 3. 1880, pp. 745 and 1073. 1881, p. 913. 1884, p. 292, vol. 4.	4,000½. ² <i>Rivista</i> , April, 1886.	1,744½. 1877, p. 29. 1881, pp. 946 and 1194. 1884, p. 292, vol. 4.	959·8½. 1882, p. 876. 1883, p. 284. 1884, p. 292, vol. 4.	620½. 1884, p. 103. 1875, p. 337. 1876, p. 335. 1884, p. 292, of vol. 4.	416½. 1883, p. 211. 1884, p. 292, vol. 4.	176½. 1883, p. 211. 1884, p. 292, vol. 4.

¹ The long 24-cm. gun can exceptionally be mounted on the low carriage with platform No. 5, and the short 24-cm. gun on the high carriage with platform No. 1, but the platforms are not interchangeable.

² Cost of buying the carriage alone without gear.

The following gives a *resumé* of the chief studies and experiments actually being made on the subject of our coast matériel.

Tubing of Coast Guns.—The duration of service of the 24-cm. and 32-cm. cast-iron guns is somewhat limited in consequence of the rapid corrosion in the powder chambers and at the commencement of the rifling produced by the heavy charges of slow burning powder: the consequent advance of the projectile in the bore thus modifying the conditions of discharge.

Long experience with a 9-cm. B.L. Parsons gun of manganese-bronze having shown the great resistance which this metal offers to the corrosive action of the powder gases, trials are now being made to reline with it a 32-cm. gun rendered unserviceable through corrosion.

The retubing will be limited to the portion of the bore which corresponds to the double hooping of the gun. After suitably enlarging the portion of the bore which is to be replaced by the tube, the tube will be introduced and lightly forced into the gun and will then be compressed with a steel, or very hard iron mandrel, in the same manner as is done with bronze guns.

If these experiments should prove as successful as is anticipated a sufficiently economical method will have been found for prolonging the service of coast guns, and one which can be applied as well to the coast howitzers and 15-cm. G.R.C. B.L. guns.

24-cm. and 28-cm. Steel Torpedo-shells.—In order to be able to throw larger quantities of powerful explosives, trials are being made, for use with the 24-cm. and 28-cm. howitzers, of steel shell which have a large internal capacity. These are called torpedo-shells (*granate-torpedini*).

The 24-cm. torpedo-shell consists of a cylindrical steel jacket with removable cast-iron ogival head: in this jacket is inserted a zinc casing which contains the gun-cotton or other powerful explosive. The fuze, which is similar to the one already described, has a body, however, of larger diameter than the 1885 pattern with pellet and priming of the 1885 pattern; to the body is attached the appendix for the fulminating cap and to the appendix the case which contains the pellets of dry gun-cotton.

Two types of 28-cm. torpedo-shells are being experimented with; one of which has the filling hole in the head and the other at the base.

The shell with loading hole in the head consists of a steel cylindrical casing with movable ogival head, also of steel, fitted with a fuze similar to the 24-cm. torpedo shell. The wet gun-cotton in discs, to the weight of about 44 lbs., or other explosive, is introduced directly into the casing.

The other torpedo-shell, filled from the base, has a chilled head with screw base, and carries a fuze similar to the one employed for the cast-iron shell, loaded with granular gun-cotton, or another kind of fuze which is being experimented with; the gun-cotton in discs, over 44 lbs. in weight, or other explosive, is introduced directly into the casing.

Both these torpedo-shells, in weight and length, about equal the ordinary cast-iron shell.

Shrapnel Shell for Coast Artillery.

In order to defend the lines of torpedo mines from being fished for by boats, and to act against landing boats, it was decided to try the effect of shrapnel shell from coast artillery; the experiments for the present being limited to calibres of 32-cm. (12·6-inch).

After trying a few types the trials are now being continued with a shrapnel having a steel casing, iron diaphragm, and base filling.

The casing has a movable ogival head, and the iron shot, which have a diameter of 1·89 inches, are arranged in layers which are kept in position by perforated discs. The projectile weighs about 593 lbs., and the experiments, so far as they have gone have given excellent results.