GARRISON GUN AND BARBETTE CARRIAGE; LOADING POSITION.

CONSTRUCTED BY THE FORGES ET CHANTIERS DE LA MEDITERRANÉE, HAVRE.

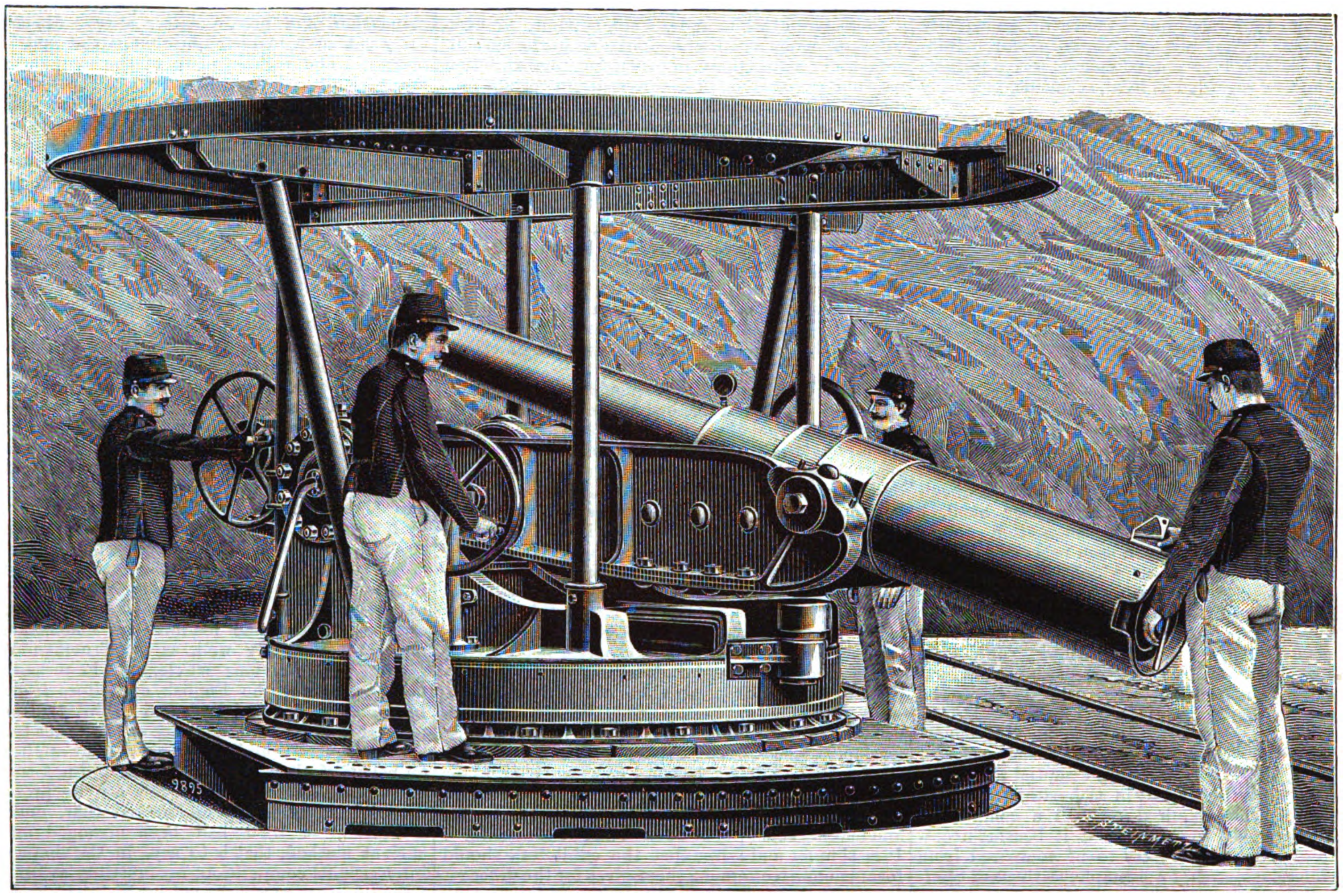

FIG. 289.

evening fêtes of an exhibition, and are in the habit of going home before setting out to dine and to enjoy themselves for the evening, also made up a considerable number. I would also point out that it would be unwise to encourage the admission to the Exhibition, just at the time when the surveillance is most difficult and the cost of management highest, of a crowd of idle folk of the less wealthy sort, who are set free after their day's work from the workshop or the counting-house about six or seven o'clock in the evening. The evenings of Sundays and special holidays ought to be enough for visitors of this last class.

As regards the question of the catalogue, I think that my suggestion is a good one. My plan is to ask each foreign commission to print its catalogue in a certain determined shape, in the language of the country where the exhibition is held. These catalogues would together form the general catalogue, the entries of which must be as short as possible, without advertisements of any sort. The profit of the sale should be divided, or perhaps, after the number of copies required for public purposes had been supplied gratuitously, each commission might undertake the sale of the portion of the general catalogue relating to its own section. In addition to the official catalogue, each commission would be free to publish in any shape, and under any conditions it thought fit, its own special catalogue in its own tongue.

I do not think that congresses held on the occasion of an international exhibition should be specially organised by existing societies, such as the French Society of Civil Engineers, or the English Society of Electricians. There is no reason why these important bodies should hold extraordinary sessions in connection with an exhibition, but it is above all essential that the congresses, which assist in forming an exhibition of ideas, side by side with an exhibition of industrial products, should be international, that is to say, they should be composed above all things of members representing the most competent authorities of each country on the subject with which each congress may deal.

Since the appearance of the article in the *Century* review, I have been a good deal occupied with the Chicago Exhibition by way of correspondence. I have not hesitated to point out to the organisers of that Exhibition, that they will have to concern themselves not only with the fiscal conditions in connection with the Exhibition, but also with the entire economic system of the United States as regards the duties to be levied on foreign imported goods. They will have to consider that European exhibitors will not show their wares unless they can be assured of finding sufficiently remunerative markets for those wares amongst the consumers of North America. They will also have to be assured that industrial and artistic property will be certain to enjoy in Chicago and in the United States that protection which is their due in the name of civilisation and of international loyalty. If those guarantees, which all the world has a moral right to demand, are provided, as I hope they may be, I have no doubt but that the participation of France will be full and brilliant, and with Sir Trueman Wood, I trust that this may also be the case with the participation of Great Britain.

MODERN FRENCH ARTILLERY.
No. XXVI.

FORGES ET CHANTIERS DE LA MEDITERRANEE—SIEGE AND GARRISON GUNS—*continued.*

A SPECIAL form of barbette mounting for garrison guns is shown by Figs. 289 to 295 (pages 4, 5, and 8); the length of the gun illustrated is 26 calibres of 15 cent., and its weight is 2.75 tons. It is mounted on a disappearing carriage which is furnished with a hydraulic brake and a compressed air apparatus for bringing the gun back into firing position. The gun is carried in bearings at the upper end of two swinging arms A A; these are of cast iron of the form shown, connected near the top with rigid bracing and turning below upon horizontal trunnions in the underframe. These trunnions are formed of two cylinders or drums B and B^1, which are cast in one piece with the arms A, and are held in suitable bearings in the standards F cast on the bedplate. In addition to this support the gun is further held by two parallel rods M, which are attached to the forward ring of the gun, and at their lower ends to a crosshead that slides in an arc cast on the front of the standard F of the underframe. On each side of this crosshead are two short levers *u* which are articulated to two levers C C that extend back to the prolongation of the arms A A beneath their axes. The underframe is carried on a pivot cast on the bedplate, and around its circumference it is supported upon steel balls, the whole being inclosed in a casing around the bedplate. To separate the balls from one another they are placed in holes made around a horizontal iron plate, the diameter of these holes being slightly larger than that of the balls. This plate turns around with the mounting and is supported by rollers placed between the balls and bearing upon the baseplate. In the perspective views, Figs. 289 and 290, it will be seen that the cover-plate is bolted to the forward part of the bedplate; this plate can be removed whenever it is desired to inspect the turning mechanism or to remove any of the balls. In the brake mechanism the cylinder is movable and the ram is fixed to the frame; the cylinder is placed horizontally between the standards F F^1 and is provided with blocks cast upon it which slide in gun-metal guides bolted to the bedplate. The ram H, Fig. 294, consists of a hollow bronze casting, and the discharge opening for the liquid is reduced by the counter rod *g* of variable section passing through it. The rear guide blocks on the cylinder have a provision made on them for attaching the ends of the two connecting-rods d d^1, Fig. 293; the other ends of these rods pass to the ends of the swinging arms. The two air-compressing cylinders for storing up the power of the recoil are shown at B B^1; each of these cylinders is divided into two parts by the plungers m m^1; the inner spaces in which the air is compressed are in free communication with each other by means of the pipes l l^1; the outer spaces which are filled with liquid are connected by the pipes i i^1, and the valve J, which

GARRISON GUN AND BARBETTE CARRIAGE; FIRING POSITION.

CONSTRUCTED BY THE FORGES ET CHANTIERS DE LA MEDITERRANÉE, HAVRE.

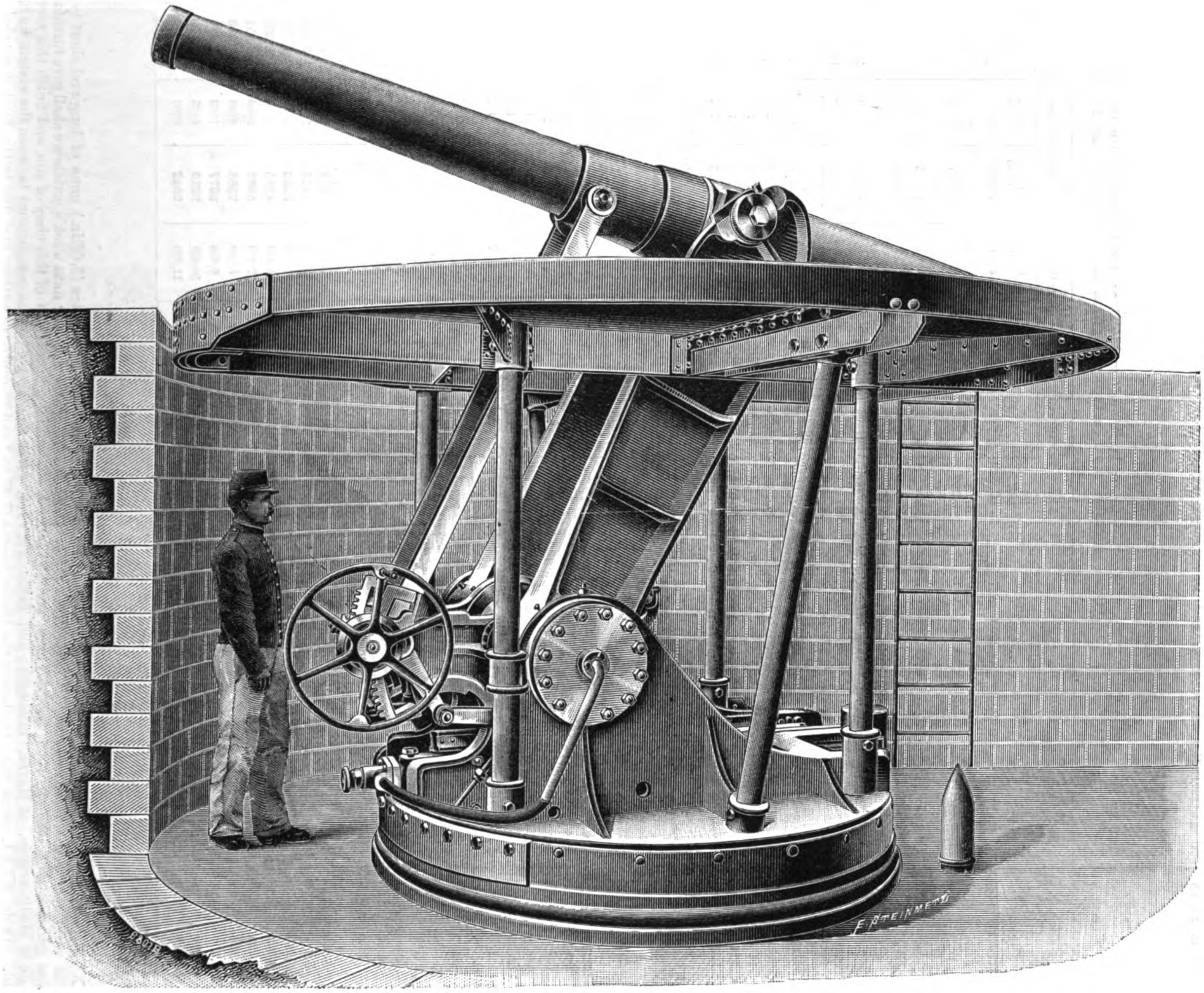

Fig. 290.

is shown in Fig. 295 to an enlarged scale, establishes a communication with the exhaust chamber of the brake apparatus. The valve J is held in its place by a Belleville spring inclosed in a case; communication can be established or cut off by means of the handwheel *p*. The operation of the mechanism is as follows: When the gun is in firing position as is shown in the perspective view, Fig. 290, the spindle *o* is screwed down hard upon the valve; when the gun is fired the force of recoil throws it back, the arms turning around the trunnions B B[1]; the levers C C[1] are forced forward and the brake cylinder is also drawn forward in the same movement between its guides, the ram of the cylinder entering it in consequence of this movement, and compressing the liquid which is driven through the orifice *h*, the area of which is constantly changing on account of the varying section of the controlling spindle, and thus maintaining a uniform resistance throughout the whole period of recoil. A small air pump is placed on one side of the frame, and serves as an auxiliary to the automatic action of the compressors; by means of this pump any pressure that may be desired can be maintained in the cylinders B B[1]. When a number of these barbette mountings are placed in the same battery, one pump suffices to maintain the pressure in all the accumulating cylinders; in this case the pump is placed in a suitable recess in the battery, and is connected by pipes to the different mountings.

The pressure set up is sufficient to raise the valve J and to compress the Belleville springs in the casing at the head of the valve, while at the same time the plungers in the drums are forced inwards, compressing the air between them; during the period of recoil the valve J is lifted, but as soon as the gun has fallen through the whole of its travel and has been received upon the buffer stops on the carriage, the valve falls, cutting off communication between the brake cylinders and the air compressors; the gun then remains held down in its lowest or eclipse position, as in Fig. 289. The operation of reloading having been completed, the gun can be raised to its highest or firing level; for this, all that is necessary is to release the valve by turning the handwheel and thus establish communication between the compressed air chambers and the brake. As soon as this is done the rams in the drums are forced outwards, and acting on the liquid in the brake the cylinder of the latter is moved slowly between its guides on the baseplate of the mounting, and the gun is thus raised into its highest position. When the maximum height, which is about 10 ft., has been reached, the gun can be held securely by again closing the valve and isolating the brake gear from the air compressors. In a special arrangement not shown in the illustrations, an electric circuit can be completed in such a way that on rising to its highest or firing position, or at any desired intermediate height, the gun may be discharged automatically; by this arrangement the men serving the gun are enabled to remain in shelter, and the rapidity of firing can be considerably increased. The mechanism for training the gun in elevation is clearly shown in the perspective views as well as in the details. As has been already explained, the lower ends of the two rods attached to the forward part of the gun are linked to a block that slides in a quadrant; in front of the latter and carried on brackets is a handwheel by which motion can be given through a system of differential gearing to a pinion that engages in the teeth of a rack on the face of the quadrant; it should be explained that the brackets carrying this gearing are mounted on the blocks to which the lower ends of the connecting-rods are attached, and that there are two sets of racks and gearing, one on each side of the block. On turning the handwheel the pinion mounts or descends the racks on the quadrants, raising or lowering the gun to a corresponding extent; on the face of the quadrants graduated scales are engraved to enable the man training the gun to set it to any desired angle. For horizontal training the carriage is turned round on its pivot and ball bearings by a lever. The

MODERN FRENCH ARTILLERY.

TABLE XXVII.—BALLISTICAL DATA OF CANET 16-CENT. COAST AND NAVAL GUNS. CONSTRUCTED BY THE FORGES ET CHANTIERS DE LA MEDITERRANEE, HAVRE.

Length of Gun			25 Calibres.		30 Calibres.		36 Calibres.		43 Calibres.		50 Calibres.	
			in.	mm.	in.	mm.	in.	mm.	in.	mm.	in.	mm.
Calibre			6.29	160	6.29	100	6.29	160	6.29	160	6.29	160
Total length of gun			157.5	4000	189.0	4800	226.8	5700	270.9	6880	315.0	8000
			tons	kilos.	tons	kilos.	tons	kilos.	tons	kilos.	tons	kilos.
Weight of gun			4.13	4200	5.66	5750	6.74	6850	9.05	9200	10.2	10,380
			lb.		lb.		lb.		lb.		lb.	
,, shell			110.2	50	110.2	50	110.2	50	110.2	50	110.2	50
,, powder charge ..			37.5	17	48.5	22	59.5	27	68.3	31	79.4	36
			ft.	metres	ft.	metres	ft.	metres	ft.	metres	ft.	metres
Initial velocity			1770	540	2000	610	2230	680	2424	740	2625	800
			foot-tons	m. tons	foot-tons	m. tons	foot-tons	m. tons	foot-tons	m. tons	foot-tons	m. tons
Striking energy			2400	742.99	3061	948.11	3807	1178.3	4508	1395.28	5270	1630.72
	yds.	m.	ft.	metres	ft.	metres	ft.	metres	ft.	metres	ft.	metres
Remanent velocities at	547	500	1642	501	1853	565	2066	630	2256	688	2455	749
	1094	1000	1522	464	1722	525	1919	585	2095	639	2290	698
	1641	1500	1414	431	1594	486	1776	542	1974	602	2138	652
	2188	2000	1311	400	1482	452	1649	503	1850	564	2003	611
	2735	2500	1223	373	1370	418	1528	466	1734	529	1881	574
			foot-tons	m. tons	foot-tons	m. tons	foot-tons	m. tons	foot-tons	m. tons	foot-tons	m. tons
Striking energy at	547	500	2064	639.55	2627	813.38	3267	1011.5	3895	1206.08	4613	1429.43
	1094	1000	1770	548.57	2268	702.29	2818	872.13	3359	1040.40	4010	1241.39
	1641	1500	1528	473.32	1943	601.83	2411	746.91	2961	923.40	3500	1083.16
	2188	2000	1315	407.68	1680	520.57	2082	644.77	2620	810.51	3073	951.22
	2735	2500	1144	354.50	1444	447.33	1754	543.41	2302	713.03	2710	839.50
Striking energy in foot and metric tons per inch and per cent. of circumference of projectile ..	At muzzle		122.4	14.93	156.1	19.05	194.7	23.74	229.8	28 04	268.7	32.77
	547	500	105.3	12.85	134.0	16.34	166.9	20.87	198.7	24.23	235.5	28.72
	1094	1000	90.35	11.02	115.6	14.11	144.0	17.57	171.3	20.90	204.4	24.94
	1641	1500	77.9	9.50	90.1	12.09	123.6	15.08	152.0	18.55	178.5	21.76
	2188	2000	67.1	8.19	85.8	10.46	106.4	12.99	133.4	16.28	156.6	19.11
	2735	2500	58.61	7.12	73.6	8.98	91.45	11.15	117.3	14.32	138.3	16.87
			in.	cm.	in.	cm.	in.	cm.	in.	cm.	in.	cm.
Thickness of wrought-iron plate penetrated (Gâvre formula)	At muzzle		9.80	24.9	11.69	29.7	13.66	34.7	15.39	39.1	17.21	43.7
	547	500	8.81	22.4	10.47	26.6	12.24	31.1	13.90	35.3	15.67	39.8
	1094	1000	7.91	20.1	9.45	24.0	11.02	28.0	12.48	31.7	14.17	36.0
	1641	1500	7.12	18.1	8.42	21.4	9.88	25.1	11.45	29.1	12.83	32.6
	2188	2000	6.37	16.2	7.63	19.4	8.89	22.6	10.43	26.5	11.69	29.7
	2735	2500	5.78	14.7	6.80	17.3	7.90	20.3	9.52	24.2	10.71	27.2
	deg.		yards	metres	yards	metres	yards	metres	yards	metres	yards	metres
Range at different angles	3		2,479	2,265	2,950	2,096	3,420	3,125	3,810	3,475	4,155	3,795
	5		3,689	3,370	4,508	4,120	5,030	4,595	5,514	5,040	3,955	5,445
	7		4,930	4,505	5,444	4,975	6,390	5,840	6,940	6,340	7,441	6,800
	10		6,440	5,885	7,308	6,675	8,115	7,420	8,645	7,900	9,305	8,505
	15		8,475	7,750	9,500	8,675	10,400	9,505	11,125	10,160	11,745	10,735
	20		10,050	9,195	11,220	10,255	12,520	11,445	12,980	11,855	13,620	12,445
	25		11,240	10,275	12,565	11,480	13,610	12,440	14,390	13,145	15,055	13,755
	30		12,050	11,010	13,580	12,405	14.650	13,390	15,450	14,115	16,125	14,735
	35		12,570	11,495	14,290	13,055	15,380	14,055	16,180	14,790	16,870	15,415

TABLE XXVIII.—BALLISTICAL DATA OF CANET 19 CENT. AND 22 CENT. SIEGE AND GARRISON GUNS. CONSTRUCTED BY THE FORGES ET CHANTIERS DE LA MEDITERRANEE, HAVRE.

—			19 cm. Short Gun.		19 cm. Long Gun.		22-cm. Short Gun.		22 cm. Long Gun.	
			in.	mm.	in.	mm.	in.	mm.	in.	mm.
Calibre			7.47	190	7.47	190	8.66	220	8.66	220
Total length of gun			134.6	3420	194.5	4940	155.9	3960	225.2	5720
			tons	kilos.	tons	kilos.	tons	kilos.	tons	kilos.
Weight of gun			3.296	3350	5.412	5500	5.117	5200	8.364	8500
			lb.		lb.		lb.		lb.	
,, shell			154.3	70	154.3	70	242.5	110	242.5	110
,, powder charge			23.1	10.5	39.7	18	36.4	16.5	63.9	29
			ft.	metres	ft.	metres	ft.	metres	ft.	metres
Initial velocity			1312	400	1705.6	520	1312	400	1705.6	520
			foot tons	m. tons	foot-tons	m. tons	foot-tons	m. tons	foot-tons	m. tons
Striking energy			1842.8	570.96	3114.2	964.94	2895.9	897.23	4893.4	1516.3
	yds.	metres	ft.	metres	ft.	metres	ft.	metres	ft.	metres
Remanent velocities at	547	500	1223.3	373	157.43	480	1236.5	377	1597.3	487
	1094	1000	1148.0	350	1466.0	447	1170.9	357	1499.0	457
	1641	1500	1092.2	333	1357.9	414	1118.3	341	1404.0	428
	2188	2000	1046.2	319	1262.7	385	1072.5	327	1318.5	402
	2735	2500	1007.0	307	1184.0	361	1036.3	316	1239.9	378
			foot-tons	m. tons	foot-tons	m. tons	foot-tons	m. tons	foot-tons	m. tons
Striking energy at	547	500	1602.4	496.48	2653.5	822.18	2575.6	797.01	4292.3	1330.0
	1094	1000	1410.95	437.14	2301.2	713.02	2306.6	714.69	3779.9	1171.2
	1641	1500	1277.20	395.71	1974.0	611.63	2017.2	625.07	3315.9	1027.3
	2188	2000	1172.0	363.13	1707.1	528.94	1935.2	599.62	2909.6	901.58
	2735	2500	1085.5	336.33	1500.9	465.05	1807.0	559.96	2586.0	801.25
Striking energy in foot and metric tons per inch and per cent. of circumference of projectile ..	At muzzle		79.29	9.67	134.0	16.34	107.6	13.12	181.88	22.18
	574	500	68.96	8.41	114.21	13.93	95.51	11.65	159.48	19.45
	1094	1000	60.67	7.40	98.96	12.07	85.7	10.45	140.47	17.13
	1641	1500	54.94	6.70	84.87	10.35	78.23	9.54	123.10	15.03
	2188	2000	50.48	6.15	73.39	8.95	71.92	8.77	108.16	13.19
	2735	2500	46.66	5.69	64.54	7.87	67.16	8.19	96.1	11.72
			in.	cm.	in.	cm.	in.	cm.	in.	cm.
Thickness of wrought-iron plate penetrated (Gâvre formula)	At muzzle		7.2	18.3	10.47	26.6	8.93	22.7	13.03	33.1
	547	500	6.53	16.6	9.33	23.7	8.22	20.9	11.85	30.1
	1094	1000	5.94	15.1	8.42	21.4	7.59	19.3	10.82	27.5
	1641	1500	5.54	14.1	7.55	19.2	7.12	18.1	9.88	25.1
	2188	2000	5.19	13.2	6.80	17.3	6.73	17 1	8.97	22.8
	2735	2500	4.91	12.5	6.21	15.8	6.37	16.2	8.26	21.0
	deg.		yards	metres	yards	metres	yards	metres	yards	metres
Range at different angles	3		1525	1395	2,313	2,115	1558	1425	2,378	2,175
	5		2395	2190	3,511	3,210	2455	2245	3,641	3,330
	7		3193	2920	4 560	4,170	3286	3005	4,757	4,350
	10		4243	3880	5,938	5,430	4385	4010	6,222	5,690
	15		5758	5265	7,825	7,155	5993	5480	8,251	7,545
	20		6999	6400	9,328	8,530	7305	6680	9,880	9,035
	25		7994	7310	10,510	9,610	8377	7660	11,170	10,215
	30		8778	8025	11,410	10.435	9213	8425	12,810	11,715
	35		9384	8580	12,040	11,010	9842	9000	12,838	11,740

perspective views, Figs. 289 and 290, show the shield by which the carriage and the men serving the gun are protected; it consists of an iron framing covering the pit in which the gun is placed, attached to the carriage and turning with it. Tables XXVI., XXVII., and XXVIII., contain full ballistical data of several of the calibres and types of the siege and garrison guns made by the Forges et Chantiers de la Mediterranée, at Havre, on the Canet system. Table XXVI. gives particulars of the long and short (4.72 in. and 5.90 in.) guns; Table XXVII. of those of 16-centimetre (6.29-in.) bore, and 25, 30, 36, 43, and 50 calibres in length; and Table XXVIII. gives similar particulars of the 19-centimetre (7.47 in.) and 22-centimetre (8.66 in.) guns of long and short types. In our next week's article we shall give further particulars of this class of gun, and finish this section with some comparisons between the system we have been describing and that in the English service.

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TABLE XXVI.—BALLISTICAL PARTICULARS OF SIEGE AND GARRISON GUNS (CANET SYSTEM) OF 4.72 IN. AND 5.9 IN. CALIBRES.

—			12 cm. Short Gun.		12 cm. Long Gun.		15 cm. Short Gun.		15 cm. Long Gun.	
			in.	mm.	in.	mm.	in.	mm.	in.	mm.
Calibre			**4.72**	120	**4.72**	120	**5.90**	150	**5.90**	150
Total length of gun			**85.0**	2160	**122.8**	3120	**106.3**	2700	**153.5**	3900
			tons	kilos.	tons	kilos.	tons	kilos.	tons	kilos.
Weight of gun			**8.367**	850	**1.378**	1400	**1.624**	1650	**2.71**	2750
			lb.		lb.		lb.		lb.	
" shell			**39.7**	18	**39.7**	18	**77.2**	35	**77.2**	35
" powder charge			**5.95**	2.7	**10.36**	4.7	**11.7**	5.3	**19.8**	9
			ft.	metres	ft.	metres	ft.	metres	ft.	metres
Initial velocity			**1312**	400	**1706**	520	**1312**	400	**1706**	520
			foot-tons	m. tons	foot-tons	m. tons	foot-tons	m. tns.	foot-tons	m. tons
Striking energy			**473.5**	146 69	**801.06**	248.12	**921.52**	285.42	**155.77**	482.46
	yds.	metres	ft.	metres	ft.	metres	ft.	metres	ft.	metres
Remanent velocities at	**547**	500	**1177**	359	**1519**	463	**1204**	367	**1551**	473
	1094	1000	**1086**	331	**1351**	412	**1113**	341	**1410**	430
	1641	1500	**1014**	309	**1213**	370	**1053**	321	**1289**	393
	2188	2000	**971**	296	**1112**	339	**1000**	305	**1184**	361
	2735	2500	**905**	276	**1036**	316	**954**	291	**1105**	337
			foot-tons	m. tons	foot tons	m. tons	foot-tons	m. tons	foot-tons	m. tons
Striking energy at	**547**	500	**381.66**	118.21	**635.1**	196.71	**775.7**	240.27	**1288.8**	399.19
	1094	1000	**324.5**	100.51	**502.9**	153.76	**669.7**	207.43	**1065.1**	329 91
	1641	1500	**282.8**	87.59	**405.6**	125.62	**593.7**	183.91	**890.4**	275.78
	2188	2000	**250.8**	77.62	**340.4**	105.45	**535.8**	165.96	**749.8**	232.53
	2735	2500	**225.6**	69.88	**295.8**	91.63	**487.7**	151.06	**654.1**	202.63
Striking energy in foot and metric tons per inch and per cent. of circumference of projectile	At muzzle		**31.89**	3.89	**51.45**	6.64	**49.69**	6.06	**84.83**	10.35
	547	500	**25.75**	3.14	**43.13**	5.26	**41.82**	5.10	**70.27**	8.56
	1094	1000	**22.06**	2.69	**34.19**	4.17	**35.26**	4.30	**58.05**	7.08
	1641	1500	**19.02**	2.32	**27.55**	3.36	**31.98**	3.90	**48.46**	5.91
	2188	2000	**16.89**	2.06	**23.12**	2.82	**28.86**	3.52	**41.00**	5.00
	2735	2500	**15.17**	1.85	**20.09**	2.45	**26.24**	3.20	**35.67**	4.35
			in.	cm.	in.	cm.	in.	cm.	in.	cm.
Thickness of wrought-iron plate penetrated (Gâvre formula)	At muzzle		**3.78**	9.6	**5.51**	14.0	**5.15**	13.1	**7.55**	19.2
	547	500	**3.23**	8.2	**4 64**	11.8	**4.56**	11.6	**6.61**	16.8
	1094	1000	**2.87**	7.3	**3.94**	10.0	**4.05**	10.3	**5.74**	14.6
	1641	1500	**2.60**	6.6	**3.38**	8.6	**3.78**	9.6	**5.07**	12.9
	2188	2000	**2.40**	6.1	**2.99**	7.6	**3.50**	8.9	**4.52**	11.5
	2735	2500	**2.20**	5 6	**2.72**	6.9	**3.27**	8.3	**4.05**	10.3
	deg.		yards	metres	yards.	metres	yards	metres	yards	metres
Range at different angles	**3**		**1487**	1360	**2,220**	2,030	**1504**	1375	**2,264**	2,070
	5		**2313**	2115	**3,335**	3,050	**2351**	2150	**3,417**	3,125
	7		**3067**	2305	**4,309**	3,940	**3128**	2860	**4,423**	4,405
	10		**4051**	3705	**5,632**	5,150	**4145**	3790	**5,763**	5,270
	15		**5462**	4995	**7,310**	6,685	**5598**	5120	**7,518**	6,875
	20		**6583**	6020	**8,666**	7,925	**6786**	6205	**8,940**	8,175
	25		**7523**	6880	**9,732**	8,900	**7737**	7075	**10,067**	9,205
	30		**8251**	7545	**10,527**	9,625	**8431**	7755	**10,924**	9,990
	35		**8764**	8015	**11,056**	10,110	**9044**	8270	**11,537**	10,550

THE PROJECTED JUNGFRAU RAILWAY.

By CHAS. KING.

WHEN, in the year 1872, the now world-famed railway up the Rigi was opened for traffic, probably few engineers imagined that within a decennium, the scheme, then for the first time practically worked out, would prove so profitable a source of revenue to the happy shareholders, that enterprising spirits, both in commercial and scientific circles, would look with confident anticipations towards other tourist-frequented points and compel them to accept within their domains that great agent of civilisation, the railway. In Switzerland this has especially been the case, and mountain railways almost too numerous to mention, have been and are being carried out. When, in June 1889, the Mount Pilatus Railway was opened for traffic, climbing, with gradients of 48 per cent., up to a height of 7000 ft. above the sea, it seemed that a climax had been reached and that future projects would hardly dare to take higher flights, and penetrate further into the secret hiding-places of nature to lay open to public gaze the ice-bound secrecy of the Alpine world. Those, however, who were of this opinion have been grievously disappointed, for in the autumn of last year there appeared, almost simultaneously, two plans for a railroad up to the very summit of the Jungfrau, perhaps the grandest and most majestic of the whole chain of Bernese Alps. From the valley of Lauterbrunnen, 2670 ft. above the sea, the mountain rises, a vast mass of snow and glacier, abruptly, and, as it seems almost perpendicularly, to a height of 13,670 ft. Although not the highest point of the range (for Finsteraahorn is upwards of 14,000 ft. high) the Jungfrau by reason of its colossal rugged mass, seems naturally to form the centre of attraction, and is not unfrequently ascended during the summer months by good mountaineers, attended by the most skilful guides. The usual route is from Lauterbrunnen, and the descent follows the course of the great Aletsch Glacier down into the canton of Valais. But as two guides and a bearer are required, the charges for which alone amount to 8*l*.—30*s*. per guide, and 20*s*. per bearer per day—and as the expedition requires the passing of at least one night on the mountain, to say nothing of the outlay for ice-axes, ropes, tent, &c., and further, as great danger is incurred by the sudden changes of weather so common in the Alps, when the "Folhn" sweeps down to carry all before it in its fury, meaning almost certain death to the unhappy traveller, under such circumstances, no wonder that the "Virgin" mountain has maintained her maiden purity, and her icy realms are even, at the end of the nineteenth century, almost untrodden by the foot of man.

Of the two projects previously mentioned, we now lay that of Herr Trautweiler, of Lucerne, before our readers. This gentleman is well known in Swiss technical circles as a gifted and experienced engineer, whose name is connected with the "Pfaffensprung" tunnel, on the St. Gothard Railway, with railway construction in Greece, and lastly, with the building of the lately opened railway over the Brünig Pass, between Lucerne and Meyringen. Further, as an enthusiastic member of the Swiss Alpine Club, he is well calculated to weigh earnestly and thoughtfully, the "pros and cons." of the case. As his report to the Federal Council says: "For a railway running to a height of over 13,600 ft., far above the lowest limit of perpetual snow, the circumstances demand a design which is affected neither by storm nor tempest, avalanche nor landslip; and this renders the task doubly difficult. On this account, therefore, it is absolutely necessary that we confine our operations to the *interior* of the mountain. As long as we are safely shut in by the rocks, we can go ahead confidently. The whole arrangement for forwarding passengers in tunnels presents itself then as an ordinary problem, which has been more than once solved, and in which engineering science is no novice." These few concise words give us in a nutshell the substance of the whole scheme. The profile of the mountain from the Lauterbrunnen valley is further, in many respects, most favourable to this plan, for being steep, the tunnels are not inordinately long, and auxiliary shafts can be driven at convenient places to lighten the labour of removing the rock, &c., and at the same time serve as a means of beginning operations on several spots as the same time, and so shortening the period of construction, and the loss of interest during that interval.

About two miles from Lauterbrunnen, at Stegmatten, 2850 ft. above sea level, the line will begin. It is divided into four sections, with a station at the end of each. The total length of line measured on the incline, is 21,460 yards, and the total height climbed is 10,700 ft. From this it follows that the last station is only some 120 ft. below the summit. Here, as well as at the intermediate halting places, shafts varying from 70 ft. to 350 ft. in length will be driven leading into the open air at comparatively sheltered spots, and thence footpaths must be made to the nearest points whence the views are the best, and these paths must be (daily if necessary) kept in a safe and passable condition. Further, of course, all passengers must follow the appointed guides, and no safety appliances will be neglected which might be of any use. The following Table gives the dimensions of the four sections of the railway:

—	Lower Station. Height above Sea.	Length of Tunnel.	Upper Station. Height above Sea.	Height Climbed.	Ruling Gradient. Tangent of angle of Elevation.
	ft.	ft.	ft.	ft.	per cent.
1st tunnel ...	2,850	4,530	6,070	3,220	98
2nd " ...	6,070	6,040	8,530	2,460	48
3rd " ...	8,530	6,170	11,940	3,410	67
4th " ...	11,940	4,720	13,550	1,610	33
		21,460		10,700	

As regards the first tunnel, although the shortest, it will be seen that it is by far the steepest, rising at an angle of almost 45 deg. The sketch map on the next page shows the route which the proposed line

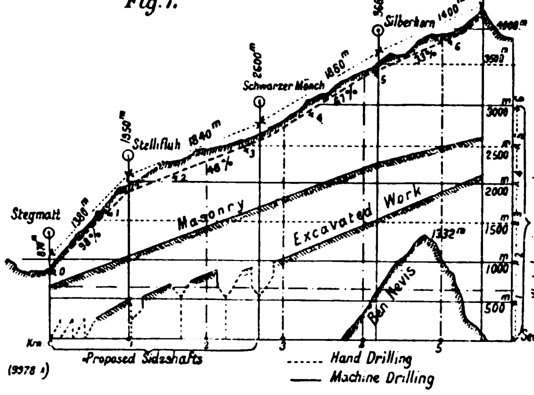
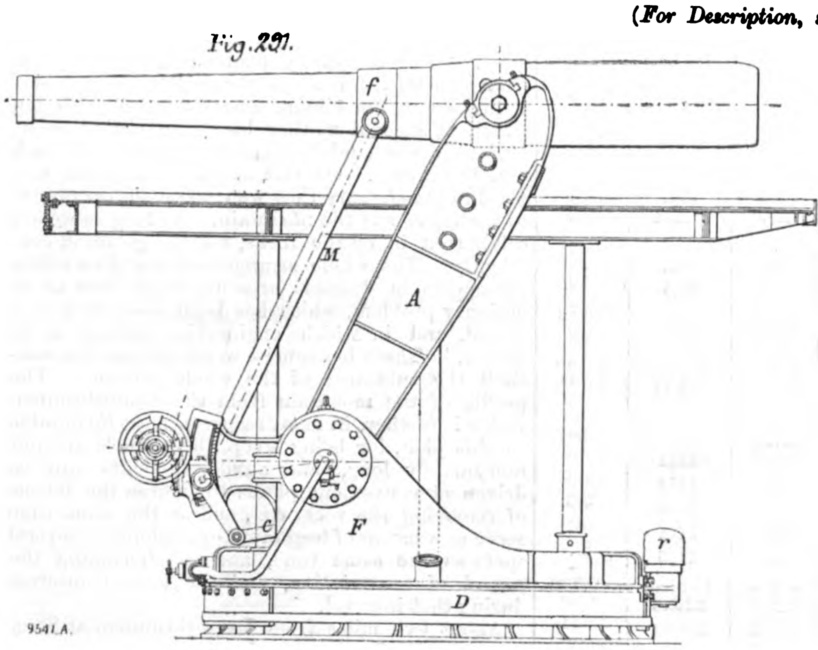


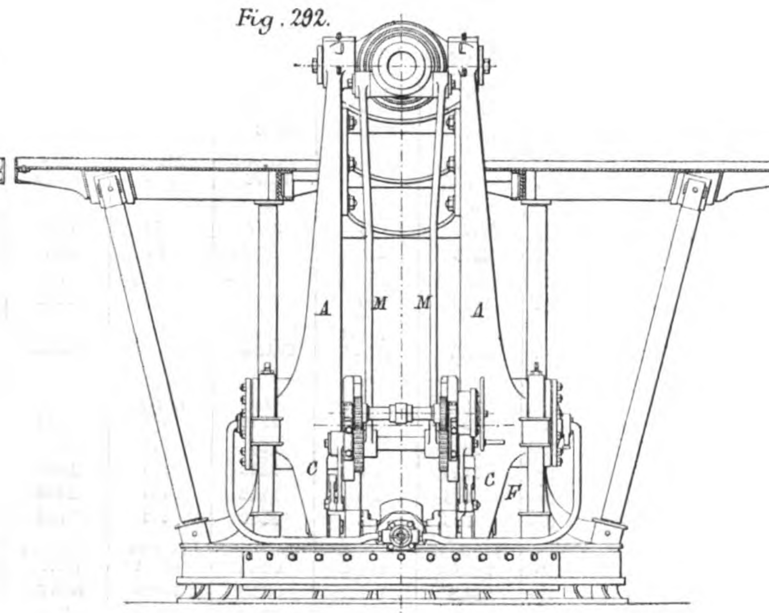
Fig. 1.

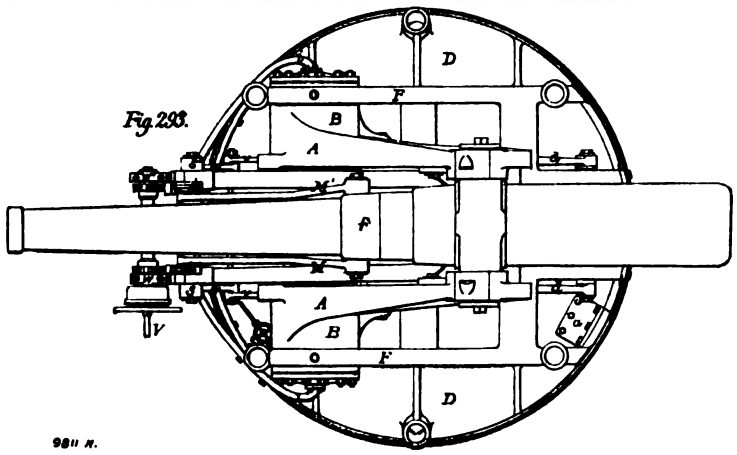
will take. As will be seen, the positions of the stations form a slightly curved line running in a south-easterly direction, the halting points being

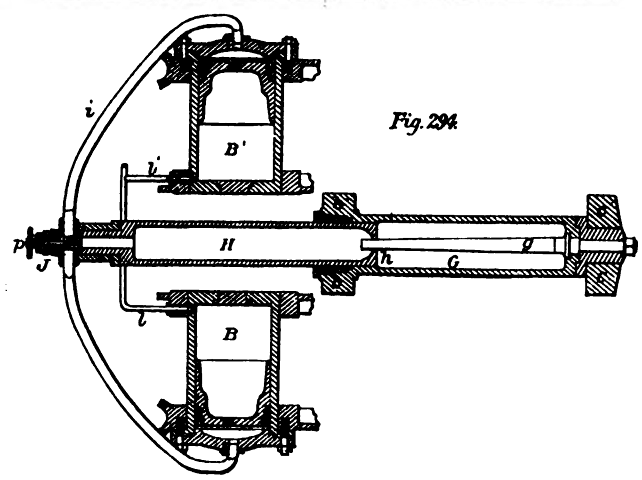
15-CENT. COAST DEFENCE AND GARRISON GUN WITH DISAPPEARING CARRIAGE.

(*For Description, see Page* 4.)



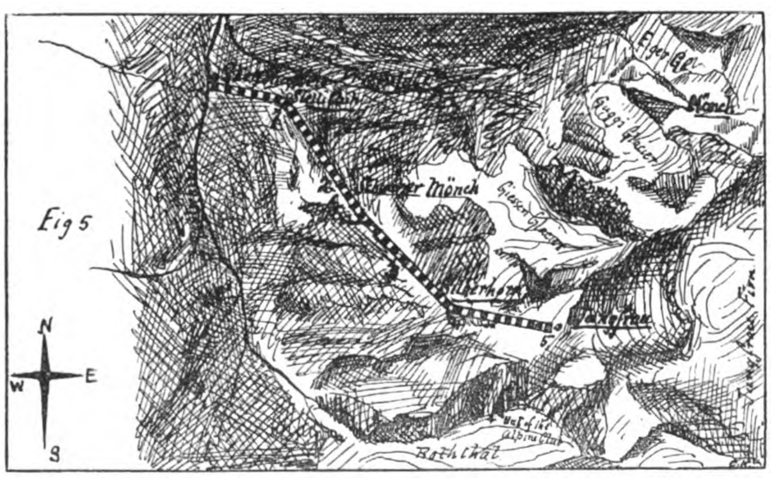






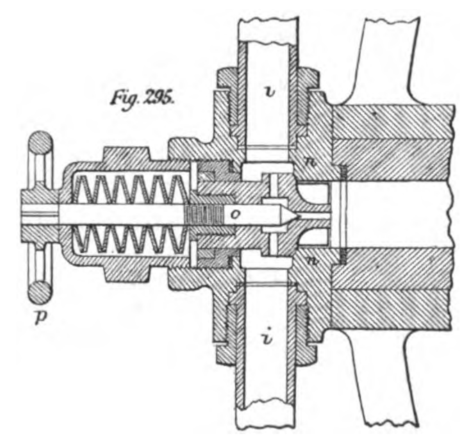
Stellifluh, Schwarzer Mönch, Silberhorn, and Jungfrau.

The section of the tunnel is comparatively small, the height measuring 8 ft. and the breadth 7 ft. 5 in., giving an area of only 59 square feet. As lining, cement blocks with a thickness of 8 in. are proposed, so that the total area of material to be removed is 71.5 cubic feet per foot of tunnel length. By retaining such small dimensions the excavating



work has been greatly reduced, the total being only 84,500 cubic feet, or about $\frac{1}{3}$ that of the great Gothard Tunnel. The breadth of the profile is so designed that, outside the rails, on each side, there is room for a man to pass, while along gradients of over 50 per cent. steps will be hewn out of the rock, and at convenient intervals niches will be provided, so that the members of the staff who are compelled to traverse the line on foot may be able to rest. In the middle of each section a double track with points will be laid for a short distance so that the carriages will be enabled to pass each other. The stations will afford accommodation for about 50 persons, exclusive of apartments for the servants of the line, and that at the summit will be provided with a restaurant and form a sort of hotel, offering the traveller all necessary comfort and ease. The projected total cost is expected to be not less than 240,000*l.*, and six years will be occupied in the construction of the line.

The summer season in Lauterbrunnen may be taken on the average to last 100 days, and during this short period practically the whole of the revenue must be earned. A short consideration will soon show us what the financial prospects are. The speed of the carriages will be limited to 1 metre per second, or about 66 yards per minute. Each carriage contains three compartments, and each compartment six seats, so that a running load consists of 18 passengers. As the entire journey at the above speed requires, including stoppages,



about two hours, it is calculated that a train could be sent off every 30 minutes, and as many would travel during the night hours so as to witness sunrise from the summit, it will be seen that 300 to 400 passengers could be despatched per day, giving for the season a grand total of 30,000 to 40,000 persons. In order, however, not to be accused of not looking at the dark side, when years of commercial depression, war, wet summers, &c., reduce the number of tourists very considerably, Herr Trautweiler contents himself with an annual total of 8000 passengers, 20 or 25 per cent. of the possible number, and the cost of a ticket being 65 francs, or 52s., we thus have a travelling revenue of 20,800*l.*, and in addition the bye sources of profit from the hotel and restaurant are by no means to be despised. From this we may infer that the shares of the company stand a good chance of being as high in favour on the Exchange as those of the Gothard, Rigi, or Pilatus Railways.

Five years are expected to be occupied in the construction, for with the exception of the first diameter have been put up, running from ten to twenty stamps each. In one of the mills the ore is pulverised dry, in all the others water is introduced to the stamps. The pulverised ore, in charges of 4 cwt., is passed to the calcining furnaces, where it is subjected at first to a moderate heat, increased later on. Towards the close of the operation, which lasts about three and a half hours, 12 per cent. of salt is introduced to effect the chlorination, when the mass is ready for amalgamation. The amalgamation was formerly carried on in copper kettles cast on the spot, and of a capacity of from 100 lb. to 150 lb. of calcined ore, but of late years wooden tubs (Fig. 4) run by steam machinery have been introduced, effecting a great economy; these tubs are from 5 ft. to 6 ft. in diameter by 3 ft. to 4 ft. deep, and are furnished with thick cast copper soleplates, similar segmental plates being also secured round the sides, while a vertical axle run by bevel gearing above causes three or four copper arms to revolve on the soleplate, the axle admitting of being raised and lowered to facilitate the cleaning up of the amalgam; the tubs have a capacity of from 2000 lb. to 4000 lb. of ore, and each operation lasts about six hours, during which steam, under a pressure of from 40 lb. to 60 lb., is injected to maintain as high a temperature as possible, 12 per cent. of salt being again employed in this part of the operation. The loss of silver by the old system of kettles was no less than from 25 to 30 per cent. of the assay contents of the raw ore, while by the employment of tubs it has been reduced to some 15 per cent. The amalgam being collected, washed, and pressed in cylindrical moulds, is strongly heated for some eight hours in vertical retorts until all the mercury distills off and is condensed in a vessel of water below, when the mass of spongy silver, or "piña," is ready for shipment. The total loss of mercury is from 4 oz. to 6 oz. for every pound of silver extracted, while the wear on the copper plates is rather more than double the weight of the silver.

Most of the Oruro ores contain from 5 to 20 per cent. of tin oxide; the tailings from the amalgamation are consequently washed, either by hand or with Frue vanners to extract this, when a product containing from 64 to 68 per cent. of metallic tin is obtained.

Precise data do not generally exist for determining the average silver contents of the lodes, but in the "Socavon de la Virgen" it has been ascertained that the silver extracted during the past two years represents 100 oz. to the ton on the total mass taken out.

The Oruro mines during the past few years have afforded an average of about 28 tons of picked ore per day, which with about one ton of rich ore exported brings up the total production to some 1,500,000 oz. yearly.

Traffic to the coast is chiefly carried on with mules and donkeys, the freight on imported goods being 17*l*. per ton, and on exports 12*l*. per ton, though these prices are subject to certain fluctuations.

The silver, though of greater value, represents but a small fraction of the tonnage yearly sent to the coast, the greater part of this being in the form of tin ore. The natives are excellent workmen and are easily managed, but owing to the increased number of mines opened up of late years labour has become scarce; a miner gains 3s. 6d. a day and is supplied with powder and fuze.

Materials in general are costly, especially machinery, owing to the heavy freight from the coast, but salt is comparatively cheap; this is brought on llamas from the deposits which exist further south on the tableland and is delivered at the mills for 2s. 6d. per cwt.; flour, grain, and other produce from the fertile valleys to the east are also supplied at very reasonable prices. In the San José Mine the total expenses range between 60 and 70 per cent. of the gross production.

MODERN FRENCH ARTILLERY.
No. XXVII.

SIEGE AND GARRISON GUNS—*concluded*.

It will be of interest to conclude our notice of the siege and garrison guns and carriages made by the Forges et Chantiers de la Mediterranée, with a general comparison of some of the mountings used in the English service with this class of gun; we take our information and illustrations from the Official Treatise on Military Carriages. Passing over the wooden carriages, which, although they are in the service, may be disregarded for present purposes, we come to the iron siege artillery mountings, particulars of which are given in the following Table:

TABLE XXVIII.—BALLISTICAL DATA OF 9 CENT. AND 10 CENT. (3.54 IN. AND 3.94 IN.) SIEGE CANET GUNS. CONSTRUCTED BY THE FORGES ET CHANTIERS DE LA MEDITERRANEE, HAVRE.

—			9-Centimetre Short Gun.		9-Centimetre Long Gun.		10-Centimetre Short Gun.		10-Centimetre Long Gun.	
			in.	mm.	in.	mm.	in.	mm.	in.	mm.
Calibre			**3.54**	90	**3.54**	90	**3.94**	100	**3.94**	100
Total length			**63.3**	1620	**92.1**	2340	**70.8**	1800	**102.3**	2600
			tons	kilos.	tons	kilos.	tons	kilos	tons	kilos.
Weight			**.3543**	360	**.5904**	600	**.4851**	490	**.807**	820
			lb.		lb.		lb.		lb.	
„ of shell			**167.5**	7.6	**167.5**	7.6	**167.5**	10 5	**167.5**	10.5
„ powder charge			**2.64**	1.2	**44.0**	2.0	**3.52**	1.6	**5.94**	2.7
			ft.	metres	ft.	metres	ft.	metres	ft.	metres
Initial velocity			**1312**	400	**1706**	520	**1706**	400	**2080**	520
			foot-tons	m. tons	foot-tons	m. tons	foot-tons	m. tons	foot-tons	m. tons
Energy at muzzle			**200.19**	61.99	**333.3**	104.76	**276 45**	85.62	**467.40**	144.74
	yds.	m.	ft.	metres	ft.	metres	ft.	metres	ft.	metres
Remanent velocity at	**547**	500	**114.80**	350	**1443**	444	**1153**	353	**1483**	452
	1094	1000	**104.0**	317	**1250**	381	**1053**	321	**1289**	393
	1641	1500	**69.12**	293	**1106**	337	**977.7**	298	**1145**	349
	2188	2000	**892.4**	272	**1010**	308	**912.01**	278	**1050**	320
	2735	2500	**833.4**	254	**933.4**	286	**85[illegible].0**	260	**9717**	298
			foot-tons	m. tons	foot-tons	m. tons	foot-tons	m. tons	foot tons	m. tons
Striking energy at	**547**	500	**153.2**	47.46	**246.6**	76.38	**215.27**	66.68	**353.07**	109.36
	1094	1000	**125.7**	38.93	**181.55**	56.24	**178.01**	55.14	**266.9**	82.67
	1641	1500	**107.4**	33.26	**142.05**	44.00	**153.4**	47.52	**210.5**	65.20
	2188	2000	**92.53**	28.66	**118.63**	36 75	**133.52**	41 36	**176.95**	54.81
	2735	2500	**80.68**	24.99	**102.30**	31.69	**116.8**	36.18	**152.81**	47.33
Striking energy per inch and per centimetre of circumference of shell	At muzzle		**18.12**	2.21	**30.59**	3.73	**22.14**	2.70	**38.21**	4.66
	547	500	**13.86**	1.69	**22.31**	2.72	**17.38**	2.12	**28.95**	3.52
	1094	1000	**11.40**	1.39	**16.40**	2.00	**14.35**	1.75	**21.81**	2.66
	1641	1500	**9.679**	1.18	**12.83**	1.57	**12.38**	1.51	**17.22**	2.10
	2188	2000	**8.364**	1.02	**10.74**	1.31	**10.82**	1.32	**14.43**	1.76
	2735	2500	**9.298**	0.89	**9.266**	1.13	**9.43**	1.15	**12.54**	1.53
			in.	cm.	in.	cm.	in.	cm.	in.	cm.
Penetration in wrought-iron	At muzzle		**2.52**	6.4	**3.66**	9.3	**2.87**	7.3	**4.28**	10.9
	547	500	**2.08**	5.3	**2.91**	7.4	**2.44**	6.2	**3.50**	8.9
	1094	1000	**1.81**	4.6	**2.32**	5.9	**2.13**	5.4	**2.87**	7.3
	1641	1500	**1.61**	4.1	**1.97**	5.0	**1.93**	4.9	**2.40**	6.1
	2188	2000	**1.45**	3.7	**1.73**	4.4	**1.73**	4.4	**2.13**	5.4
	2735	2500	**1.29**	3.3	**1.57**	4.0	**1.57**	4.0	**1.93**	4.9
	deg.		yards	metres	yards	metres	yards	metres	yards	metres
Range at angles of	**3**		**1572.4**	1315	**2111**	1930	**1465**	1340	**2,176**	1990
	5		**2220**	2030	**3139**	2870	**2275**	2080	**3,253**	2975
	7		**2920**	2670	**4024**	3680	**3007**	2750	**4,188**	3830
	10		**3827**	3500	**5156**	4715	**3959**	3620	**5,413**	4930
	15		**5112**	4675	**6676**	6105	**5315**	4860	**7,0[illegible]0**	6420
	20		**6146**	5620	**7874**	7200	**6408**	5860	**8,305**	7595
	25		**6972**	6375	**8803**	8050	**7283**	6660	**9,310**	8515
	30		**7612**	6960	**9498**	8685	**7966**	7285	**10,061**	9200
	35		**8087**	7395	**9963**	9110	**8475**	7750	**10,563**	9660

TABLE XXVII.—*Particulars of Iron Siege Artillery Carriages, &c., in the English Service.*

Nature.	Weight Empty.	Tonnage.
	cwt. qr. lb.	tons
6.6 in. R.M.L. hydro-pneumatic carriage	52 1 16	9.562
25-pounder R.M.L. carriage with top carriage	22 0 0	*1.567
40-pounder R.M.L. (34 cwt.) carriage, Mark I.	27 0 0	4 058
Ditto ditto Mark II.	32 2 0	4.058
40-pounder R.M.L. with top carriage	42 0 0	*1.039
6.3 in. R.M.L. (18 cwt.) howitzer carriage, Mark I.	32 2 0	4.058
6.6 in. R.M.L. (36 cwt.) howitzer carriage, Mark II.	32 2 0	
8 in. R.M.L. (70 cwt.) howitzer carriage, Mark I.	45 0 0	5.893
40 pounder limber, Mark I.	13 0 27	2.658

* Top carriage only.

Fig. 296 (page 36) illustrates one form of mounting for a 25-pounder gun when used for firing over a parapet 5 ft. 8 in. high; the maximum elevation is 35 deg., and the greatest depression attainable is 5 deg. The peculiarity of this arrangement is that the gun is mounted for firing on an upper carriage attached to the lower or ordinary one as shown. The extra height required for firing over the parapet is secured by two brackets each formed of plate and angle-iron stays spread out at the bottom and rivetted to a deep ⊥ iron bedplate; at the top these stays converge, and are stiffened round the trunnion bearing thus formed by a T iron rivetted to them. The brackets are connected together by four bolts, the lowest of which passes through a semicircular projection made on the ⊥ iron baseplate so as to fit the trunnion bearings on the lower carriage. The ends of this through bolt project sufficiently to receive the forward attachment of the top to the lower carriage. This attachment consists of a plate passed underneath the head of the lower carriage, and receiving four bolts, two on each side of the brackets; the upper ends of these holding-down bolts are made with eyes through which the bottom transverse bolt passes; the lower ends are held by nuts. At the rear the upper carriage is secured in place by clips passing over the baseplate and bolted to the frame. The figure shows the mode of elevating and depressing the gun; a toothed arc is secured to it near the breech and the chase, and a toothed pinion gears into it, being driven by a wormwheel provided with a friction cone. Trunnion bearings for travelling are placed on the rear of the brackets, or the whole of the top carriage can be easily removed when desired.

Fig. 297 shows a 40-pounder siege gun carriage, as well as that used for the 6.6 in. howitzer for siege purposes, the difference for the latter consisting in the addition of a brake. The mounting very closely resembles that for the field guns already described, and the training mechanism consists of a toothed arc fastened to the gun and raised or lowered by a worm with an intermediate pinion. The brake is the only feature of interest calling for description. It consists of a horizontal cylinder fixed to the carriage and containing a piston, the rod of which is anchored to the parapet when the gun is placed in position. When the carriage recoils the oil contained in the cylinder is forced from the front to the rear through small holes in the piston. The

TABLE XXIX.—THE FORGES ET CHANTIERS DE LA MEDITERRANEE: PARTICULARS OF SIEGE AND GARRISON GUNS (CANET SYSTEM, MODEL 1889).—CALIBRES, 24 CENT. AND 27 CENT.; 9.45 IN. AND 10.63 IN.

—			9.4 Short Gun.		9.4 Long Gun.		9.4 Short Gun.		9.4 Long Gun.	
Calibre			in. **9.45**	cent. 24	in. **9.45**	cent. 24	in. **10.63**	cent. 27	in. **10.63**	cent. 27
Total length of gun			ft. in. **14 2.03**	metres 4.320	ft. in. **20 5.67**	metres 6.240	ft. in. **15 11.54**	metres 4.860	ft. in. **23 0.38**	metres 7.020
Weight of gun			lb. **14,903**	kilos. 6760	lb. **24,912**	kilos. 11,300	lb. **21,208**	kilos. 9620	lb. **35,575**	kilos. 16,140
,, shell			**308**	140	**308**	140	**440**	200	**440**	200
,, powder charge ..			**46.2**	21	**79.4**	36	**66**	30	**114.6**	52
Initial velocity			ft. **1312**	metres 400	ft. **1705**	metres 520	ft. **1312**	metres 400	ft. **1705**	metres 520
Striking energy			foot-tons **3686**	m. tons 1141.9	foot-tons **6229**	metre tons 1929.8	foot-tons **5266**	m. tons 1631.3	foot-tons **8920**	m. tons 2763.3
Remanent velocities at	yds. **547**	metres 500	ft. **1240**	metres 378	ft. **1604**	metres 489	ft. **1250**	metres 381	ft. **1614**	metres 492
	1094	1000	**1177**	359	**1512**	461	**1191**	363	**1523**	466
	1641	1500	**1128**	344	**1424**	434	**1141**	348	**1450**	442
	2188	2000	**1086**	331	**1338**	408	**1102**	336	**1374**	419
	2735	2500	**1050**	320	**1266**	386	**1066**	325	**1302**	397
Striking energy at	**547**	500	foot-tons **3292**	m. tons 1019.8	foot-tons **5511**	metre-tons 1707.4	foot-tons **4777**	m. tons 1480.0	foot-tons **7952**	m. tons 2463.7
	1094	1000	**2969**	919.83	**4895**	1516.7	**4336**	1343.5	**7147**	2214.1
	1641	1500	**2726**	844.57	**4339**	1344.3	**3985**	1234.7	**6429**	1991.9
	2188	2000	**2524**	781.94	**3835**	1188.1	**3715**	1151.1	**5778**	1790.0
	2735	2500	**2356**	729.99	**3437**	1064.9	**3479**	1077.9	**5186**	1606.9
Striking energy in foot and metric tons per inch and per cent. of circumference of projectile ..	At muzzle		**125.5**	15.31	**212.1**	25.87	**159.5**	19.45	**269.5**	32.87
	547	500	**112.1**	13.67	**187.6**	22.88	**144.8**	17.66	**240.3**	29.30
	1094	1000	**101.1**	12.33	**166.7**	20.33	**131.3**	16.02	**216.4**	26.39
	1641	1500	**92.8**	11.32	**147.8**	18.02	**120.7**	14.72	**194.7**	23.75
	2188	2000	**85.9**	10.48	**130.6**	15.93	**112.7**	13.75	**175.0**	21.34
	2735	2500	**80.4**	9.80	**117.1**	14.28	**105.3**	12.84	**157.1**	19.16
Thickness of wrought-iron plate penetrated (Gâvre formula)	At muzzle		in. **10**	cent. 25.4	in. **14.57**	cent. 37.0	in. **11.85**	cent. 30.1	in. **17.25**	cent. 43.8
	547	500	**9.21**	23.4	**13.31**	33.8	**11.06**	28.1	**15.51**	39.4
	1094	1000	**8.58**	21.8	**12.24**	31.1	**10.31**	26.2	**14.76**	37.5
	1641	1500	**8.07**	20.5	**11.22**	28.5	**9.72**	24.7	**13.70**	34.8
	2188	2000	**7.63**	19.4	**10.27**	26.1	**9.25**	23.5	**12.68**	32.2
	2735	2500	**7.28**	18.5	**9.52**	24.2	**8.81**	22.4	**11.73**	29.8
Range at different angles	deg. **3**		yards **1,569**	metres 1435	yards **2,406**	metres 2,200	yards **1,591**	metres 1455	yards **2,455**	metres 2,245
	5		**2,476**	2265	**3,690**	3,375	**2,532**	2315	**3,783**	3,460
	7		**3,324**	3040	**4,828**	4,415	**33,90**	3100	**4,969**	4,545
	10		**4,445**	4065	**6,332**	5,790	**4,576**	4185	**6,544**	5,985
	15		**6,080**	5560	**8,420**	7,700	**6,260**	5725	**8,754**	8,005
	20		**7,423**	6790	**10,099**	9,235	**7,653**	7000	**10,535**	9,635
	25		**8,518**	7790	**11,428**	10,450	**8,797**	8045	**11,946**	10,925
	30		**9,381**	8580	**12,441**	11,380	**9,705**	8875	**13,008**	11,895
	35		**10,029**	9170	**13,153**	12,030	**10,083**	9495	**13,948**	12,755

cylinder is 55 in. long and 6 in. bore; the rear end is closed with a solid cap and the front by a cap *b* provided with a stuffing-box, the detail of which is shown in Fig. 298; a trunnion is forged on each side of the cap. On the centre of the cylinder a trunnion ring *c* is shrunk; the front and centre trunnions are connected by a wrought-iron bar *d* on each side, and the centre trunnions are also connected by bars *g* and a steel bolt passing through wrought-iron brackets rivetted under the trail. The centre trunnions rest in bearings at the lower ends of the suspension bars *f*, which are hung to bolts held in brackets rivetted to the under side of the axle-tree. The piston working in the cylinder is 2 in. thick and has four holes .35 in. in diameter for the oil to pass; provision is made for emptying and filling the cylinder. Fig. 299 shows a similar arrangement for a 6.3-in. gun, but with the addition of a travelling brake F worked by a lever B and draw gear C D acting on the brake-bar carrying the blocks. The figure shows the hydraulic brake cylinder slung into position for travelling.

Figs. 300 to 306 illustrate a hydro-pneumatic mounting for a 6.6 in. gun; the carriage consists of two steel brackets, the transom *b*, and the axle-tree *d*. The iron cylinder *g* is mounted on trunnions between the brackets, suitable bearings being provided on them. Within the cylinder is the hollow steel ram *h*, the upper end of which is forked (see Fig. 301) to receive the gun trunnions; the cylinder is closed at the bottom with a steel plug finished with a hemispherical projection, and inclosed in wrought-iron socket bearings. To the axle-tree of the carriage are hung long slotted arms *m*; these pass over the trunnions and allow the latter to slide within them, when the gun is shifted into the travelling position. The brake cylinder is shown in the section Fig. 301; it is surrounded by the outer chamber *g*, and this is connected with the cylinder by the recoil valve *i* and the by-pass valve *k* (shown in detail at Fig. 306) within the trunnions. When the gun is down in the loading position, the ram fills the cylinder as shown in Fig. 301, the chamber being filled with liquid and compressed air. The lever *a* is for opening the valve *k*, and when this is done the air forces the liquid under the ram, raising the gun into the firing position; when recoil takes place the oil is driven back into the chamber through the valve *i*, and the air is again compressed. The valve *k* is connected with an air-pump and gauge so that any desired pressure can be maintained within the chamber. As shown in Fig. 303, a pawl *l* is attached to the chamber that can be thrown into a recess in the ram to prevent the latter from rising unless desired. It will be seen in Fig. 300 that safety chains *w* pass from the side frames of the carriage to the top of the radial arms; these are to check any excessive rising movement of the ram. The elevating gear consists of two straight racks sliding in guides and raised or lowered by a pinion driven with a worm and friction gear. The racks are bolted to long straight bars *s* which are pinned to each side of the gun near the breech. The carriage illustrated is designed for firing over a parapet 7 ft. 3 in. high, and admits of a maximum elevation and depression of 12 deg. and 5 deg. respectively.

Fig. 307 illustrates the mounting for a 40-pounder breechloading gun for firing over a 6-ft. parapet; the carriage is of light angle-iron and plate-framing, the construction of which is clearly shown in the drawing, and the only detail to which attention need be called is the elevating gear shown in section in Fig. 308. It consists of an open frame A on which the gun rests, one end being pinned to the frame and the other to the head of the inner screw B which is 2 in. in diameter and .625 pitch, left-handed. This screw works within another C, 3 in. in diameter, and of the same pitch, but right-handed. This screw passes through the nut F secured to the bottom of a box casing, made with hollow trunnions, one of which works in a bearing on front of the transom of the carriage, and the other on one of the brackets. A pinion D rests on the top of the nut F, and the screw C passes through it. Slots and phosphor-bronze keys connect the screw and pinion, and the latter gears with the pinion E mounted on a horizontal spindle passing through one of the trunnions; a handwheel at the other end of this spindle is used to work the gear. Mountings of the same character and of steel are made for siege guns of 4 in., 5 in., and 6 in. guns. Fig. 309 gives a good idea of the Armstrong system of eclipse carriage for siege guns, which have been largely made at Elswick even for natures up to 70 tons. The gun is mounted in bearings in one end of a pair of long elevating levers, the other end being hinged to the frame in the pit; these levers are connected together and are attached to the end of a ram working in a cylinder on trunnions and placed between the main girders of the lower frame. The cylinder is arranged on the same principle as that above described, that is to say, the cylinder is in communication with a chamber into which the force of recoil drives the oil or other liquid, and compresses the air which is afterwards utilised for raising the gun into firing position. The pit is covered by a circular shield, so that the men working the gun are well protected.

In Tables XXVIII. and XXIX. we complete the particulars of the siege and garrison guns made by the Forges et Chantiers de la Mediterranée at Havre, and we shall now proceed to describe the mortars and howitzers made on the Canet system, and the various methods of mounting them.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

(FROM OUR NEW YORK CORRESPONDENT.)

(*Continued from page* 21.)

THE following day, May 17, opened with one of the most important subjects of the session, or at all events one of the most thoroughly discussed papers of the meeting; it was by W. F. Dixon on

THE EFFICIENCY OF LOCOMOTIVES.

The author decided that the shifting link valve gear was on the whole advantageous, although he recognised the two charges against it of, first, the slow opening of the ports for steam admission, and consequent wire-drawing and loss of pressure, and second, the early closing of the exhaust, creating an undue amount of compression.

He decided that with a well-designed link motion of liberal proportions the objection of wire-drawing has but little weight, and he also decided that although the clearance spaces in locomotive cylinders are usually larger than desirable, there is a limit pretty sharply defined below which it is not best to go in reducing them if the link motion is retained.

To overcome the evils of cylinder condensation and re-evaporation (1), steam-jacketting (2), superheating and (3), compounding have been suggested and tried.

That steam-jacketting the cylinders of a locomotive, taken by itself and not in connection with compounding, would result in some little saving, may be taken as certain, provided sufficient means of draining were used. The application of jackets to the cylinders of an ordinary locomotive by Mr. Borodin, of Kief, Russia, showed a mean economy of steam of about 13 per cent. This, however, is probably much greater than could be expected in regular day-in, day-out service, and it is still further probable that the expense of constructing and maintaining the jackets would more than neutralise the benefit derived.

Superheating the boiler steam, to the degree of increasing its pressure, before admitting it to the cylinders, has been tried several times in locomotive practice and as often abandoned. The chief difficulties met with were: (*a*) The expense of providing and keeping up the superheating apparatus; (*b*) the difficulty of lubrication, owing to the vapo-

ENGLISH SIEGE AND GARRISON GUNS.

(*For Description, see Page* 34.)

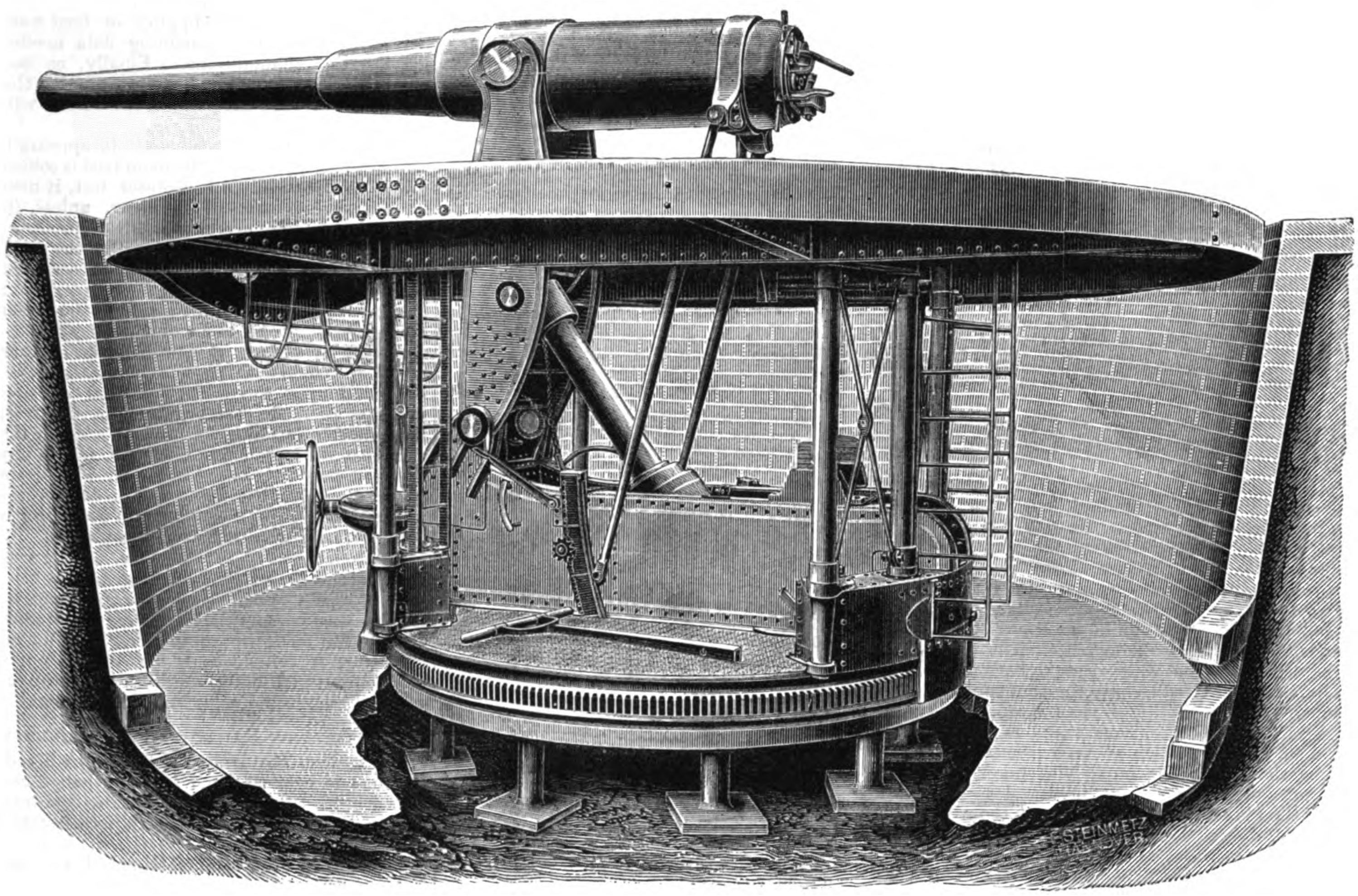
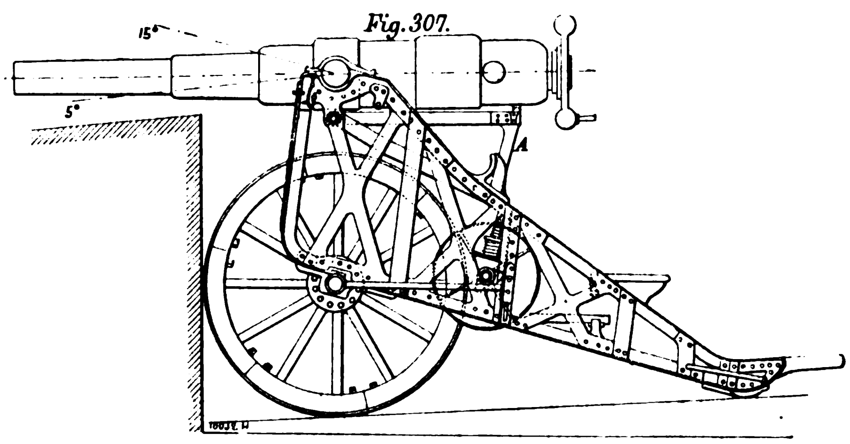
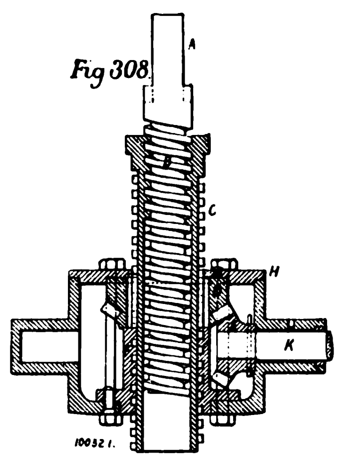


FIG. 309. ARMSTRONG SIEGE GUN ON DISAPPEARING CARRIAGE.





CARRIAGE AND BRAKE FOR 40-POUNDER BREECHLOADING SIEGE GUN.

risation of the lubricants at the high temperature; (*c*) the impossibility of preventing leakage at the stuffing-boxes, all vegetable packings charring with the heat and becoming worthless. Nor is it likely that the metallic packings, now so largely used, would be able to overcome this last difficulty, for, with a possible exception or two, their prominent features are steel springs and white metal rings. The springs would gradually lose their temper and become useless, while the soft rings, fusible at temperatures of from 250 deg. to 400 deg. Fahr., would melt.

The advantages claimed for compounding are two in number. First, economy in the use of steam and, consequently, fuel; and, secondly, a more uniform pressure on the cranks. The latter, although largely incidental, is held by some engineers, rightly or wrongly, to be the greater of the two, as a more uniform crank pressure, followed to a logical conclusion, means greater durability of parts, and a possible lengthening of the life of tyres, caused by the reduction of wheel slipping.

It is tolerably certain, though, that were this to begin and end the advantages derivable from compounding, the continuance in favour of the ordinary single-expansion engine, to the exclusion of the compound, would be assured. The economy shown by the compound locomotive is usually attributed to the lessening of cylinder condensation, due to reducing the range of temperature per cylinder. When engines with well-protected cylinders are running at high speeds, it is hard to understand how condensation can take place to any hurtful extent. Supposing that some small amount of steam, say 7 per cent., was condensed at each stroke, why expanding in two cylinders, one presenting twice the area of the other, should diminish it, is almost beyond comprehension. At slow speeds, however, the benefit of compounding is beyond dispute, as witness the success of the system both in marine and stationary work; but the bulk of the compound locomotives so far built has been for express passenger traffic.

Sir Frederick Bramwell claimed for a compound engine not so much economy in principle as that derived from the impossibility of the driver being able to dispense with high expansion. He must have it, whether he wanted it or not. The author did not, however, think this applied with the same force to American engines, since in them, many of the engines cannot be entirely handled with the reversing lever, and if an engine is obtained by compounding, which must be worked expansively irrespective of the shortcomings of the valve gear, good results would follow.

It may safely be stated that no locomotive built during the last twenty years has been deficient in adhesive weight after once getting its train well in motion, notwithstanding the slight and unreliable evidence adduced to the contrary. In other words the mean effective pressure in the cylinders when running at all fast is quite insufficient to cause the tractive force to exceed the adhesion. A feature of any substantial change in locomotive design will then probably be a method of increasing the coefficient of adhesion at starting, for although many devices tending to this end have been experimented with, we still, in default of something better, have to rely on mere dead weight, a large proportion of which is useless at other times, to get the trains away from the stations.

The author thought 60 per cent. a good showing of efficiency for a well-designed bituminous coal-burning boiler. This paper, as stated, was very fully discussed by the experts present, but there did not seem to be any conclusions reached. It would seem from this discussion that the locomotive was in an embryo state, or perhaps in one of transformation, and that it would develop later into a perfect machine. It was certain that none of the speakers entirely approved of any existing form of engine.

Reports.

The report of the condition of the Society showed a membership of 1183. The report of the committee to memorialise Congress in regard to some public recognition of the services of the late John Ericsson, member of this Society, showed progress, and it is to be hoped that their efforts may result in some substantial testimonial of the great inventor.

The report of the committee on "A Standard Method of Conducting Duty Trials of Pumping Engines" was then read.

The object stated was as implied by the title, it being designed to have a standard, not alone for making tests, but to be used in drawing contracts for construction. They attributed the variety of results due to the varied nature of the coal unit. They recommended the existing unit of 100 lb. of coal be abolished, and 1,000,000 heat units be used, or an evaporation of 10.355 lb. of water at 212 deg. per pound of fuel. They also thought the performance of the engine and of the boiler should be treated separately. They desired to have the heat supplied to the entire plant, including all the accessory parts of the engine, considered. They would retain the plunger displacement system of measurement, but would have the slip of the pump also taken into the account, so far as this is produced by the leakage of the plunger. They would omit the work of overcoming the friction of the water in passing through the passages and valves in the pump, but would include the work expended in friction of both the force and suction mains. The data to be determined apart from that relating to the plunger displacement are the indication of a pressure gauge attached to the force main, and that of a vacuum gauge attached to the suction main, and the vertical distance between the centres of the two gauges. No air should be allowed to enter the pump cylinders during the test.

The following are the formulæ:

1. Duty

$$= \frac{\text{foot-pounds of work done}}{\text{total number of heat units consumed}} \times 1{,}000{,}000$$

$$= \frac{A\,(P \pm p + s) \times L \times N}{H} \times 1{,}000{,}000 \text{ (foot-pounds).}$$

2. Percentage of leakage

$$= \frac{C \times 144}{A \times L \times N} \times 100 \text{ (per cent.)}$$

3. Capacity = number of gallons of water discharged in twenty-four hours

$$= \frac{A \times L \times N \times 7.4805 \times 24}{D \times 144}$$

$$= \frac{A \times L \times N \times 1.24675}{D} \text{ (gallons).}$$

4. Percentage of total frictions

$$= \left[\frac{\text{I.H.P.} - \dfrac{A\,(P + p + s) \times L \times N}{D \times 60 \times 33{,}000}}{\text{I.H.P.}} \right] \times 100$$

$$= \left[1 - \frac{A\,(P \pm p \times s) \times L \times N}{A_s \times \text{M.E.P.} \times L_s \times N_s} \right] \times 100 \text{ (per cent.)}$$

Or, in the usual way, where the length of the stroke and number of strokes of the plunger are the same as that of the steam piston, this last formula becomes:

Percentage of total frictions

$$= \left[1 - \frac{A\,(P \pm p + s)}{A_s \times \text{M.E.P.}} \right] \times 100 \text{ (per cent.)}$$

In these formulæ the letters refer to the following quantities:

A = Area, in square inches, of pump plunger or piston, corrected for area of piston-rod. (When one rod is used at one end only, the correction is one-half the area of the rod. If there is more than one rod, the correction is multiplied accordingly).

P = Pressure, in pounds per square inch, indicated by the gauge on the force main.

p = Pressure, in pounds per square inch, corresponding to indication of the vacuum gauge on suction main (or pressure gauge, if the suction pipe is under a head). The indication of the vacuum gauge, in inches of mercury, may be converted into pounds by dividing it by 2.035.

s = Pressure, in pounds per square inch, corresponding to distance between the centres of the two gauges. The computation for this pressure is made by multiplying the distance, expressed in feet, by the weight of one cubic foot of water at the temperature of the pump well, and dividing the product by 144; or by multiplying the distance in feet by the appropriate quantity, found in the following Table. The quantities in this Table are computed from the weights of one cubic foot of water at the various temperatures, as given by D. K. Clark in his "Rules and Tables," which also correspond to Charles T. Porter's figures in his work on the "Richards' Steam Engine Indicator."

Temperature of Water in Pump Well. Deg. Fahr.	Weight of 1 Cubic Foot of Water divided by 144.
32	.4335
35	.4335
40	.4335
45	.4334
50	.4333
55	.4332
60	.4331
65	.4329
70	.4327
75	.4325
80	.4322
85	.4319
90	.4315
95	.4311
100	.4307
105	.4303
110	.4298

L = Average length of stroke of pump plunger in feet.

N = Total number of single strokes of pump plunger made during the trial.

A_s = Area of steam cylinder, in square inches, corrected for area of piston rod. The quantity, A_s × M.E.P. in an engine having more than one cylinder, is the sum of the various quantities relating to the respective cylinders.

L_s = Average length of stroke of steam piston in feet.

N_s = Total number of single strokes of steam piston during trial.

M.E.P. = Average mean effective pressure, in pounds per square inch, measured from the indicator diagrams taken from the steam cylinder.

I.H.P. = Indicated horse-power developed by the steam cylinder.

C = Total number of cubic feet of water which leaked by the pump plunger during the trial, estimated, from the results of the leakage test.

D = Duration of trial in hours.

H = Total number of heat units [B.T.U.] consumed by engine = weight of water supplied to boiler by main feed pump × total heat of steam of boiler pressure reckoned from temperature of main feed water + weight of water supplied by jacket pump × total heat of steam of boiler pressure reckoned from temperature of jacket water + weight of ony other water supplied × total heat of steam reckoned from its temperature of supply. The total heat of the steam is corrected for the moisture or superheat which the steam may contain. For moisture, the correction is subtracted, and is found by multiplying the latent heat of the steam by the percentage of moisture, and dividing the product by 100. For superheating the correction is added, and is found by multiplying the number of degrees of superheating (*i.e.*, the excess of the temperature of the steam above the normal temperature of saturated steam) by 0.48. No allowance is made for heat added to the feed water, which is derived from any source, except the engine or some accessory of the engine. Heat added to the water by the use of a flue heater at the boiler is not to be deducted. Should heat be abstracted from the flue by means of a steam reheater connected with the intermediate receiver of the engine, this heat must be included in the total quantity supplied by the boiler.

The total and latent heats may be found by reference to the Tables of the Properties of Saturated Steam, from Charles T. Porter's treatise on the "Richards Steam Engine Indicator." The pressures given are reckoned from zero Fahrenheit. To convert the gauge pressure to that referred to the zero basis, the barometric pressure is to be added to the corrected indications of the gauge. When the barometer indicates 29.92 in., the pressure to be added is 14.7 lb. per square inch. For other indications of the barometer, the corresponding pressure may be found by using the multiplier 0.491.

They would first subject the plant to a preliminary run under working conditions to determine the temperature of the feed water, or in case of more than one supply, of the several temperatures. The main test of the boiler and engine is then carried forward, and during this test the weights of the various supplies of feed water are determined, and the remaining data needed for making the computations. Finally, as soon as practicable after these tests are completed, the rate of leakage through the pump is measured, with the engine at rest.

As to the duration of the test, it appears to the committee that, so far as the main trial is concerned, which is practically a feed-water test, it need not be prolonged more than ten hours, unless, in that time, appreciable errors should be produced by inaccuracies in the observations of the height of water in the gauge glass. The duration of the boiler trial might, with good reason, be made longer, were it not that the results of the boiler test are independent of those of the duty trial. It is desirable to reduce, if possible, the number of hours of the trial to such a point that the time expended upon the work, including that required in preparation for the beginning of the test, and that spent in bringing the test to a close, shall be such that the same expert, without undue physical exertion, may have the test under his continuous supervision from beginning to end. This is feasible, where the length of the duty trial, according to the plan proposed, does not exceed ten hours.

The report was quite elaborate, and space only permits the foregoing general glance at it. The Society were so pleased with the committee's work that it was unanimously resolved to continue it, and then as an incentive to other work of similar character, a committee of seven was appointed to examine and determine the comparative economy of simple and compound locomotives.

Working of Railroads by Electricity.

The author, Mr. Wallis E. Hall, predicted that the time is near at hand for the change contemplated in his title. He thought the concentration of power a great gain and would locate stations 30 to 40 miles apart.

The question of attainable speed enters as a factor for the speed to which an engine can safely be driven is known to have its limits—and which, to all appearances, we are now closely approaching. The piston speed of an engine with 24 in. stroke and 68 in. diameter of driving wheels, travelling at 60 miles per hour, would be about 1400 ft. per minute. An increase in the diameter of driving wheels, with the object of decreasing the number of strokes, makes the engine correspondingly weaker, so that two sharp horns of a dilemma are placed before him who attempts to design an engine to haul the increasing weight of trains at a high speed. The questions of parts and velocity of steam are mentioned in passing. The resistance of trains is now quite positively known to increase about with the square of the velocity which would enter as a function in the power to be given to a motor to drive a train at a desired speed. With such a means, however, the speed is limited only by the power which is given in its design, and is determined more by what the conditions of the service will stand.

With electric motors it would not be necessary to have track tanks and water standpipes distributed closely throughout the line, which means considerable trouble and expense for maintenance, attention, and repairs (especially through the winter season). The delay, too, where freight engines are not equipped with water scoops, is apparent; and even this latter method of filling tanks is beginning to show its effects upon the schedule which it is possible to make on lines which are worked closely to their limit. Nor would it be necessary to carry the dead weight of tender with contained water, which is hardly as easy an accompaniment as its name would imply. In this connection it might be well to mention the annoyances from cleaning fires, as is required in freight service where the division is a long one. As all trains would not be climbing heavy grades at the same time, he believed a 60 horse-power engine could supply an equivalent for 100 horse-power.

This paper received considerable handling, but the chief attack was made by a gentleman who submitted data so evidently compiled in haste and so full of palpable errors that the force of his argument was entirely lost. The general tone of discussion was, however, against electricity on long lines as an economic factor.

Several papers were then read which may be very briefly noticed. Professor Carpenter presented two papers, one on the "Comparative Test of a Hot Water and a Steam Heating Plant." This showed the steam used 22.5 per cent. more coal than the hot water. The other paper was on the "Use of Kerosine in a Steam Boiler," and showed the oil prevented scale, and that now in the boilers was softening and disappearing; also that the oil tended to preserve the parts and acted in a cleansing manner on the steam traps and pipes. They used about 2 dols. worth of oil per annum.

Following this came "Determination of the Sensitiveness of Automatic Sprinklers," by Mr. A. F. Nagle. This was written to correct errors about the temperature at which sprinklers work. The oven test, by placing them in an oven and raising the temperature, is the common method; this is affected by the size of the oven, and the question of time is not taken into account. The thermometer he also found a source of error. The latter should be carefully tested, and its time of action noted. The area of the oven should be calculated, and what Mr. Nagle termed thermal minutes determined. Professor Jacobus described at length the tests demanded by the New York Board of Fire Underwriters, extracts from which may be condensed into the following:

1. Tests in the oven to determine sensitiveness and reliability of action.
2. Tests by applying direct flame at intervals to the head, to determine reliability of action.
3. Tests of distribution and rate of flow of water through the heads.

The most prevalent and dangerous defect usually found in sprinkler heads is the sticking of the valve to its seat after the releasing device has operated. To test the heads thoroughly in this respect the first and second tests, in addition to being made on the new heads, are repeated on heads that have been connected to piping and subjected to the action of water and of brine for about three months. The action of the water and brine for three months has caused the valves of many heads to stick, so that they would not open under ordinary pressure.

Professor Jacobus's discussion was in reality a paper on this subject, and was well presented and listened to with much interest.

(*To be continued.*)

MISCELLANEA.

SOME settlement has taken place at the Hawkesbury Bridge, New South Wales, one of the piers having moved 4 in. No fears as to the safety of the structure are, however, entertained.

The gross receipts of the twenty-three principal railways in the United Kingdom for the week ending June 2, amounted, on 16,187 miles, to 1,448,44*l*., and for the corresponding period of 1889, on 16,059½ miles, to 1,412,077*l*., an increase of 127¾ miles, or 0.7 per cent., and an increase of 36,367*l*., or 2.5 per cent.

Messrs. Hayward Tyler and Co., hydraulic engineers, ask us to state that owing to the renumbering of the houses in the street, their London address is now 90 to 92, Upper Whitecross-street, though this change implies no alteration in the position of their offices, which are in the same place they have occupied for so many years.

The drawings and plans for a new heavily-armoured battle-ship, to be constructed at Chatham, have been received at that dockyard from the Admiralty. The new vessel is to be named the Barfleur, and she is to be hastened forward in her construction in order to be ready for launching in the course of the ensuing year.

We may remind intending competitors that in connection with its Doncaster meeting of 1891, the Royal Agricultural Society of England is offering a first prize of 100*l*., a second prize of 50*l*., and a third prize of 25*l*. for the best combined portable thrashing and finishing machine, to be worked by steam, and adapted to the preparation of corn for market, and that the entries for this competition close on Friday, the 1st August next.

Dr. Elliott, of the University of Edinburgh, out of a total of 39 candidates, has been appointed professor of engineering at the University College of South Wales and Monmouthshire. He will enter upon the work of the organisation of his department, planning out the necessary buildings, &c., at once. Dr. Turpin, who is a graduate of the University of London, and a first-class man in the natural science tripos at Cambridge, has been appointed lecturer and demonstrator in chemistry at the same college.

An article in the Allahabad (India) *Pioneer* gives some interesting particulars concerning the tunnel that has just been completed through the Khojak on the railroad from Quetta to Candahar. The Khojak Pass is 7500 ft. above the sea and about 2000 ft. above the level of the surrounding country. The tunnel pierces the range at right angles, and its course is therefore due east and west. It enters the hill about 1000 ft. below the crest of the pass. The length of the tunnel is 12,600 ft., or 2⅓ miles approximately, and it will carry a double line of rails.

A company has recently been formed with the object of constructing a Metropolitan Railway at Vienna. It is proposed to serve the suburban districts in four lines, which will connect these localities with one another, and with the stations of the Austrian main lines. The new lines are to be either underground or on viaducts as circumstances dictate, but level crossings are everywhere to be avoided. The capital required is put down at 35,000,000 florins, and to insure the raising of the capital and the success of the scheme, the company ask to be exempted from taxation, both by the Government or the municipality for a period of thirty-five years.

During the recent gas strike in Leeds, which left the town in darkness, Mr. Wilson Hartnell, of the Volt Works, Leeds, did a smart piece of work in lighting throughout the works of the *Yorkshire Post*. At one o'clock in the day excavations were commenced in the basement of the building to provide room for the driving pulley and the necessary foundations for the dynamo. Countershafts and pulleys had to be turned and bored for the driving belts; and at 10.50 p.m. the dynamo started running with forty lamps of 50 candle-power, twenty lamps of 20 candle-power in the composing room, and six 100 candle-power lamps in the machine room.

Some six months ago the Birmingham and District Association of Foremen and Draughtsmen was organised, and it has since met with a very gratifying success. During this period papers have been read "On the Modern Direct-Acting Pump," by Mr. J. Floyd, and "On the Locomotive," by Mr. C. O'Brien, both of which led to interesting discussions. The Association already numbers sixty-five members, and five candidates are still awaiting admission. For the benefit of our Birmingham readers we may state that the secretary is Mr. C. O'Brien, of 15, Fulham-road, Spark Hill, Birmingham, and from him full information of the objects and scope of the Association can be obtained.

The unopposed Bill Committee of the House of Commons on Wednesday last passed the Bill which confirms the provisional orders recently granted by the Board of Trade for the electric lighting of a portion of the parish of St. Mary, Lambeth, the parish of Islington, and the parishes of Clapham, Wandsworth, and Putney. The powers for the electric lighting of these parishes are all conferred upon the House to House Electric Light Supply Company. Provisional orders were also conferred for lighting the parish of St. James's, Westminster, by the St. James's and Pall Mall Electric Light Company, and the whole of the parish of St. George-the-Martyr, Southwark, and a portion of the parish of Camberwell by the London Electric Supply Corporation.

On Wednesday last, Professor T. M'Kenny Hughes delivered a lecture at the Mansion House, on "Is there Coal in the South-east of England?" in the course of which, he laid before the meeting the evidence on which geologists relied, when they stated that there was a strong probability of the coal basins extending right across the south of England. In the discussion which followed the lecture, Mr. W. Whitaker referred to the Government boring at Chatham, which has now been carried down to a depth of 1000 ft., and stated if coal was found within the next 400 ft. or 500 ft., the product would not go into private pockets, but into the public purse. He further suggested that the Essex marshes at the mouth of the Thames might be used for experimental borings, for in that locality there was no scenery to be spoilt by the workings.

The new quick cruiser Barham made a second attempt on Wednesday morning at Portsmouth to complete her contractors' eight hours' machinery trial with open stokeholds. At the previous trial the thrust-block bearings displayed such a degree of weakness that it was found necessary to prematurely cease steaming. In the mean time the supports to the bearings had been stiffened and several feet added to the height of the funnels. The alterations answered their purpose admirably, but in other respects the trial proved a failure. During the third hour, when a speed of about 17 knots had been realised with an inch of air pressure in the stokeholds, and when the engines were exerting more than their contract power, the tubes of several of the boilers began to leak, and the ship returned into harbour. The Barham will not be ready for further trial for some time.

Mr. Bernhofer, an Austrian engineer, has recently tried the effect of adding crystallised soda to Portland cement mortar and exposing the same to the action of frost. The mortar consisted of 1 litre of cement, 1 litre of lime, with 3 litres of river sand, mixed with a solution of 1 kilogramme of crystallised soda in 2 litres of water. The experiment commenced at 7.30 p.m. on December 9th, 1890, and lasted till 10 a.m. on December the 10th, a period of 14½ hours. During the night the temperature fell to 31½ deg. below zero, and at the finish of the experiment was still 15¾ deg. below zero (Cent.), at which time the specimens were placed in a hot oven where they remained for three hours. At the expiration of this time it was found the extreme cold had had no disadvantageous effect on the setting of the specimens, and the experimenter accordingly concludes that the addition of soda enables Portland cement to withstand the action of frost.

Some interesting experiments with the Brennan torpedo were carried out last week on the coast of the Isle of Wight. An old collier brig of about 500 tons burden was taken in tow by H.M.S. Seahorse and towed at a speed of about 10 knots an hour past the torpedo station. As the brig passed this point the torpedo was launched at it and rapidly approached its object, and on nearing the vessel somewhat astern of it, turned and followed it, finally striking it on its starboard quarter. As the weapon contained 300 lb. of blasting gelatine the destruction of the brig was very complete. The Brennan torpedo has already been described in our columns, but we may repeat here that it is driven by two fine steel wires which are coiled upon drums inside it. When the torpedo is launched these wires are wound upon two drums 4 ft. in diameter by a 100 horse-power engine on shore. In this way the drums inside the torpedo are set rotating and actuating the screws which propel it forward. The steering is effected by modifying the speed at which either wire is wound up on shore.

The quantity of coal brought to London by rail and canal during the month of June was 602,748 tons, and by sea 380,026 tons. For the same month last year the quantities were respectively 474,921 tons and 289,873 tons. For six months to date the quantity brought by rail was 4,081,203 tons, as against 3,820,998 tons in the corresponding period last year, while the quantity brought by sea was 2,463,665 tons, as against 2,357,090 tons. The total imports of coal into London during the last six months thus show the very large increase of 366,780 tons. This increased importation is fairly distributed between the different ports sending coal to London, whilst four of the principal coal-carrying lines—viz., Midland, North-Western, Great Eastern, and Great Western—divide between them the increased quantity brought by rail. The prices for coal have been very high during the six months, the average being 19s. 1d., although the duty payable to the City authorities is 9d. per ton less than in the corresponding period of last year, when the average price was 16s. 4d.

Mr. Von Borries' rule for the diameter of the low-pressure cylinder of a compound locomotive is:

$$d^2 = \frac{2\,Z\,D}{p\,h},$$

where d = diameter of low-pressure cylinder in inches, D = diameter of driving wheel in inches, p = mean effective steam pressure per square inch (after deducting internal machine friction), h = stroke of piston in inches, Z = tractive force required, usually 0.14 to 0.16 of the adhesion. The value of p depends upon the relative volumes of the two cylinders, and from experience indicator experiments may be taken as follows:

Class of Engine.	Ratio of Cylinder Volumes.	p in Percentage of Boiler Pressure.	p for Boiler Pressure of 176 lb.
Large tender engine	1:2 or 1:2.05	42	74
Tank engines ..	1:2.15 or 1:2.2	40	71

Tenders are being invited by the New South Wales Government for the supply of pipes for the purpose of duplicating the existing line of water mains from Pott's Hill to Crown-street, Sydney. The tenders are to be alternative, one to embrace the portion of the line in wrought iron or steel, and the balance in cast-iron pipes. The other tender will be for cast-iron pipes alone. Of wrought-iron pipes, 4 ft. in diameter, 2500 tons will be required, in conjunction with 10,000 tons of cast-iron pipes, and these would be sufficient to make a continuous line from Pott's Hill to Sydney, composed of wrought and cast-iron pipes. If it should be determined to use cast-iron throughout, the total amount of pipes required will be 18,000 tons. Tenders will be received until October 15 of this year, and they are invited in the colonies, and from all parts of the world. The contract for the supply must be completed within ten months from the date the tender is accepted, and it is expected that the laying of the pipes will occupy six or eight months after this date. Special provision has been made for the shipment of certain pipes and "specials," whereby the laying of the duplicate line may be commenced immediately after the arrival of the first shipment of material.

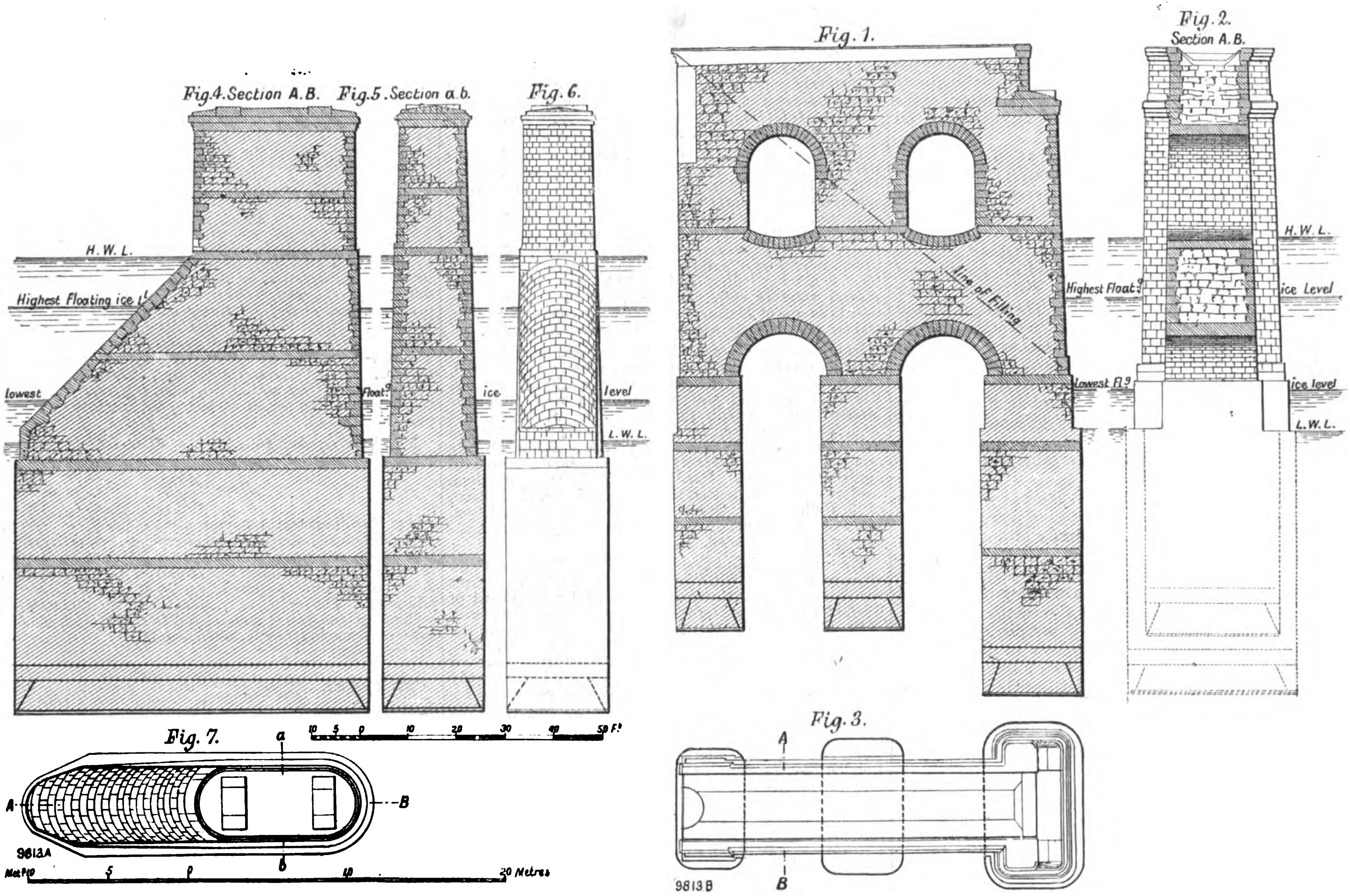
A committee of the American Railway Master Mechanics' Association, in a report on the efficiency of the link as compared with other valve motions, state that nowhere is "the survival of the fittest more pronounced than in railroad practice, and that in America the link has outlived all its rivals. It has, they say, been urged against the link that it is not a scientific or true mechanical motion. This may be true, but the fact remains that fairly good results are obtained from it; that it will take more punishment in the shape of rough usage and neglect, and cost less to make and repair, than any form of valve motion now being experimented with on locomotive engines. They further state that poor results obtained from a locomotive are often unjustly charged to the valve motion, when the cause may be found in contracted steam ways, leaky valves and pistons, and similar defects, and in conclusion they add that no valve motion brought before them is more efficient for all-round work, and general utility, than a well-designed link with large bearing surfaces. As for the Strong valve gear, for which very high claims have been made, Mr. Ross Kells, of the New York, Lake Erie, and Western Road, reports that on his line they have found the link motion fully as economical in coal and more economical on maintenance of the valve gear.

THE SUEZ CANAL.—The transit revenue collected by the Suez Canal Company in May amounted to 235,200*l*., as compared with 217,111*l*. in May, 1889. The aggregate revenue collected to May 31 this year amounted, however, to only 1,150,721*l*., as compared with 1,197,366*l*. in the corresponding period of 1889.

BRIDGE OVER THE RIVER BELAJA; SAMARA-UFA RAILWAY, RUSSIA.

PROFESSOR N. BELELUBSKI, ENGINEER, ST. PETERSBURG.

(*For Notice, see opposite Page.*)



WATER SUPPLY OF NOTTINGHAM.

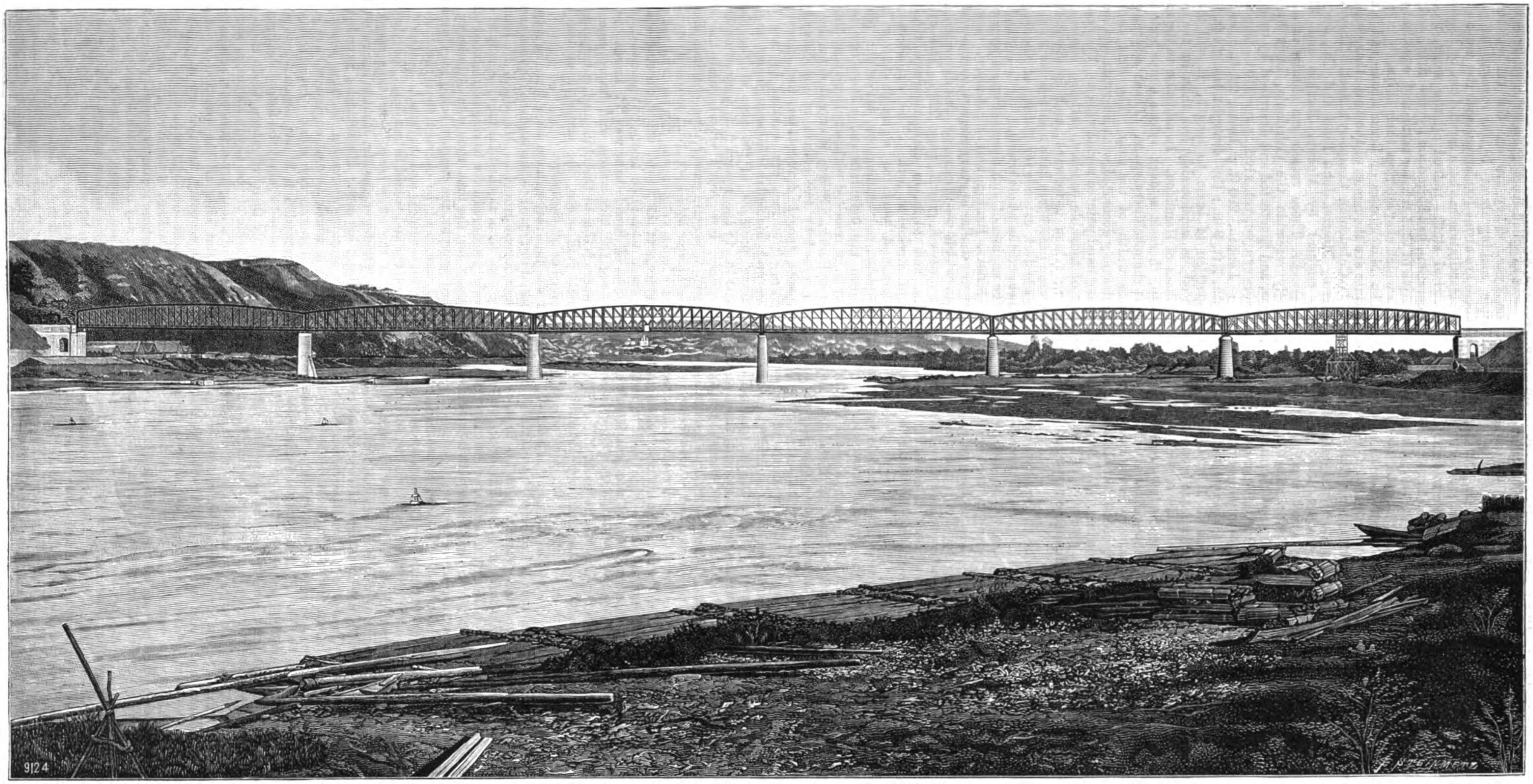
THE revenue of the Nottingham Corporation Water Works for the year ending March 25, 1890, showed an increase of 866*l*. 5s. 5d. as compared with 1888-9, while the working expenses were 220*l*. 8s. 5d. less than in the previous year. After paying annuities and interest on loans and consolidated stock, and the annual contributions to the renewal fund, and the different sinking funds, the ultimate balance of profits available for disposal by the Town Council, in aid of the rates or otherwise, amounted for 1889-90 to 2540*l*. 1s. 4d. Mr. L. T. Godfrey, the borough water works engineer, states in his annual report, that the whole of the machinery is in an efficient condition, and fully capable of performing with ease the demands which for some years to come are likely to be made upon it. In the Basford district the engines have undergone the usual repairs; the grounds have received more than ordinary attention, the trees and shrubs requiring thinning, replanting, &c. During the autumn of last year an electric fire alarm was fixed at Mapperley reservoir to communicate with this station in case of a fire upon the Mapperley Hills. By this means the engines can in case of necessity commence to pump over the standpipe, and so give a good pressure of water within three minutes of any alarm being sounded. The engines at the Bestwood Station have been thoroughly overhauled, the boilers scaled, the tower and other parts of the building repointed, and tie-bolts fixed in the walls of the porchway, which were giving way in consequence of vibrations caused by the engines. The most interesting work here has been improvements effected in the efficiency of the force pumps, which formerly delivered only 82 per cent. of their capacity. By means of an improved suction valve (the whole of the work upon which, excepting the casting, was done at the corporation workshops), the engineer has raised the efficiency to 95.40 per cent., this being equivalent to an addition of 16 gallons pumped for every stroke of the engine. The improved valve has only at present been applied to one engine, but the engineer trusts that the other engine will be working quite as well, if not better, next year. At the Papplewick Station, the waste land has been levelled and turfed, so that the machinery is now quite protected against drifting sands. At this station the force pumps, which were allowing 10.50 per cent. of water to slip back, have been more effectively dealt with than even those at Bestwood, and they now practically lift their full capacity. In addition to this two new auxiliary ram pumps have been attached to the main pumps, whereby the surplus water, which had hitherto flowed back into the well, is forced into the reservoir. An arrangement has been introduced so that when the well-bucket begins to fail, water can be drawn back from the main to keep the main pump supplied. The amount of this "flow back" is regulated by an automatic valve, and registered through a meter, thereby indicating the condition of the well-bucket, and the probable time when it will require changing. The amount of water undelivered, or "loss on pumps," which many engineers contend cannot be reduced below 5 per cent., has been reduced to below 2 per cent. Perret's patent furnaces have been fixed on approval to the boilers at this station. They burn an inferior, and consequently cheaper, class of fuel by means of a forced draught; and the engineer hopes after their trial at Papplewick to report that they have fulfilled expectations. A considerable increase in the demand for water in the Eastwood district has compelled the engineer to work the small special engine for a longer period. One of the principal causes of this increased consumption is the continual leakages from the large mains on the roads in this district. These leakages are entirely due to the sinking of the road in consequence of mining operations carried on below; and it is greatly to be regretted that neither protection nor compensation can be obtained for the expense incurred through this subsidence. During the past year the engineer has been able to more fully investigate the storage capabilities and resources of the reservoirs. From an extended series of experiments he finds that at their highest working levels there was only, under maximum conditions of consumption, 1.39 days supply, and at their lowest working levels under similar conditions, only 0.68 of a day's supply. It will be seen that even with an average supply of water, it would be necessary under conditions which might occur at any time during the summer months, to rely upon the pumps to a great extent. There are now 249 miles of water mains in Nottingham, 7¼ miles of which were laid during the past year, resulting in the supply of 651 additional houses, exclusive of trade supplies. Strenuous attempts have been made to cope with the enormous waste continually going on, and during the past year 28,209 taps were releathered.

A NEW FRENCH CANAL.—The French Minister of Public Works has just inaugurated a canal from the Aisne to the Oise. The length of the canal is 1¾ miles. It has been constructed in order to facilitate traffic by water between the north and the east of France; it will obviate a previously existing *détour* by way of Compiegne, and it will also relieve traffic from certain difficulties attending the navigation of the Aisne. Altogether the canal, although in itself of no great length, will reduce a voyage between the north and the east of France by no less than 36¼ miles. The works upon the new canal comprise two canal bridges, thirteen sluices, and a tunnel 2628 yards in length. The piercing of this tunnel was attended with considerable difficulties.

ARTESIAN WELL BORING.—Messrs. C. Isler and Co., of Southwark, have recently completed artesian bored tube wells for the following brewers: Mr. J. A. Chadwick, Burton Brewery, Wrexham, where the depth reached is 331 ft., and the water rises 10 ft. above the surface. Mr. J. W. Wright's brewery, Leeds; an inexhaustible supply has been tapped a few feet deeper than the depth of the orginial well; formerly, the supply could be exhausted after a few hours' pumping. At Messrs. Ridley, Cutter, and Firth's Manor Brewery, Newcastle-on-Tyne, an inexhaustible supply has been obtained, also at Messrs. Carter and Co., Mineral Water Works, Bristol; at Watford, close to Messrs. Wells' Brewery, a 120-ft. tube well has been completed in a little over a week. Among the other works Messrs. Isler are engaged upon, may be mentioned the Ely Brewery Company, Ely, near Cardiff, and the Kelsterton Brewery Company, Kelsterton Brewery, Flint, Mr. Kops' Brewery, Fulham, S.W., at Sturry, near Canterbury, and at Northfleet, Kent.

BRIDGE OVER THE RIVER BELAJA; SAMARA-UFA RAILWAY, RUSSIA.

PROFESSOR N. BELELUBSKI, ENGINEER, ST. PETERSBURG.



We illustrate on our two-page plate this week, and also on present and opposite pages, a bridge over the River Belaja, on the Samara-Ufa Railway, in Russia, constructed from the designs of Professor N. Belelubski, of St. Petersburg, by Mr. Beresin, at the works erected near the site of the bridge. We shall next week give some further engravings of this interesting structure, and reserve our description until then.

LAUNCHES AND TRIAL TRIPS.

On Thursday, July 3rd, there was launched from the shipbuilding yard of Messrs. Harvey and Co., Limited, Hayle, Cornwall, a large steel screw steamer named the Penurth and built to the order of Mr. R. B. Chellew. The vessel is of the following dimensions: Length over all, 279 ft. 5 in.; beam extreme, 36 ft. 9 in.; depth moulded, 21 ft. 2 in.; with a deadweight capacity of about 2900 tons. The engines and boilers have also been built by Messrs. Harvey and Co. and are on the tri-compound principle with cylinders 21½ in., 32 in., and 56 in. in diameter, by 30 in. stroke. Steam will be supplied from two steel boilers each 13 ft. 6 in. in diameter by 10 ft. long, fitted with Purvis's patent ribbed flues and constructed to Lloyd's requirements for a working pressure of 160 lb. per square inch.

On Thursday, July 3rd, Messrs. Sir Raylton Dixon and Co. launched from their Cleveland dockyard a steel screw steamer which has been built to the order of Messrs. Arthur Holland and Co., London. The leading dimensions of the vessel are: Length over all, 287 ft.; breadth, 39 ft.; depth moulded, 21 ft. 3 in.; with a deadweight carrying capacity of 3300 tons. Her engines, which are being supplied by the North-Eastern Marine Engineering Company, Sunderland, are of 180 nominal horse-power, with cylinders 21 in., 35 in., and 57 in. in diameter, by 39 in. stroke. On leaving the ways she was christened Sola.

On Friday afternoon, the 4th inst., Messrs. Craig, Taylor, and Co. launched from their Thornaby shipbuilding yard, Stockton-on-Tees, the largest vessel that they have as yet built, which has been named Alleghany, and is of the following dimensions: 328 ft. 8 in. by 42 ft. by 28 ft. depth moulded to spar deck. The vessel has been built to the order of Mr. J. S. Barwick, of Sunderland, and has been designed and constructed by the builder for the purpose of carrying 4000 tons of oil in bulk. Her engines are supplied by Mr. John Dickinson, of Palmer's Hill Engine Works, Sunderland, the cylinders being 25 in., 40 in., and 66 in. in diameter, by 45 in. stroke.

On Monday, the 7th inst., Earle's Shipbuilding and Engineering Company, Limited, launched from their yard at Hull a fine screw steamer named the Volo, which they have built for Messrs. Thomas Wilson, Sons, and Co., of the same town, to the following dimensions: Length, 260 ft.; breadth, 32 ft.; depth of hold, 16 ft. 6 in. After launching, the vessel was towed round to the Albert Dock to receive her machinery, which is on the triple-expansion principle, and has been built by Messrs. Amos and Smith, of Hull.

St. Gothard Railway.—The dividend of the St. Gothard Railway Company for 1889 has been fixed at 7¼ per cent. per annum. The corresponding dividend for 1888 was at the rate of 6 per cent. per annum.

Honeysett's Hydraulic Slide Rule.—We have received from Mr. W. F. Stanley, of Great Turnstile, London, W.C., a new slide rule, the invention of Mr. Arthur Honeysett, and intended for use in hydraulic calculations. Taking a wrinkle from the well-known Gravet rule, the new rule is fitted with a cursor, but of an improved type, consisting of a sheet of horn, on which is scribed a line serving to mark any number on the rule. The rule has been graduated in accordance with Bazin's formula to give the velocities and discharges of pipes and conduits of all sizes. The great value of slide rules in reducing the labour of calculation is well known, and with this rule this labour is, in the case of hydraulic calculations, still further reduced. For instance, the diameter of a pipe to furnish a given discharge can be got by its means directly, an operation which by ordinary methods involves the fifth root of a quantity. We may add, the rule is neatly got up and clearly engraved, as is indeed only to be expected from the reputation of its maker.

THE CLYDE COAST SERVICE.

THE magnificent flotilla of passenger steamers trading in the estuary of the Clyde has, this year, had more than the usual number of additions made to it, and all the new steamers are of interest. Many of the old craft, too, have been overhauled, some of them have had new engines, and generally the respective owners have shown a commendable spirit of enterprise. The competition is very keen. A few years ago passengers all sailed from the Broomielaw at Glasgow, but now the journey to the coast is made half-way by trains, the escaping of the nauseous smells of the upper reaches of the river being regarded as more than compensation for the little addition to fares. The charges, however, are probably less than on any other river, all things considered. The three railway companies have suitable lines for coast traffic, the Glasgow and South-Western carrying passengers to Greenock, the North British to Craigendoran on the opposite side of the river, and the Caledonian to Gourock, which is further out on the firth than the other places named.

The Caledonian Company in the past two years have made great efforts to secure the coast traffic, and they are succeeding in a sufficient degree to alarm the other railway and private competitors. Last year they had two or three fast steamers engaged in the service from Gourock new wharves,* and this year they have added three new steamers to the fleet. These steamers do not belong to the railway company—Parliament last year refused them powers to own them—but they are the property of the Caledonian Steam Packet Company, which is so closely allied to the railway company as to be the same so far as the public are concerned. Formerly the Caledonian Company worked, although it did not own, the line to Wemyss Bay Pier, on the Ayrshire coast, but recently they purchased the concern, and now instead of chartering steamers they are utilising their own vessels for the traffic from that pier. A new line, too, has been opened to Ardrossan, which the Caledonian work, and from that port also they are now running a steamer. A reference to the map will show how extensive the company's advantage is for all coast traffic. They are on equal terms with their opponents, the North British Company, in the upper part of the estuary—in many cases they have an advantage—and the result of the competition is that passengers may travel very comfortably by rail and steamer, to any point between Glasgow and Rothesay for between 1s. 6d. and 2s. 3d. In the lower part of the firth the Caledonian may be said to have all the advantage, for although the Glasgow and South-Western, their only opponents in Ayrshire, may compete by steamers from Fairlie or Ayr, they cannot do so with any degree of success, as they have no steamers of their own, nor are they likely of themselves to purchase them, while their lines, being somewhat circuitous, do not admit of the same rapid transit from city to seaboard as do those of the Caledonian Company. If the amalgamation of the South-Western and North British companies is authorised by Parliament—the Bill has already passed through one House—more strenuous opposition will be offered. There are already distinct indications of this. The North British, presumably in the full confidence that the Amalgamation Bill will be passed, are arranging to purchase Troon and Irvine harbours on the Ayrshire coast, the former belonging to the Duke of Portland, and the latter to the Harbour Trustees. The trustees are asking forty to fifty years' purchase of the profits, taking the average of the three past years. For a number of years the profits have averaged 1000*l*., last year they were 2288*l*. The two ports, with Ayr, owned by the Glasgow and South-Western, which is being amalgamated with the North British, are important as cargo ports, so that the mineral traffic is heavy, but already mention is made of possible extensions to suit rapid transit from the city to the seaboard.

An evidence of the great competition not only among railway steamers, but also among privately owned vessels, is afforded by the racing of as many as three or four steamers for a pier on the firth, and this has become so pronounced in recent years as to be almost dangerous. Lately the Pilot Board caused semaphore signals to be placed on the principal piers, so that the piermaster could regulate the traffic by indicating which of the contending crafts is to have the preference. He usually decides according to the distance, and this is not always an easy matter when steamers are approaching from three of the four points of the compass. The principle, however, is a good one, and has worked well.

The most important of the Caledonian Company's new steamers is the Duchess of Hamilton, built and engined by the Messrs. Denny, of Dumbarton. This vessel is conducting a service to Arran, and so complete are the arrangements that the distance between Glasgow and Arran is accomplished in an hour and a half. A special train known as the Arran express, made up of bogie carriages, similar to those lately illustrated and described by us (vol. xlix., page 194), drawn by a large bogie engine, convey the passengers from Glasgow to Ardrossan—a distance of 30 miles in 38 minutes. In the external decoration of these carriages the Caledonian Company have made a decided departure, having painted them "cream" and "chocolate" tints, instead of the dark sombre colours with which the public are so familiar. At Ardrossan the Duchess of Hamilton is boarded and the trip to Brodick across the firth, made in 36 minutes, the vessel maintaining the excellent results got on speed trials. Running between the Cloch and Cumbrae Lights the speed attained was 18.09 knots, notwithstanding that there was a beam wind causing a considerable list. A premium of 3000*l*. was paid the builders for speed in excess of the guarantee. The steamer since she started has been giving every satisfaction to owners and the travelling public, doing her work particularly well and keeping good time.

The Duchess of Hamilton is a smart-looking vessel; she is 250 ft. long between perpendiculars, 30 ft. beam, and 10 ft. 6 in. depth moulded, the gross tonnage being 570 ft. She is propelled by a pair of surface-condensing diagonal engines upon the principle introduced and used by Mr. Walter Brock of Messrs. Denny's firm, whereby all the working parts are brought to the top, and within view and reach of the engineer. Instead of having the valve outside of the low-pressure cylinder, Mr. Brock has placed it above it and it is worked by his own type of gearing. Not only is the space of the ship economised in this arrangement, but all the parts are more accessible for overhauling. We hope to illustrate the arrangement in an early issue. The cylinders are 34½ in. and 60 in. in diameter respectively, and the stroke of piston 5 ft.

Steam is supplied to the engines by three boilers of the Admiralty type working under forced draught on the closed stokehold system. The fans are driven by Messrs. Brotherhood's three-cylinder noiseless engines. The steam pressure is 115 lb. to the square inch. The boiler feeding is done by Weir's independent pumps through their combination check valves, which dispenses with surface and blow-off cocks and pipes and which are used for circulating the water in the boilers while raising steam.

A remarkable feature of the vessel is her great beam. Although about 50 ft. shorter than the favourite Columba she has 3 ft. more beam, and the Columba is an usually broad beam steamer of the class. Indeed, in these steamers Messrs. Denny appear to have solved a problem which proved somewhat difficult to the designers of high-speed paddle steamers in such cases where length and draught had to be limited. In many of the coasting ports, circumstances demand short steamers and light draught. Amongst these may be named Calais, Ostend, the Channel ports, and many in the kingdom which need not be particularised. Under these circumstances beam was required for stability and to admit of the extensive deck saloons now demanded in first-class steamers. These conditions as to dimensions made high-speed difficult of attainment; but, as a result of a long series of careful experiments in their tank, Messrs. Denny have succeeded in producing a model to meet the demands as to dimensions and at the same time to so reduce the resistance to the minimum. The proportion of length to beam in the Duchess of Hamilton is 8.3 to 1, but in the case of the vessels Princesse Henrietta and Princesse Josephine, the proportion is 7.9 to 1, while in the Princess Victoria, for the Stranraer and Larne trade, it is 8.8 to 1. By this attainment, through their tank experiments, Messrs. Denny have done a service to marine construction.

This extra breadth adds to the promenading space, which is very extensive. The promenade deck extends from stem to stern. Forward and aft it is carried on stanchions. The captain's bridge is forward the funnel, and affords him a capital look-out.

The internal arrangements of the vessel are most satisfactory, and the fittings handsome. The saloon abaft the machinery on the main deck is 60 ft. long and the whole width of the steamer. The woodwork is walnut, with mahogany pilasters, enriched with hand-painted gilt panels. The ceiling is panelled with wood, painted cream colour, relieved with gold. Settees with spring seats, covered with Moquette, are placed athwartship, Pullman style, while reading and writing tables are arranged at convenient intervals. Light is obtained by large square windows along either side of the vessel, and these are draped with spring blinds, with curtains in terra cotta and tan colours. At the forward end of the saloon is the ladies' cabin, while at the after end there is a sliding door, with stained glass panel and a fine painting of the Duchess of Hamilton. This door gives access to the quarter-deck. On the lower deck aft is the first-class dining saloon, having accommodation for ninety passengers. The saloon is decorated in pale blue, and upholstered in old gold frieze velvet. The smoking-room is upholstered in brown buffalo hide. Forward of the machinery is the accommodation for second-class passengers, with a saloon on the main deck for seating 100 passengers, while underneath is a dining saloon. The crew, numbering about twenty, with sixteen stewards, are housed in the fore part of the ship.

The deck machinery is very complete. The vessel is lighted by electricity, generated by dynamos and motors supplied from Parsons' well-known works on the Tyne. They are on the turbo-generator principle, making about 10,000 revolutions per minute. There are about 100 lamps, and the work of fitting up the installation has been carried out by Messrs. Denny's electrical staff. Indeed all the work, including the decoration, has been done by the firm, and is demonstrative of that artistic taste and excellent workmanship which characterises their ships.

The Marchioness of Breadalbane and Marchioness of Bute are the names of the two other steamers added to the Caledonian Company's fleet. They were both built by Messrs. John Reid and Co., Port-Glasgow, and engined by Messrs. Rankin and Blackmore, Greenock. These vessels are similar in design, and closely resemble the Caledonia, built by the same firms, and illustrated and described by us at the time (ENGINEERING, vol. xlvii., page 510). The dimensions are: Length, 200 ft.; beam, 22 ft.; and moulded depth, 7 ft. 9 in.; the draught being 4 ft. 3 in. The proportion of beam to length, it will therefore be noticed, is considerably less than in the case of the Duchess of Hamilton. In addition to the usual wing-house, there is a deck saloon house both before and abaft the machinery space. These saloons extend the whole width of the ship. The after deck-house is handsomely decorated with lincrusta and small panels having hand-painted scenic views. The furniture consists of movable couches, settees, chairs, &c. The dining saloon is forward, and is about 20 ft. long. Steerage passengers have a saloon forward. The promenade deck extends for 150 ft. of the length of the vessel and the whole width.

The engines of both these steamers were constructed by Messrs. Rankin and Blackmore, Greenock, and they are similar in every respect to those of the Caledonia which we illustrated and described (see ENGINEERING, vol. xlviii., page 220). The cylinders are 30 in. and 54 in. in diameter respectively, with a piston stroke of 5 ft. The cylinders are placed tandem and work on a single-throw crankshaft. One piston-rod stuffing-box takes the place of two between the cylinders and allows the low-pressure cover to be removed without disturbing the high-pressure cylinder. Steam is supplied to the engines in each vessel by two boilers of the Navy type, working with forced draught on the closed stokehold system. The fans are worked by one of Messrs. Alley and Maclellan's Westinghouse engines. The working pressure in the case of the Marchionesses is 100 lb. to the square inch instead of 90 lb. in the Caledonia, last year's vessel, and the boilers are larger. The extra power thus obtained drove the new vessels faster by ¼ knot per hour. The Marchioness of Bute had a very stormy day for trial but maintained an average of 17 knots, while running with the wind the speed was 17.56 knots. The speed of the Marchioness of Breadalbane was 17 knots. Much of the credit of the innovations and improvements in these steamers is due to the skill and enterprise of Captain James Williamson, the manager of the Caledonian Steam Packet Company.

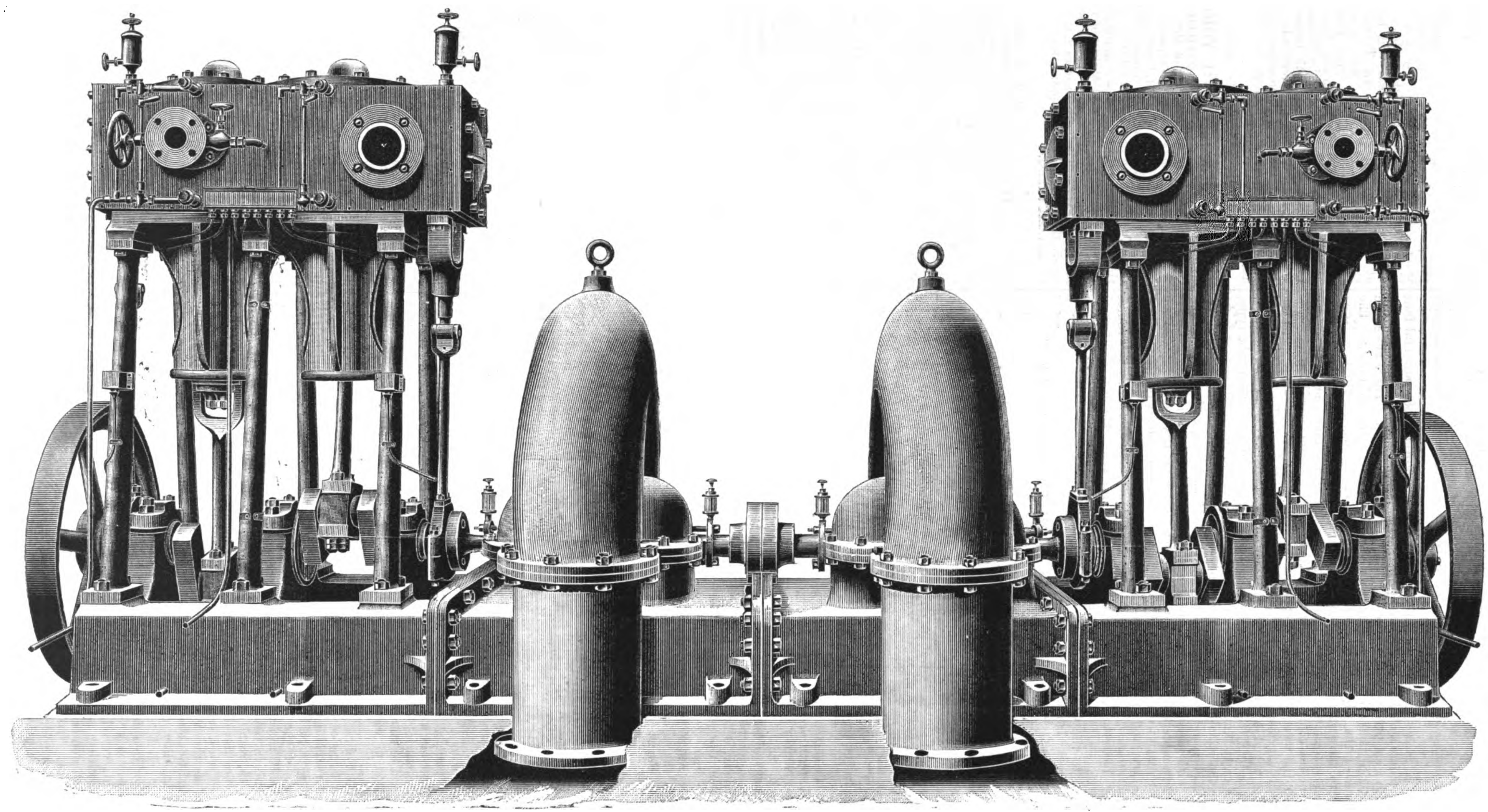
These innovations have been very largely discussed, especial in regard to the tandem engines and the adoption of forced draught. Mr. John F. Rankin, of the engineers' firm, at the trial trip recently of one of the vessels, took credit for having introduced into a paddle steamer for the first time the Admiralty system of forced draught, the steamer being the Ozone, built five years ago, and he claimed that the "old-fashioned wasteful engines and haystack boilers" had been superseded and would before long "be relegated to the limbo of the scrap heap." In thus speaking of the single-cylinder engine Mr. Rankin has raised a hornet's nest about his ears. His remarks have led to a lively semi-scientific discussion in the leading Glasgow journal, in which several engineers have joined, ranging themselves on two sides. Into the historical part of the discussion it is not necessary to go. Several points are urged against the forced draught compound boats, notably their vibration, while it is urged that years ago some of the Clyde steamers were equally as speedy, and a long list of famous crafts have been mentioned. But after all the question is one of relative speed with economy, and this can only be put to the test in a most thorough manner.

Mr. R. Darling, of the North British Steam Packet Company, whose steamers probably compete more distinctly than any others with those of the Caledonian Company, has thrown down the gauntlet. He says he will be glad to demonstrate that the North British Clyde steamers, without forced draught, barring exceptional circumstances, are equal, if not superior, in speed to anything of their size. He promises a fair trial and not "with a superflous number of firemen." The North British boats are not old, the Lucy Ashton is comparatively new; they have, with an exception or two, single-cylinder engines, and their deck saloons are not so large as in the Caledonian vessels.

* See ENGINEERING, vol. xlvii., pages 326 and 510.

CENTRIFUGAL PUMPING ENGINES FOR THE S.S. "COLUMBIA."

CONSTRUCTED BY MESSRS. TANGYES, LIMITED, ENGINEERS, BIRMINGHAM.



We give above a perspective view of the circulating pumping engines made by Messrs. Tangyes, Limited, Birmingham, for the twin-screw steamer Columbia, built by Messrs. Lairds, Birkenhead, for the Hamburg-American Line, and which recently made the fastest passage on record between Southampton and New York.

There are two pumps, each driven direct by a separate compound engine. Two sets, as shown, were fitted on board; one for the port and one for the starboard main engines. The suction and discharge branches are 14 in. in diameter. The casing is of cast iron, the lower half forming a portion of the bedplate, and the pumps are bolted together and to the engine base by outside flanges. The suction and discharge, being in the lower half of the pump, permit of the disc being removed without disturbing any pipe joints. The discs are gun-metal, and are keyed on manganese bronze spindles, having solid forged couplings for connecting to the crankshaft. Couplings are also provided between the pumps so that they can be connected if desired.

The engines are of the coupled compound column type, suitable for a steam pressure of 160 lb. per square inch, the cylinders being 6½ in. high pressure, 10 in. low pressure, with a stroke of 9 in. The cylinders are lagged with sheet steel, and are fitted with Dewrance's patent asbestos packed drain cocks. The high-pressure cylinder is fitted with a Trick slide valve. A small supplementary valve is fitted to admit high-pressure steam to the low-pressure valve chest to assist in starting. The crosshead guides are cast with the bottom cylinder covers and are bored concentric with the cylinder at one setting, thereby insuring great accuracy in fitting. Feet are cast on these guides for bolting to six bright wrought-iron columns, splayed out so as to prevent vibration. The piston-rods and crossheads are steel, and have been forged together. The connecting-rods are wrought iron with adjustable gun-metal bearings at each end. To enable these pumps to be run continuously special care has been devoted to the means of lubrication. Gun-metal oil boxes are attached to the front of the engines with copper tubes leading to all the working parts.

Paris Exhibition, 1889.—Sir Henry Trueman Wood, the late Commissionaire Delegate for the British Section of the Paris Exhibition, has just received information that the diplomas and complimentary medals for the British exhibitors will not be likely to be issued before the end of October next.

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pended per mile of line open was only about 28,000*l*., whereas in 1888 it had increased to 40,800*l*., showing an advance of 12,800*l*. It is difficult to understand the necessity for an increase of capital expenditure that is practically equal to the present total average outlay, per mile opened, on the railways of the United States. In the case of the North British line, the construction of the Forth Bridge has no doubt had something to do with the difference, but this, after all, is but a small percentage when compared with the increase of close on twenty millions expended during this period on the system as a whole. It would appear as if the Scotch railway directors had made up their minds that, instead of having to provide for the traffic of a poor and sparsely populated country, they had only to spend sufficient money in order to tap Eldorados of incalculable riches. While this latter idea is, of course, out of the question, there has been a really remarkable development of passenger traffic on both systems during the period under review, as shown in the following figures :

Caledonian Railway—Passenger Traffic in 1873 *and* 1888.

—	1873.	1888.	Increase in 1888.
First-class passengers ...	1,261,000	1,412,000	151,000
Second " " ...	1,525,000	834,000	*691,000
Third " " ...	10,790,000	18,575,000	7,785,000
Season ticket holders ...	12,024	12,507	483

North British Railway—Passenger Traffic in 1873 *and* 1888.

—	1873.	1888.	Increase in 1888.
First-class passengers ...	1,482,000	1,763,000	281,000
Second " " ...	1,033,000	213,000	*820,000
Third " " ...	10,778,000	24,514,000	13,736,000
Season ticket holders ...	10,889	68,568	57,679

* Decreases.

In these Tables the most remarkable features are the enormous development of third-class travellers and the great falling off in the number of second-class passengers. It may, indeed, be said that third-class travelling has largely been extended at the expense of the second class, and that the latter may be regarded as all but extinguished. The Scotch railways will no doubt soon follow the Midland lead in having two classes only, and getting rid of the second class entirely.

The railways of Scotland carry more live stock, relatively to their total traffic than those of England, and it is not without significance to note that this traffic, notwithstanding the long prevalence of agricultural depression, or rather, it may be, in consequence of that fact, has increased considerably of late years. In 1873, the live stock gross returns amounted to 146,000*l*., and in 1888, they had risen to 203,000*l*., being an increase of about 40 per cent.

The railways of Scotland depend mainly upon two factors, the mineral and engineering traffic of the Glasgow district, and the increasing preference shown for the Highlands as a health resort, and the consequent increase of tourist traffic. Whether these sources of traffic will so far develop as to justify the serious increase of expenditure incurred during recent years, will be one of the interesting railway problems of the future.

DEPOSITED COPPER.

We have several times referrred to the copper depositing process of Mr. William Elmore,* and have kept our readers informed of the progress of the undertaking. As we announced last week the manufacture has now been placed on a commercial basis, and the Elmore Patent Copper Depositing Company, Limited, of 20, Bucklersbury, E.C., are taking orders for pipes of any sizes up to 3 ft. 4 in. in diameter and 10 ft. long. The material of these pipes is of a quality which must be described as perfectly wonderful, for it has a tensile strength of 25 tons per square inch with an extension of 20 per cent. in breaking. Added to this the "ratio of limit to break" is .925. The annexed report by Professor Kennedy gives the results of three tests.

Report on Tensile Tests of Three Pieces Cut from Copper Tube, Received from William Elmore, Esq.
Engineering Laboratory, University College, London, W.C. Received, 20th April. Tested, 21st April.
21st day of April, 1888.

U.C.L. Test Number	Marks on Piece	Dimensions.			Limit of Elasticity.		Breaking Load.		Ratio of Limit to Break.	Extension on Whole Length of 4 in.	Reduction of Area at Fracture.	Work of Fracture in Inch-Tons per Cubic inch (calculated).	Remarks.
		Breadth	Thickness.	Area.	Pounds per Square Inch.	Tons per Square Inch.	Pounds per Square Inch.	Tons per Square Inch.					
		in.	in.	sq. in.		about	about			per cent.	per cent.		
$14,178_1$	No. 9 C April 19	1.245	0.135	0.168	49,370	22.05	59,660	26.64	0.828	17.5	70.5	4.40	Silky.
$14,178_2$	"	1.263	0.131	0.165	55,620	24.83	60,090	26.83	0.925	14.3	63.5	3.47	"
14,178	"	1.272	0.131	0.167	51,590	23.03	58,060	25.92	0.888	17.5	66.0	4.87	"

William Elmore, Esq. Alex. B. W. Kennedy.

After the experience of recent failures in copper steam pipes it is a relief to find that there is a metal, free from welds and joints of every kind, that offers absolute security with the high pressures of steam now employed. Each pipe has etched upon it the results of a test which is made of a strip cut from its end, and thus the engineer is relieved from anxiety as to how it will behave. Even without this guarantee he could have little cause for anxiety, for the process of manufacture does not admit of any irregularity of chemical composition. The pipe consists of pure copper, free from admixture with other metals, and the only variation which can occur is in its hardness. It is possible to produce hard or soft metal at will, according to the purpose for which it is to be employed, and of course it is important that the hard varieties should not be used for steam pipes.

We have already described the method of manufacture, but it is so interesting that it is worth while to refer to it again. Every one is aware that copper can readily be deposited from its solutions. Practically all the crude copper which comes into this country is refined by electric deposition. By means of currents derived from large dynamo machines the Chili bars are dissolved, the pure copper being thrown down on the cathodes in rough nodular masses, and the impurities, often containing gold and silver, being left as mud in the bath. The refined copper has afterwards to be melted, with the chance of oxidising it, cast, and rolled into bars or sheets. If it is desired to obtain the copper of soft quality and even texture it is necessary that the process be carried on very slowly indeed. If any attempt be made to hurry it the result is a coarse granular metal entirely wanting both in strength and ductility. In our series of articles on the Maps of the Ordnance Survey* we stated that the copper electrotypes of the engraved plates, as well as the plates themselves, were deposited with a current of 6 ampères per square foot. Now as each ampère deposits .00033075 grammes per second, it follows that, working night and day for six days (144 hours), there will be deposited on a square foot 1026 grammes, or about $2\frac{1}{4}$ lb. of copper. This would give a plate $\frac{1}{32}$ in. thick. What the tensile strength of such a plate would be we do not know, but since many large copper manufacturers have tried to utilise the process for the production of tubes, and have abandoned it, it would seem that the metal was of inferior quality in some important respect, or else the cost was prohibitive. At the Ordnance Survey Office the cost of such copper, made from anodes of the best quality, is stated to be 1s. 5d. per pound, but unless we know on what principle the books are kept, and whether due allowance is made for rent and depreciation, these figures may be misleading. The Elmore tubes are deposited at the rate of $\frac{1}{8}$ in. in thickness per week of 144 hours, or 6 lb. per square foot of surface. The process by which they are produced differs only in one respect from that hitherto followed in the electro-plating of rollers for calico printing machines. The surface of the copper is continuously burnished by an agate the whole time, and as rapidly as the particles of copper are formed they are rubbed and matted into those beneath and beside them, thus forming a fibrous plate of perfectly uniform structure and great strength. So closely are the particles interlaced that the specific gravity is increased until a plate one-eighth of an inch thick weighs 6 lb. to the square foot. As the mandrel on which the tube is formed rotates in the bath of copper sulphate, the agate travels along it, forming a fine spiral on its surface, the speeds being so arranged that only a very fine film can form between two applications of the burnisher to a given spot. The physical properties of the metal depend to a certain extent upon the rate of deposition, and the thickness of the film burnished. This last is usually $\frac{1}{1000}$ in., but it is subject to variation. For instance, steam tubes are usually thickened up at the ends for the flanges to be attached to them. To this end the anode of common Chili bars is placed nearer to the ends of the tube than to the rest of the length. The electric resistance is therefore decreased at those points, the result being an increased density of current and a thickening of the tube. The ends are thus rendered thicker and softer, so that they can be very readily flanged. These flanges do not serve alone for the union of successive lengths of pipe. Gun-metal flanges with grooves in their faces are first slipped over the cylindrical tubes, and then the ends are rolled over into these grooves, into which they fit exactly. By varying the position of the anode other alterations of form can be effected. For instance, when it was intended to bend the Elmore tubes by the ordinary process it was proposed to make them thicker down one side than the other, so that the stretching which takes place on the other side of the bend should not reduce the general strength. To do this the mandrel would have been mounted eccentrically, the result being that the side which approached nearest to the anode would have been the thicker of the two. However, since the introduction of the Fowler bending machine it is not necessary to do this. This machine, an American invention, will bend a pipe of any size without extending the metal on the outer side of the curve. In place of this it sets up or thickens the metal on the inner side.

Electrically deposited burnished copper may, of course, be applied for many purposes besides steam pipes. Indeed, since all copper is electrically deposited, and the burnishing only takes the place of remelting and casting, it is quite possible that the new process many serve for the preparation of every variety of copper goods. One of the uses for which it is being prepared is that of electric conductors. By cutting a tube up spirally there is produced a square filament which can be drawn down in the dies until 40 miles only weigh 1 lb., and that, too, without annealing, and so pure is the quality that its conductivity exceeds the best article in the market by 4 per cent., and is actually 2 per cent. better than the standard prepared with the utmost care in the laboratory. Pans of all kinds can also be made by the process at a cheaper rate than by brazing or rivetting. Pump plungers and hydraulic rams can have coats of copper applied directly to them, and if their surfaces are cleaned and grooved, the union of the two metals is as firm as if they were welded. This intimate connection is avoided in the case of tubes by coating the mandrel with black lead. After it is taken out of the bath the copper is rolled ; this has the effect of causing it to expand, when it can be easily slipped off the centre.

The burnishing of electrically-deposited metal is a process which may eventually be applied to other substances than copper. It is quite evident that it would improve the union between a protective outer metal and a base of inferior metal, and that it would entirely obliterate all holes or cracks. A thin coat thus applied would afford equal security with a thicker coat that was not uniform.

Since the deposited copper is made direct from Chili bars, which are simply placed in the bath and allowed to dissolve, it follows that the expense of manufacture relates chiefly to engine power and

* See Engineering, vols. xlv., xlvi., pages 95, 116, and 509.

* See Engineering, vol. xlv., page 120.

rent, labour being comparatively an insignificant item. When a mandrel is put into a tank it remains there for one or several weeks slowly turning round, and only needs the slightest attention, until it is ready to be lifted out and to be replaced by another. All this time the process goes on automatically and there is scarcely any expense except that for driving the dynamo. It is certain that this cannot be great per pound of copper deposited. It requires an electromotive force of from .2 to .3 volts to effect the chemical reduction of copper sulphate solution, and if we assume the combined efficiency of engine, dynamo, leads, and bath to be only 25 per cent., then each indicated horse-power will deposit 888 grammes, or 1.95 lb. of copper per hour. This shows that a ton of coal used in a modern engine will deposit a ton of copper. Now taking the Lancashire standard of 1d. per hour as the cost of rent and power, it would follow that copper could be deposited at a cost for these two items of ½d. per pound. We have no information as to what the expense of manufacture actually is, but we think that our estimate cannot be far wrong. The new material starts on an excellent commercial basis; it is better than anything yet in the market, and can be produced more cheaply than the goods it seeks to replace. No company could wish to carry on business under more favourable conditions. As can be seen at 56, Queen Victoria-street, the goods turned out are of splendid appearance, while the tests of numerous independent authorities show that the strength is practically twice as great as that of the best solid-drawn tubes.

WINDING-UP COMPANIES.

Now that the "Companies Winding-up Bill" has been read a third time by the Commons, there is some prospect that it will pass into law during the present session of Parliament. But although the measure may be expected to put an end to some of the scandals arising out of joint stock enterprise, we doubt whether it will be found wholly satisfactory or completely final. The discussion which the Bill has met within and outside of the House of Commons, and especially in the Standing Committee of Trade, has disclosed a considerable difference of opinion as to the best means of redressing grievances which are universally admitted to exist. There is for example great diversity of view as to the efficiency of the Chancery Division in windings-up. As Sir M. Hicks-Beach pointed out to the Standing Committee, "the experience of the Court of Chancery has not resulted to the advantage of the public, it has not resulted at all events to the advantage of the creditors of the companies, it has resulted in long proceedings, inefficient proceedings, and expensive proceedings, and proceedings carried to such an extent in point of time that winding-up has become a farce altogether." Mr. Chamberlain, too, who upon such a question speaks with very great authority, emphatically declared that "it was the scandals of the existing system which had produced this measure. The universal opinion of commercial men was that the winding-up of companies in the Chancery Division had been attended with the greatest possible inefficiency and disadvantage to the public, that proceedings should be assimilated to those in bankruptcy." This is strong speaking, but not a whit too strong, and we wish that the Bill had dealt with the difficulty in a still more drastic manner. It appears from a return of 1888 of joint stock companies ordered to be wound up that 22 liquidations had been going on for ten years, 20 between five and ten, 147 for more than ten, and one since 1863. The return, moreover, displayed, in Mr. Chamberlain's view, a total lack of knowledge and control on the part of the Court. Thus, he instanced, that out of 44 cases of companies wound up in 1867 in the chambers of Mr. Justice Chitty, in 28 there was no return of the assets at all, in 17 the return was that nothing had been paid to the creditors or that the result was unknown. Again, with regard to costs, in one case the assets were 687*l.* and the costs 450*l.*, in others the assets were 33,000*l.* and the costs 11,500*l.*; assets 2910*l.*, costs 1250*l.*; assets 400*l.*, costs 393*l.*; assets 2923*l.*, costs 1546*l.*; assets 2000*l.*, costs 2000*l.*; assets 3668*l.*, and costs 1650*l.* These figures suffice to show the urgent necessity that exists for one of the main changes initiated by the Bill, the conferring of jurisdiction in windings-up upon county and local courts. Sir Horace Davey's proviso that the maximum limit of local jurisdiction should be 10,000*l.* was carried before the third reading was agreed to in the House of Commons last Friday, and this materially strengthens the Bill, since 5000*l.* was the amount originally fixed. It remains of course to be seen whether the local bankruptcy machinery is competent to deal efficiently and promptly with these cases, but it may be hoped that the creditors of companies will eventually derive great benefit from the change in the law.

The assimilation of proceedings in windings-up to proceedings in bankruptcy is no doubt a step in the right direction. The bankruptcy law, it is true, is still in a state of transition. In spite of all the improvements which have been made in the last 25 years, it is full of defects which call loudly for reform. But our bankruptcy procedure is highly efficient as compared with that which governs windings-up. One of the most important provisions of the Bill is that empowering the Lord Chancellor to assign company business to a particular judge or judges, in much the same way, we imagine, as bankruptcy business has been assigned to Mr. Justice Cave. There is no doubt whatever that this may be extremely useful, because if it is acted upon as it may be expected to be these proceedings will go to what is tantamount to a special court whose officials will acquire special skill and experience. If at the same time care is taken that it shall not as at present clash with ordinary equity work, much of the delay and consequent expense which is now inevitable will be avoided. We think that it would have been better to have constructed a special court with special officials like the Registrars in Bankruptcy. There is work enough and to spare to keep such a tribunal fully occupied, and if it were carefully constituted it would command the confidence of commercial men, which is certainly much more than is the case with the present Chancery Division. But it largely rests with the Lord Chanceller to supply this defect. It will, doubtless, in any case always cost more to carve up the assets of a company than an individual. There is a difference in the classes of claims, and their relative rights and priorities are more difficult of adjustment. But at the same time, as sufficiently appears from the figures we have given, there is no doubt whatever that there is plenty of scope for improvement, and some hope that it may be gradually accomplished.

Officialism is we fear a necessary evil now-a-days. It is certainly difficult to contemplate with equanimity the introduction of the Board of Trade and the Official Receiver into windings-up. No doubt the fact that a Board of Trade official is intrusted with the duty of reporting as to the cause of a company's failure may, in flagrant cases, be valuable, and will, so far as it goes, do something to hinder the improper promotion of companies. A power which will, too, be properly appreciated by those chiefly concerned is that of the Court not only to expose offenders but to order them summarily to repay any moneys misapplied or retained, and to contribute such sums of money by way of compensation in respect of any misapplication, misfeasance, or breach of trust as the Court thinks just. The stringent character of much of the proceedings initiated by the Bill with regard to insolvent companies (which must be carefully distinguished from companies wound up for some other reason) will further, we hope, put a stop to the now systematic practice of "company smashing," which has long been regarded as providing a fair opportunity of plunder by unscrupulous solicitors. It has for years been the custom for the petitioning creditor to nominate a person as liquidator, and for the Court to sanction that nomination, and in this way to make a clean present of the by no means despicable advantages accruing from the carriage of the liquidation. But under the Bill the Court will now appoint its own liquidator, provisionally, and his authority can only be superseded except with the consent of the creditors and contributories of the company. It is, of course, impossible to speak with confidence with regard to details, and the working capabilities of such a measure generally, until these have been tested by practical experiment. The attempt to graft upon the old machinery new powers constructed for purposes which, although analogous to, are still distinguishable from those in use in bankruptcy proceedings, is clearly a hazardous one, and we could wish that the Bill were more complete in itself. But as we have briefly shown, there seems little reason to doubt that many of its innovations are capable of producing great results. The powers of local courts, for instance, should do away with the gross scandal of the assets of small companies being swallowed up by lawyers. But, upon the whole, there is good reason to hope that the measure will secure to the public the advantages of a beneficial amendment in the law which is of immense importance to the commercial community. The Bill is, of course, avowedly an experimental measure. It was introduced by Sir M. Hicks-Beach as intended to deal with a flagrantly defective part of the law, since in view of the complexity and difficulty of the subject and the state of public business it was hopeless to attempt to submit a general measure for the consideration of Parliament. It is one of the worse evils resulting from the overcrowded state of public business that legislation should now have to be almost always piecemeal and tentative.

THE "ELECTROPHONOSCOPE."

DOUBTLESS many of our readers have had their interest and curiosity aroused by the sensational accounts given in the daily papers of one of the attractions provided for the visitors to the Conversazione held at the South Kensington Museum on the 2nd instant in celebration of the Jubilee of Penny Postage. From these accounts it would appear that an invention in physical science of startling novelty and importance was shown to the public for the first time; the names of two of the most prominent electricians were quoted as the parents of the invention, and it was implied that the question of transmitting sight as well as hearing to a distance by means of electricity was at last scientifically and practically solved. Such a discovery and invention, if such had been made, would naturally have commanded a conspicuous place in our columns, and most of our readers will have gathered from our silence that there was "nothing in it." This silence would have been preserved had it not been for the fact that this exhibit intended only to form a popular attraction at an essentially popular gathering, was successful in taking in at least one of our technical contemporaries, a journal to which its readers had a right to look as a guide, philosopher, and friend.

The "electrophonoscope" is nothing more or less than a combination of a telephone with a modified form of the old optical toy whereby the observer is enabled to "see through a brick." At the South Kensington soirée there were two telegraphic huts which were connected electrically by pairs of microphonic transmitters and telephonic receivers, and optically by a hidden channel or tube bent four times at right angles, being furnished at each bend with a skilfully concealed mirror set at an angle of 45 deg. with each limb of the bend. An observer in one hut speaking into the opening provided for the purpose saw the face of the person listening in the other hut, each face being brilliantly illuminated by the electric light, and at the same time his speech was transmitted by well-known microphonic and telephonic methods.

It is an understood thing that all is fair in love and in war, and as this conversazione was held for a charity which we may include under the former head, we cannot complain of any unfairness in an innocent "take in" which added very considerably to the attractions and amusements of the evening. It is only what is done every day at bazaars and country fairs, and used to be carried out on the most elaborate scale at the dramatic fêtes which were held a few years ago at the Crystal Palace. There was nothing unfair in the installation, but it was in our opinion somewhat out of place in the midst of a magnificent collection illustrative of the rise and development of the postal system of this country and of the world, including all the splendid achievements in the application of electric science which have been made in connection with telegraphy, while the reference to the illusion in the Official Catalogue quoted below, carried the joke a little too far. "In the Textile Gallery there may possibly be met with a Telegraph Office of 1990, where special facilities for the transaction of new developments of Post Office business will be provided, and where by means of contrivances which are certainly not as yet publicly known, the expectation will be held out of instantaneous communications passing between London and all parts of the world by sight and speech, and not by the old world contrivances of the nineteenth century, and its so-called Electric Telegraph. Moreover, the greatest invention of the age—the Electrophonoscope—will be shown there for the first time." Explicit statements such as these would be quite in place at a fancy fair, or at the Red Lion dinner of the British Association, but they strike us as scarcely harmonising with the important occasion of a Post Office Jubilee Conversazione. We cannot but believe that of the many hundreds that visited the "electrophonoscope" last week, a large number must have come away with the idea that they had been witnessing a *bonâ fide* illustration of the transmission of sight as well as of sound through an electrical conductor, for not only did many of the daily papers extoll the great invention of the day, but the editor of a technical journal, which assumes that it is in the confidence of the electrical profession, was drawn readily into the snare.

It certainly will be interesting to see how our contemporary will climb down; perhaps by implying that he knew it all the time and would not spoil the little game, and, like the unctuous Falstaff, when found out, he will address the prince of inventions with the words of Sir John, "By the Lord, I knew ye as well as he that made ye. Was it for me to kill the heir-apparent?"

NOTES.

A Compressed Air Hospital.

Readers of our Forth Bridge number will remember that many of the men employed in the caissons of that bridge were greatly affected by their work in an atmosphere of compressed air, and that they were in the habit of relieving the pain by spending their Saturday afternoons and Sundays in the air chamber. Mr. Moir, the engineer for Messrs. S. Pearson and Sons, of London, and who is now in charge of the Hudson Tunnel works, has, acting on the same idea, constructed a compressed air hospital for the men employed on the tunnel, amongst whom there have been several severe cases of "bends," although the air pressure is not particularly high, never, indeed, exceeding 30 lb. per square inch. The hospital is a cylinder 18 ft. long by 6 ft. in diameter constructed of steel plates $\frac{3}{8}$ in. and $\frac{1}{2}$ in. thick, and divided into two chambers by a transverse bulkhead. One of these chambers acts as an air lock for the other, and both are fitted up with beds and everything necessary for the comfort of the patients. The air pressure is maintained by a pump, a constant supply of fresh air being secured by keeping a pet-cock in the shell of the hospital open, through which the air continually leaks out. A safety valve is also supplied to prevent over pressure should the pumps run away.

Foreign Competition in the Shipping Trade.

An official publication by the Board of Trade affords information on the extent of foreign competition in the shipping trade of this country. The increase exhibited in the official statistics of imports and exports last year, enabled those interested in the trade to anticipate a great addition to the number and tonnage of vessels trading to the ports of Great Britain, and the fact that the figures now issued indicate unprecedented activity, will not create any great surprise. The number of vessels arriving and departing last year totalled 730,410, and the tonnage was a trifle less than 161$\frac{1}{2}$ million tons. This is an increase over last year of nearly 11,000 vessels, but when comparison is made with 1887, the addition is found to be about 54,000 vessels, and over 12$\frac{3}{4}$ million tons. Of the latter increase, British shipowners secure the benefit of three-fourths, the remainder going to foreigners. The figures we have given include the coasting trade, so that to make a fair comparison, it is necessary to consider over-sea trade only, as few foreign owned vessels trade on the coast of this country. The vessels leaving for, and arriving from, foreign ports and British colonies, numbered 124,972, and measured 71,889,895 tons, an increase over 1888 of 5240 vessels and 3,460,750 tons, of which about 38 per cent. is foreign; while over 1887 the increases are 7587 vessels, and 6,729,121 tons, foreigners securing rather more than a third of the increase. We do not suppose that the proportion has increased materially of late years, but the foreign competition is nevertheless great. It may be interesting further to notice the extent of foreign labour in our ships, and in this respect the proportion is on the increase, although the upward movement is slow. Out of a total of 230,263 persons now employed, 26,841 are foreigners, or about 14 per cent. Thirty-six years ago the percentage was not more than 4 per cent. In 1863 it was 11.4 per cent., and for the past ten years there has only been a small addition to the proportion.

Launch of the "Blenheim."

On Saturday last H.M.S. Blenheim was launched at the yard of the Thames Iron Works and Shipbuilding Company, Blackwall. This splendid vessel, with her sister the Blake, was specially designed by Mr. W. H. White, the Director of Naval Construction, to be capable of overtaking and capturing the fastest foreign cruisers, a number of which, such as the Tage, Dupuy de Lôme, and the Cecile, had recently been either launched or laid down in France. The Blenheim measures 375 ft. by 65 ft. by 38 ft., and has a displacement of 9000 tons on a mean draught of 25 ft. 6 in. This is a greater displacement than has ever previously been reached by a cruiser, but it is justified by the fact that the Blenheim will carry engines of 20,000 indicated horse-power, and will steam at 22 knots under forced draught. These engines will by supplied by Messrs. Humphrys, Tennant, and Co. Of the 9000 tons, no less than 4000 have been assigned for the load of protection, armament, equipment, and coal. The Dupuy de Lôme, the crack French cruiser, has vertical armour 4 in. thick, running from stem to stern, but in the Blenheim protection is afforded by a steel deck from 3 in. to 6 in. thick, covering the whole vessel and efficiently protecting the machinery and magazines. Further protection is afforded by the minute subdivision of the hull. The armament will consist of two 22-ton and ten 6-in. breechloading guns, sixteen 3-pounder quick-firing guns, one 1-in. and seven 0.45-in. Nordenfelt guns, and four 14-in. Whitehead torpedo tubes. At the luncheon which followed the launch, Mr. Arnold Hills, the managing director of the company, stated that they had other cruisers, the Theseus and the Grafton, in course of construction at their yard, and also made the interesting announcement that the company were about to take their workmen into partnership by adopting a profit-sharing scheme, by which means they hoped to avoid the annoying labour troubles they had experienced but successfully disposed of during the past twelve months.

New Danish Rifle.

The Danish War Ministry has recently decided upon the introduction of the new Danish infantry rifle, known officially as "1889 rifle." The decision has been arrived at after a very great deal of preparatory work, and the result is looked upon as very satisfactory. The 24th Battalion has already received the new rifle. It is a repeater, with eight millimetres calibre; length, 133 centimetres, and weight 8.5 Danish pounds, or some 9.3 lb. English. The barrel is of compressed steel, 84 centimetres long, and surrounded by another thin steel barrel, which is 75.5 centimetres long, and is screwed to the proper barrel at the back. This gives the barrel a chance of extending when it becomes hot during firing, so that bendings are avoided. The front part of the outer barrel has been made stronger by a ring soldered on to it, the foremost part of which forms a support for the barrel proper, and on which the sights are fixed, so that it is not affected by the heating of the barrel during the firing. The rifle has cylinder mechanism and a fixed magazine underneath the lock. In the magazine there is room for five cartridges, which can be fired in rapid succession, when the rifle is used as a magazine rifle. If used as a single loader, the cartridges are retained in the magazine through a simple mechanism. The cartridge consists of a bottle-shaped brass cover, with the ignition cap, compressed powder charge, and a leaden projectile covered with copper. The powder charge will probably soon be altered, and smokeless powder employed. The bayonet is a knife-bayonet and is fastened on to the strengthened part of the outer barrel. The bayonet weighs without sheath $\frac{1}{2}$ lb. Danish; it is 35 centimetres long, and the rifle and bayonet together have a length of 159 centimetres. The working of the rifle is very simple and can be quickly learnt by every soldier; it is easy to clean, and requires no cleaning during firing, however many shots may be fired. Compared with the Remington model of 1867 the new rifle has some most material advantages. Among these may be enumerated the much flatter course described by the ball, and which makes an exact measurement of the distance less important; the simple and strong construction of the rifle, its great range and great piercing power, the great rapidity of firing, even when used as a single loader, coupled with the momentary violent fire which the magazine admits of, and the easy manner in which the magazine is refilled. Both with regard to ballistic qualities and rapidity of firing, the new Danish rifle is quite equal to the best of modern European rifles.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

Middlesbrough, Wednesday.

The Cleveland Iron Market.—Yesterday the quarterly meeting of the North of England Iron and Allied Trades was held in the Royal Exchange, Middlesbrough. There were, as is customary at quarterly gatherings, several exhibits on 'Change. Messrs. Thomas W. Moenay and Co., of Middlesbrough, showed a number of specimens of Duvall's patent metallic packing. The wire is formed of fine brass wire braided into a square rope. It is cut off in lengths and inserted into the stuffing-box in the usual manner. It is said that the packing will never harden or fire, is self-lubricating, and will last for several years when in constant use. The packing is made in lengths of 7 ft. and in all sizes from a $\frac{1}{4}$ in. to 2 in. A couple of samples which had been in use for some time were shown, and they appeared to be little the worse for wear. A model of a patent steel cogging mill was exhibited by Mr. James Robertson, of Birmingham, and attracted a good deal of attention. Samples of steel fencing made by the British Metal Expansion Company, of West Hartlepool, were shown by Messrs. Thompson and Co., of Middlesbrough. Although the quarterly market was very well attended the amount of business transacted was but small. Quotations were rather easy. Early in the day a few parcels of No. 3 g.m.b. Cleveland pig iron changed hands at 43s. 3d. per ton for prompt f.o.b. delivery, but sellers soon raised their price to 42s. 6d., and as buyers were not easy to find at the last-mentioned figure few sales were recorded. Middlesbrough No. 3 warrants were steady at 42s. 6d. cash buyers, with a few sellers at 1$\frac{1}{2}$d. above that figure. Grey forge iron was in poor demand and was obtainable at 41s. Quotations for hematite pig iron were not so good as they have recently been, business being done at 54s. for mixed numbers of makers' east-coast iron. To-day the market was rather stronger, and a fair business was done at 43s. for No. 3. Middlesbrough warrants closed firm at 43s. 3d. cash buyers, with sellers asking 43s. 6d.

Manufactured Iron and Steel.—In these two important industries there is really no new feature to report. Producers of manufactured iron state that in some departments business is brisk, but the ship-plate and angle branches are very slack. Common bars maintain their price. They are still 5*l*. 15s. less 2$\frac{1}{2}$ per cent. discount for cash, but ship-plates have dropped to 5*l*. 5s. less 2$\frac{1}{2}$ per cent.; there is very little doing. Steel railmakers have a fair amount of work on hand, and heavy sections are still 5*l*. per ton at works. New orders, however, come slowly to hand. Other branches of the steel industry are very slack, and prices are a shade easier than they were a week ago.

The Make and Disposal of Pig Iron in Cleveland.—A day or two ago the Cleveland Ironmasters' Association issued from their offices at Middlesbrough their customary monthly returns showing the production and disposal of pig iron in the north. The statistics show a decrease in the public pig-iron stores and in the makers' stores. The returns show that the number of furnaces blowing at the end of the month was 104 and the number damped down or out 49, as compared with 102 blowing at the end of June, 1889, and 53 damped down or out. One more furnace has been blown in at the Acklam Iron Works. The number of furnaces on Cleveland pig iron at the end of the past month was 60. The make of Cleveland pig iron in the port of Middlesbrough during June was 105,063 tons, compared with 116,405 tons at the end of May, a decrease of 11,342 tons. Outside the port the makes of pig iron was 16,344 tons against 17,376 tons during the preceding month, a decrease of 1032 tons. The total for the whole district was 121,407 tons, compared with 133,781 tons at the end of the previous month, a decrease of 12,374 tons. The total make of other kinds of iron (including hematite, speigel, and basic) was 111,073 tons compared with 104,979 during May, an increase of 6094 tons. The gross products of all kinds of pig iron during the month amounted to 232,480 tons against 238,760 tons in May, a decrease of 6280 tons. The makers' stocks in the port of Middlesbrough amounted to 130,904 tons, against 131,410 tons a month previously, a decrease of 506 tons. Outside the port the stocks in makers' hands amounted to 23,563 tons against 23,808 tons in May, a decrease of 245 tons. The total for the whole district is given as 154,467 tons as compared with 155,218 tons at the end of the preceding month, a decrease of 751 tons. In the makers' stores there were 2161 tons of Cleveland pig iron against 3718 tons at the end of May, a decrease of 1557 tons. The amount of pig iron in the public stores at the end of the month was as follows: North-Eastern Railway Company's 287 tons, against 287 tons at the end of May; Connals' stores 93,809 tons, against 106,032 tons at the end of the previous month, a decrease of 12,223 tons. The total stocks of all hands at the month's end amounted to 250,724 tons, against 265,255 tons on May 31st, showing a decrease of 14,531 tons.

German Coal in Italy.—The exports of coal from Germany to Italy in April amounted to 5950 tons. In this total Westphalian coal figured for 3800 tons, and Sarrebruck coal for 2150 tons.

THE "CITY OF PARIS."

To the Editor of Engineering.

SIR,—The judgment of the Liverpool Court leaves the primary cause of the accident just as much in the dark as it was before. The arguments of the Court are merely negative—that is to say, the supporting of the outboard shaft was *not* insufficient, the pressure upon the stern bearing was *not* excessive, the theory of the ashes is *not* tenable; but the real causes might be perhaps looked for in the bursting of the sleeve, or in the manner of securing the lignum vitæ staves, or anywhere else.

Now, I should think it is not so difficult to arrive at the truth, and—basing my opinion solely upon facts which have been reported and such as I have seen personally—I will endeavour to explain the cause.

When Mr. Doran and the chief engineer of the ship had inspected the bearing on the evening of April 10 they came to the conclusion that the shaft must have broken inside the casing outside the ship. Some hours later, at night, the whole shafting, with the propeller and the shaft casing, fell into the dock. Mr. Walls saw it there at two in the morning, and your reporter a few hours later in the course of the forenoon, having

On April 11 your reporter wrote (see p. 482 of last volume):

"This second fracture did not extend right across the shaft, but could be traced about half round the circumference. On this point, however, we speak with reserve, on account of our not very complete facilities for observations, due to the position of the parts. The fracture was sufficiently open to enable the surface to be observed. The metal appeared good, but there were already incipient signs of *rust* on some of the facets of the fracture."

This report is fully indorsed by the sketch (Figs. 2 and 3) which I made on May 2, the day before the vessel left the graving dock, when the fractured parts were all quite visible and accessible. I may say they look shell-like or leafy, quite different to the rupture at Fig. 1.

When this fracture took place, who could tell? No doubt it must have been some time *before* the last docking of the ship in January last, when they found the wear of the lignum vitæ to be $\frac{5}{16}$ in. Had they taken out the shaft at that time they would have detected the flaw, and certainly no accident would have occurred.

When the wood was cut away then the process of wearing went on rapidly on account of the reduced wearing surface, and of the obliquity of the axis, and when the

Fig. 1.

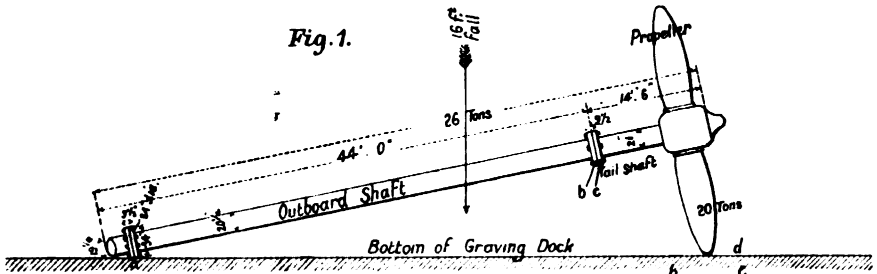


Fig. 2.

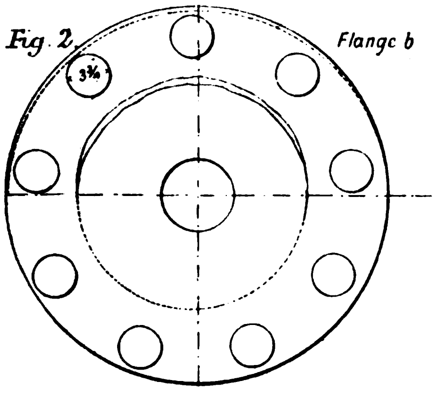


Fig. 3

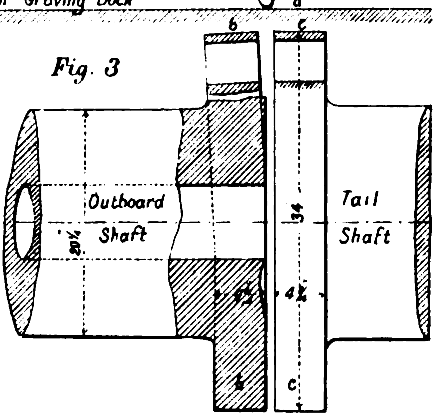
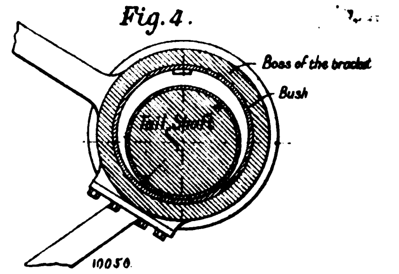


Fig. 4.



arrived in Liverpool early on the morning of April 11. The hindermost tunnel shaft was found broken square off immediately behind the stern tube, whilst the rest of the shafting was not damaged, except the coupling flange of the outboard shaft where it joins the tail shaft.

About *this* break the researches of the Court seem to have been very rash, the whole concern having been superseded by the supposition of the breaking having been caused only by the fall into the dock.

Now let us look somewhat closer into the case.

The weight of both shafts, including the propeller, was 46 tons, falling from a height of about 16 ft. On touching the bottom of the dock (see Fig. 1) this fall must have produced an enormous strain on the coupling *b c*, but that strain was evidently distributed to *both* flanges *b* and *c*, so that the pressures against *b* and *c* were quite alike. Now, either the material could stand that strain or it could not. In the first case both flanges would have remained intact, and in the latter both flanges would be broken. But that was not the case. The flange *c* of the tail shaft was found quite intact, whilst the flange *b* of the outboard shaft was torn off in the manner sketched in Figs. 2 and 3.

This single fact leads to the knowledge that this flange must have been weak or unsound before the accident took place, and, having allowed by this weakness a certain degree of bending to the shaft line, the tail shaft could not possibly work true, but turned wormlike in the lignum vitæ bearing, and such a destructive action no material, even with the very best securing, could stand.

In the course of the inquiries Mr. Heron and Mr. Ramsay, and later on Sir Edward Reed, conceded that such an action *would* be able to wear out the wood; but, strange to me, not one of these gentlemen made even the slightest endeavour to investigate the question.

As the matter is of a decided importance, I will dwell upon it at somewhat greater length.

bush was cut through, the bearing pressure rose from 45 lb. to at least 130 lb. per square inch (see Fig. 4). It seems to me likely that at *this* point the shaft gave way, and the breaking down of the engine occurred, the rest of the wearing down from, say, 2½ in. or 3 in. to 7 in. having been accomplished whilst on the way to Queenstown, and from there to Liverpool. Had the ship moved some miles further, the propeller, with the whole shafting and with the shaft casing, would have dropped into the sea, and as the evidence coming from the Court now is, it could not be more incomplete even in that case.

It is always the same old story; the true cause is very simple and natural, but instead of looking into the right direction, a number of badly supported theories have been set up, serving for nothing but to complicate the matter.

As to the statements of the Court respecting the catastrophe of the engines, my own views about the matter are also widely different. To calculate the amount of stretching (by which, according to the opinion of the Court, the cylinder cover has been driven out), the first thing is to correct the figures for weight of the reciprocating parts (as given on page 482 of last volume). The weight of piston is not 10 but 6 tons, that of the piston-rod not 3 but 1.8 tons, the whole weight not 22, but about 14 tons. The amount of final compression in regular working was 34 tons on the piston as calculated from indicator cards of the engine. The calculation based upon these figures shows that it would require more than 550 revolutions per minute to arrive at a stretching of ½ in. (which has been said to be the clearance at the top), whereas the momentum of inertia would break the piston long before that speed was reached. According to the design of this piston, there has been most likely an internal stress which helped the break. The cylinder cover was damaged at the beginning of the catastrophe, but *did not fall* before the cylinder came down. Otherwise the upper

platform would have been carried away instead of being hanging on the walls, as can be seen in the two-page plate published by you on April 18 last.

The securing of the piston-rod to the piston by that massive flange of 23 in. diameter and 4½ in. thickness was a very dangerous design in the event of a piston fracture. This flange acted like a steam hammer, the corresponding recess for it in the cylinder bottom serving as a collecting pot, and any of the broken pieces happening to get into that recess must have caused the immediate knocking out of the bottom. But by far the most powerful means for further destruction was the connecting-rod having a forked upper end with screwed bearings and caps, the latter moving about 6 in. horizontally twice and in reversed directions for each revolution whilst oscillating round the crosshead gudgeons. Imagine that just after the cylinder bottom was knocked out a suitable piece of it fell upon the crosshead; the said heads of the connecting-rod on clearing their way then exerted an incommensurable crushing against both columns and the feet of the cylinder (about 6000 horse-power of the high-pressure and intermediate cylinder were free to turn the lower end of the connecting-rod, acting then as a lever and forming a sort of squeezer), which no material and nor any design or strength could resist. So the entire ruin of the columns and cylinder was most probably the work of a few instants; the falling of the cylinder and the breaking down of both columns were accomplished perhaps within the same moment. It was just the very hard material of the columns which could cause the holes in the bulkheads and floor-plates.

All these suppositions are the result of lengthened observations and studies carried out during my stay at Liverpool between May 2nd and 9th.

I am, Sir, yours truly,
OTTO H. MUELLER.

Gmunden, Upper Austria, June 29, 1890.

THE SOCIAL STATUS OF CIVIL ENGINEERS.

To the Editor of Engineering.

SIR,—The fact cannot be denied that, in the estimation of the general public, civil engineers *as a body* do not occupy the same social position as members of other learned professions—barristers, physicians, clergymen, &c.; and the reason is only too obvious.

General councils direct and control the education of embryo lawyers and surgeons, and take watchful care that none but qualified men can enter the ranks of professors of law and medicine.

In the case of engineering education, however, no such councils exist, the result being that whilst many younger members of the profession studiously follow out what they believe to be a suitable curriculum, and so obtain a sound knowledge of the science of engineering, very many, in the absence of any incentive in the shape of a compulsory examination for qualification, find themselves at the termination of their pupilage, possessors of a very indifferent professional education.

Herein lies the secret of the unquestionable social superiority referred to; before a man can pose as a barrister, a medical practitioner, or a clergyman, he must prove himself to be possessed of a minimum amount of general and professional knowledge; on the other hand *any one* can dub himself a "C.E." (!)

Architects (who are similarly situated in the matter of social status as civil engineers) have made a move in the right direction in instituting the optional examinations of the R.I.B.A., and in endeavouring to secure Acts of Parliament similar to those controlling admission to the legal and medical professions.

At four National Congresses of Architects held in France the following resolutions have been passed:

1. "That no person in France shall be allowed to exercise the profession of architect, if he is not provided with a diploma certifying to his possession of the minimum of knowledge necessary for the profession of architecture."

2. "That the position of existing architects at the time when the compulsory diploma may come into force, shall be completely respected."

Until such legislation is obtained the general public will continue to withhold from the professions of civil engineering and architecture that complete confidence which it extends to other properly protected professions; and will continue to regard engineers and architects *as a body* with but little respect, so long as the ignorant and unqualified are allowed with impunity to profess to be what they are not, and to bring disgrace upon what are beyond doubt noble and learned vocations.

If civil engineering is to take recognised rank with other professions it is not sufficient to place it on an equal footing with other renowned studies—as it is in the universities of Edinburgh, Glasgow, Dublin, Cambridge, Manchester, &c.—and make it an avenue to a degree, but further a qualifying examination of a fixed standard must be made *compulsory*, and the education of civil engineers directed and controlled by a general council of engineering education. The compulsory course of training should be at once general and technical, theoretical and practical, as it is in other professions. Meanwhile men engage in engineering pursuits without previous thorough and systematic training or any formality beyond the assumption of a title and the displaying of a plate.

Does engineering study present so limited a field, or is the profession so mean an acquirement that no special scientific and general education is necessary? Can a young man "pick it up" as he would expect to do an insurance agency or a land jobber's business? Decidedly not. To acquire the knowledge to construct, and the skill to plan and design engineering structures, and to efficiently deal with the innumerable questions—scientific,

to prevent explosions, is performed by the insurance companies, and although they may have manifested various shortcomings, yet as regards the three leading companies established in Manchester, their occasional but comparatively rare failures, are only what may occur to any institution, or person, which undertakes so difficult and responsible a duty.

"It is high time that your Association recognised the actual state of affairs and avoided the misleading statements which are constantly being reiterated. I infer with your committee's sanction. So long ago as 1870, grossly inaccurate statements were made by Sir William Fairbairn, I presume from information supplied by you or your officials, and which statements I believe your Association never attempted to correct. Such inaccuracies or mistakes should be corrected immediately they are detected or pointed out.

"I assure you that our company have no desire to act in such antagonism to your Association. We are equally anxious, whatever your profession may be, to prevent explosions, and we most strongly object to your Association so grossly misrepresenting our action as above indicated.

"Will you please submit this communication to your committee, so that they, with others, may be made acquainted with, and understand the actual facts?

"Yours faithfully,
"(Signed) HENRY HILLER,
"Chief Engineer and Manager."

[COPY.]

"The Manchester Steam Users' Association Offices.
"9, Mount-street, Manchester,
"April 23, 1890.

"Henry Hiller, Esq.,
"National Boiler Insurance Company,
"Manchester.

"Dear Sir,—Yours of the 22nd inst. in reply to mine of the 25th ult. has been duly received. I will give the points referred to therein my best attention, and submit your communication, if possible, to my committee as you request, so that your views may be brought before them.

"I am, dear Sir, yours faithfully,
"(Signed) LAVINGTON E. FLETCHER,
"Chief Engineer."

The report of the meeting shows that my protest has had but little effect.

Reliable statistics clearly show that the number of explosions, in proportion to the number of boilers in use, has been very much reduced of late years.

Yours faithfully,
HENRY HILLER, Chief Engineer and Manager,
The National Boiler Assurance Company, Limited,
22, St. Ann's-square, Manchester, July 7, 1890.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—There was again a steady tone in the pig-iron market last Thursday, with a marked degree of firmness and an improving tendency. The market was especially strong in the afternoon, support being forthcoming from the character of the Cleveland returns. Scotch iron made an advance of 3d. per ton on the day, and hematite iron was 4d. up at the close of the market. The closing settlement prices were—Scotch iron, 46s. 1½d. per ton; Cleveland, 43s. 3d.; hematite iron, 52s. 3d. per ton. Friday's market was extremely flat and depressed and prices suffered a sharp relapse. There was nothing special reported to account for the relapse, as the stiffness of the money market was not stated to be more pressing. The withdrawals from the warrant stores on the previous day, however, were rather small in amount, and that fact may have exerted some influence. A large amount of business was done, as the easier prices induced buyers to come in. At the close of the afternoon market the settlement prices were—Scotch iron, 45s. 9d. per ton; Cleveland, 42s. 9d.; hematite iron, 52s. per ton. There was a very idle market on Monday. The good effects which the large withdrawals from store might have been expected to exercise on the price of warrants were counteracted by the disappointing accounts of trade coming from the Continent and America. A fair amount of business was done, but after a few sales were made prices broke away all round, and but for some support afforded to the market immediately before the close of the forenoon meeting of the "ring" the fall would have been heavier. The market was quiet in the afternoon, and at the close the settlement prices were—Scotch iron, 45s. 6d. per ton; Cleveland, 42s. 6d.; hematite iron, 51s. 6d. per ton. Partly owing to the improved Board of Trade returns, a stiffening effect was produced upon the market at the opening on Tuesday, when prices had an upward look. In the afternoon, however, warrants were a shade easier in price, and the rise obtained in the forenoon was lost before the close, when the settlement prices were the same as those on Monday. Scotch and hematite warrants were easier at the forenoon meeting of the iron ring to-day, the former losing 3½d. and the latter 4d. per ton on the closing quotations of yesterday. Cleveland iron was somewhat stronger on certain movements of the market becoming known, the finish being firm at an advance of 4½d. on yesterday's closing rates. Buyers at the close were offering 44s. 11d. per ton cash for Scotch iron, 43s. 3d. for Cleveland, and 51s. for hematite iron. Apart from the shipments, which continue to be satisfactory, there is very little in the situation outside to induce operators for the rise to purchase. Last week's shipments of pig iron from all Scotch ports amounted to 10,302 tons, as compared with 9886 tons in the corresponding week of last year. They included 525 tons for the United States, 277 tons for Canada, 285 tons for South America, 178 tons for India, 190 tons for Australia, 150 tons for France, 2135 tons for Italy, 780 tons for Germany, 180 tons for Belgium, 160 tons for Russia, 535 tons for Holland, 230 tons for Spain and Portugal, 115 tons for China and Japan, smaller quantities for other countries, and 3942 tons coastwise. The following are the quotations for several brands of makers' No. 1 iron; Gartsherrie and Glengarnock, 59s. 6d. per ton; Langloan, 61s.; Coltness, 61s. 6d.; Calder, 63s.; Shotts (at Leith), 62s. 6d.; Carron (at Grangemouth), 65s. per ton. The stock of pig iron in Messrs. Connal and Co.'s public warrant stores stood yesterday afternoon at 704,746 tons, against 711,922 tons yesterday week, thus showing for the week a decrease amounting to 7176 tons. There is no change to report in respect of the number of blast furnaces in actual operation.

Shipments of Machinery, &c., from the Clyde.—The foreign and colonial shipments of machinery, &c., from the Clyde, reported last week, included the following: Locomotive engines of the value of 16,400*l.* for Chili and Valparaiso; other machinery, valued at 3600*l.*, chiefly for Calcutta, Peru, United States, Canada, and Sydney; blooms, billets, plates, bars, and other steel goods, of the value of 7500*l.*, chiefly for New York, Peru, Sydney, Calcutta, the Cape, and Halifax; pipes and other castings, plates, sheets, tubes, bars, sleepers, wagonwork, and miscellaneous iron manufactures, valued at 33,040*l.*

The Scotch Coal Trade.—There is no new feature in the trade for the week. Business is still active in the shipping department. At the general terminus, orders are fairly plentiful, and quotations remain at those of last week, main coal being 8s. 9d. f.o.b. The broken weather has made merchants buy house sorts more freely, more particularly as the holidays will be on shortly at the collieries. The strike of coal porters at Dublin has checked orders at some of the Ayrshire collieries, but prices and deliveries, nevertheless, keep well up to the mark. The shipping demand has been very good, and the output has been going well away, alike at the Clyde ports, Ayrshire ports, and on the Forth. To-day's prices at Glasgow Harbour are as follows:

	F.o.b. per Ton.			
	s.	d.	s.	d.
Splint	9	0 to	9	3
Main coal	8	9 ,,	10	0
Steam	10	9 ,,	11	2
Ell	9	6 ,,	10	0

Ayrshire coal, 8s. 9d. to 9s. f.o.b. at Ayrshire ports.

The North British Railway Company and Irvine Harbour.—A very lively state of excitement prevails in the burgh of Irvine to-day on account of negotiations being announced as in progress between the Harbour Trust and Mr. John Walker, general manager of the North British Railway Company, for the acquisition of the harbour by the last-named body, consequent on their Bill being passed by which they aim at buying up the Glasgow and South-Western Railway. There is some talk of a sum of 50,000*l.* being the price at which the harbour is to be obtained by the railway company, but that is deemed, by some of the ratepayers, asking an inadequate price for a harbour which yields a profit of 2000*l.* annually on a capital of 35,000*l.*

Denny Water Supply Works.—Amid much rejoicing on Saturday the Burgh Commissioners of Denny and Dunipace, in Stirlingshire, inaugurated a new water supply scheme, the principal feature of which is a reservoir about 10 acres in extent, distant about 3½ miles from the town, and at a height of about 600 ft. above the sea level. The collecting ground is chiefly hilly pasture, extending over an area of about 250 acres. The reservoir has a capacity of about 24,000,000 gallons, which will afford an ample supply for the population over a period of three to four months. Messrs. Kyle, Dennison, and Frew, Glasgow, were the engineers for the works, and the contract was executed by Messrs. Dobbie and Baxter, Kilsyth. In Denny there are extensive paper-making works on the banks of the River Carron.

Extension of Hamilton Water Works.—A few days ago the new works, consisting of three filters and a reservoir, which have been in course of construction for more than twelve months for the purpose of providing an additional water supply for Hamilton, were formally opened by the Water Commissioners. The occasion was the annual visitation of the works by the Water Commissioners, but in honour of the occasion the engineers, contractors, the agricultural tenants whose lands adjoin, and others were invited. The new filters were unitedly capable of filtering 233,000 gallons of water in twelve hours, being an addition of 65 per cent. to the filtering capacity of the works. The new reservoir covers twenty-nine acres of land, and is constructed to store 70,000,000 gallons, being an increase of 75 per cent. on the former storage capacity. The total cost of the additions is between 15,000*l.* and 16,000*l.* The engineer for the works was Mr. W. R. Copland, Glasgow.

Royal Society of Edinburgh.—The fourteenth meeting of this Society for session 1899-90 was held on Monday evening, Sir William Thomson, president, in the chair. At the outset the president presented the Victoria Jubilee, the Keith, and the Neill prizes to Professor P. G. Tait, Professor Letts, and Mr. Robert Kidston respectively. In presenting Professor Tait with the Victoria Jubilee Prize for his work in connection with the Challenger Expedition, the president said that that work had been primarily undertaken for the purpose of correcting thermometric observations affected in a complex manner by the severe and rapidly varying pressures to which the instruments were subjected, and deducing the true temperatures of the water at the great depths explored in the Challenger expedition. Even had the investigation been confined to this object alone it must have included highly interesting researches regarding the thermo-elastic qualities of water, mercury, and glass, but Professor Tait's researches, carried on with exemplarily determined perseverance, and with peculiar skill and inventiveness through six years, had added to science a valuable body of results regarding the compressibility and expansibility of fresh water and sea water at different temperatures and pressures, the compressibility of water with different proportions of common salt in solution, and the compressibility of mercury and glass. It would, he was sure, be gratifying to Dr. Gunning, the founder of the prize, to learn that so valuable a contribution to science had earned it for the period 1887-90. The president submitted a communication in which he dealt with the mathematical problem connected with submarine cable telegraphy. He described briefly the contents of the paper to the Society. At a later stage of the proceedings Professor Tait exhibited diagrams giving a graphic record of impact. The records had been got by a body with a tracing point falling in front of a large disc of glass running on its axis once per second. Professor Tait explained that the investigation had been suggested by a question frequently addressed to him: Does a golf club remain in contact with the ball during a very large part of the stroke—in other words, could they guide a golf ball through an arc of say a yard and a half? The investigation entirely disposed of a question of that kind. It showed that, practically speaking—although he had not made the investigation directly for golf balls—the golf ball had hardly moved more than its own diameter from the tee before it was entirely quit of the club, and that the club might do what it liked after that without affecting it. The president said it was an instance of superstition dispelled by science. Golfers produced a result, and they knew that by a particular stroke they would produce that result, but the professor had shown that their idea of the manner in which the result was produced had been all a delusion.

Scotch Bills in Parliament.—The Kirkcaldy and District Railway Bill, which aims at bringing certain of the Fifeshire coalfields within easy reach of Kirkcaldy Harbour, was before a Committee of the House of Lords last week, and after a statement on behalf of the promoters of the scheme had been made by Mr. Littler, and the examination of several witnesses, the preamble of the Bill was declared proved. The fight for the acquisition of the Glasgow and South-Western Railway is still in progress in the House of Lords Committee room, where the Duke of Richmond presides most patiently over the proceedings. A great amount of interesting evidence has been given this week. It is difficult to say when the inquiry will terminate as the fight is most bitter and determined on the part both of the North British and the Caledonian Railway companies. The Clyde Navigation Bill is now before a House of Commons Committee; Sir John Kennaway, chairman. At yesterday's sitting the promoters' case was closed.

CANADIAN RAILWAYS.—The railway statistics of Canada for 1889, issued by the Department of Railways and Canals, show that there are 13,325 miles of completed line in the Dominion, while 416 miles more were under construction at the date of the report. The capital raised for Canadian railways to the close of 1889 was 152,115,289*l.* The working expenses for 1889 were 6,227,609*l.*, and the earnings 8,429,923*l.*, leaving a net income of 2,222,314*l.* Over the 12,628 miles in operation last year 12,151,051 passengers and 17,928,626 tons of freight were carried during the twelve months. The greatest system is that of the Canadian Pacific Railway. This company owns or leases in Canada 4973 miles, the Grand Trunk coming next with 3114 miles. Canadian railway mileage has doubled during the last ten years.

COAL ON THE NORTH PACIFIC.—There is evidence of the existence of vast fields of coal in the vicinity of Puget Sound. A letter from Tacoma states that in the basin of the Cowlitz, which rises in Mount St. Helens, there are over 40,000 acres of coal so far untouched. In the Chehalis Valley there are further vast deposits still unexplored. In the Carbon region a vast bed underlies three whole townships, one vein is 24 ft. thick, and it comprises a seam 8½ ft. thick, of perfectly pure coal. In the Raging, Snoqualmie, Skagit, Nooksac, and Wenatchie basins, there are other vast deposits. In Skagit county an extensive track of timber land is believed to be underlaid with a 6 ft. vein of coal of fairly good quality. The deposits extend into British Columbia and Vancouver Island.

DOCK ACCOMMODATION AT SYDNEY.—A large graving dock has just been opened at Cockatoo Island, in Sydney Harbour. On the day on which the dock was opened for use the royal mail steamer Mariposa of 3209 tons was docked. The Mariposa has been followed by the steamship Port Jackson of 2642 tons, the royal mail steamer Zealandia, of 3200 tons, the steamship Kaiser Wilhelm II. of 6990 tons, and the Messageries Maritimes steamer Australien of 5385 tons. All these vessels were docked and undocked without the slightest difficulty. The Kaiser Wilhelm II. had the greatest length of any vessels which have entered Port Jackson. Yet neither of these vessels absorbed all the accommodation which the dock affords. The length of blocks laid on the floor of the dock is 556 ft., the length of the dock from the caisson when in inner berth to the head of the dock is 608 ft.; and when the caisson is in the outer berth the length is 638 ft. The width of the dock between the pier heads it is 84 ft. The depth of water on the sill at high-water spring tides is 32 ft.; at high-water neap tides 29 ft. 6 in., at low-water spring tides, 26 ft.; and at low-water neap tides, 27 ft.

INDUSTRIAL NOTES.

The labour world has lost in Mr. William Crawford a sterling worker and an impartial mind. His election as member for Mid-Durham was a compliment to his character and qualities as the leader of the Durham miners; no one ever expected that he would or could take an active part in the debates in the House of Commons. He was, however, a powerful speaker in his native county, and among his own men. The late Mr. Crawford not only won and retained the confidence of the mining population with whom and for whom he so incessantly toiled, but he won the esteem and the confidence of the mineowners with whom he had so frequently to come into contact, and against whom he had often to contend. The employers knew and acknowledged that in Mr. Crawford they had a representative miner's advocate who would never stoop to do an unjust thing, or take a mean advantage. He was eminently just, and also judicious; if the men were in his opinion wrong, in any action they took, he boldly faced them, and fearlessly contended against the employers whenever he believed the men to be right. His place in Parliament can be easily filled; not so his place in the councils of the Durham Miners' Association, or in the Joint Committee of the Durham Wages Board. The late Mr. Crawford was, above all things, a far-seeing man. He was not led astray by the newest fad, political, social, or industrial. He was shrewdly practical, and had little faith in mere programmes, however specious. Whatsoever thine hand findeth to do, do it with all thy might, was his life-long motto.

The gas strike in Leeds does not appear to have been very creditable to those responsible for the dispute. The Gas Committee of the corporation seem to have been a good deal to blame in not endeavouring to effect a settlement ere the crisis of a stoppage of the works took place, especially as they caused the dispute by the imposition of new conditions. When the supply of gas was insufficient the townspeople began to be alarmed, and the alarm was necessarily intensified when the town was reduced to partial darkness. Locally the Gas Committee are much blamed for their share in the transaction. The attitude of the strikers was not less blameworthy. No one can defend the rioting and resistance to the authorities; the fact of the policy being for the time successful does not in the least alter matters. It is a very long time since scenes of disorder, such as were witnessed at Leeds, have been enacted in this country. Formerly it was by no means unusual for soldiers to be called in to quell riots, but we had hoped that that was a thing of the past. Fortunately nothing worse happened than some broken heads. Happily the dispute was soon settled by mediation. It was agreed that the four months' notice should be withdrawn and that one month's notice only should be given on either side; that extra pay should be given for such holidays as Christmas Day, Good Friday, Whit Tuesday, and Bank Holiday in August, the rates to be double on these days; and at last it was agreed that the blacklegs should be dispensed with, the Gas Committee having to compensate them for loss of employment, expenses, &c. The estimated cost of this short strike is stated to be 20,000*l*., including the damage done and injuries inflicted in the conflict.

The engineering trades throughout Lancashire are still in a state of general activity, there being no lack of employment. What little slackening off is felt is only as yet manifest in the decreasing pressure for overtime in certain branches. In some departments, however, it appears that the orders in hand are running out faster than new ones come to supply their places. At the same time it appears that there is a considerably increased weight of inquiry generally throughout the iron trade in the entire district, and indications are unmistakable that a larger amount of business will be done ere long. Makers of iron are busy, and do not care to take orders below fairly good rates. All this shows that the flush of trade is not over, and that recent haltings were due to causes quite outside of manufacturing industry. Fortunately there are no strikes of any consequence to interrupt trade.

In the Sheffield and Rotherham district trade is in full activity in almost every department of industry, and in several there are wages disputes, although not in the acute stage. The table-blade and spring-knife grinders have sent in notices demanding 10 per cent. advance in wages of those who have not conceded the advance, many of the larger firms having already granted the amount demanded. The men employed in the silver stamping trade have also given in their notices for 10 per cent advance to the only firm refusing the concession, while the awl-blade makers are about to take similar action. The carpenters and joiners are also demanding an increase in wages, and are seeking to make 8d. per hour the uniform standard in the entire district. Sheffield generally has experienced a better run of trade for some time past than has fallen to its lot for many a long year, and it shows no sign of abatement.

The strike of the ship-joiners is declared to be closed. The men have succeeded at all the shipyards in London with the exception of the two largest, Messrs. Samuda Brothers and the Thames Iron Company, whose shops are regarded as being closed to union workmen. The strike, which has lasted eighteen weeks, and in which about 700 men were involved, can scarcely be called successful, seeing that these two firms employ the largest proportion of men in the port of London.

The bargebuilders have made no further headway towards a settlement of their dispute, the employers showing no signs of giving way. The appeal to the trades of London for additional support is being fairly responded to by the unions.

The Greenock and Port-Glasgow engineers, shipbuilders, and other employers have given notice to their workmen that their wages will be reduced by a halfpenny per hour from the 1st of August. The iron shipbuilders determine to resist the proposed reduction, and have demanded an advance in lieu of a reduction. The matters will be discussed at a conference before any overt step is taken to cause a strike.

The dock labourers of Whitehaven have struck work for what they insist are the union prices, which in this case amount to no less than 40 per cent. advance on current rates in Whitehaven. In one or two cases the owners have through pressure been compelled to accede to the demands; in other cases the owners have employed their own men to load and discharge cargoes.

The strike of coal porters in Dublin has been causing great public inconvenience, both to householders and to factories, workshops, and institutions. No satisfactory settlement has as yet been arrived at between the two parties.

The Northumberland miners applied for an increase of wages a short time since, and the coalowners agreed to grant a concession of 2½ per cent. on Saturday last, at their meeting held in Newcastle-on-Tyne.

In the other mining districts generally labour questions are comparatively quiet. In Yorkshire there are a few local disputes, as, for instance, at the Old Silkstone Colliery, where the matters were settled amicably by concessions by the manager, certain advances of a comparatively trifling character being granted. At the Crigglestone Colliery nineteen men had been suspended, but the manager agreed to put them on again after an interview with the delegates of the union. At the Bowling pits the men complained of some deductions, which are being inquired into. There is also a dispute at Mitchell's Main, the details of which will be laid before the joint board of colliery owners and of the workmen. The pitmen at the Trystone Colliery also had a dispute over the discharge of two men, and were eager to give in their notices, but the matter was settled. At the Waterloo Colliery there was a dispute about prices, and some twenty or thirty men ceased work; the matter is under consideration. At the Topcliffe Colliery the men struck before the officials of the union could investigate the matter. The question is the mode of working, whether three men, or two men, shall work in a given place. These disputes, however trifling in themselves, involve a good deal of inconvenience at the pits, but they do not affect the mining population beyond the immediate locality, and often only at a single colliery. A proper wages board would settle all such disputes without loss or inconvenience to anybody.

In Leicestershire the coal trade is somewhat slack, and most of the collieries are working short time. The men are all hot for the eight hours' day, believing that this will be the cure-all for the fluctuations in labour. At one large colliery, where the eight hours' shift has long been the rule, the day-wage men and the boys are worked nine hours, much to the discontent of those who advocate the eight hours.

In the Staffordshire district a number of men had notice to terminate their contracts at the Fishley Colliery, the men alleging that an effort was made to reduce their pay by 2d. per ton. The Midland Wages Board, on being made aware of the circumstances, determined to support the men, whereupon the notices were withdrawn.

Trade is fairly good in Derbyshire, and the coalowners have mutually agreed to raise the standard of prices for all forward contracts, much to the satisfaction of the men, who see in this a prospect of full work at good wages for some time to come. At one of the pits the men wanted to give in their notices, and to strike against one of the colliery officials, but the agent restrained them with the promise that the managers should be interviewed with regard to the complaints.

In Durham the chief topic of conversation is the loss of Mr. Crawford, and the appointment of his successor. Mr. John Wilson has been chosen as the candidate for Mid-Durham, and it is thought likely that he will succeed. Mr. Paterson is mentioned as the probable successor to Mr. Crawford as the secretary of the Durham Miners' Association. The demonstration takes place on the 16th inst., when the vacant place of the late secretary will be more than ever noticeable, after so many years of earnest and honest work on behalf of the class from whom he had risen, and for whom he laboured to the last day of his life.

The Ferndale miners, Rhondda Valley, have served notices upon the coalowners for a reduction of working hours from 10 to 9½ per day, together with an advance in wages. The notices affect some 5000 men, and the action taken may affect a great many more.

The colliery enginemen of Durham are still striving for shorter hours, the employers having made an offer which is under consideration. These men work much longer hours than the miners, and they contend that their onerous duties entitle them to the same hours of labour as those worked in the mines, although they do not demand such assimilation in working hours at present.

Much speculation is rife as to who shall succeed Mr. Broadhurst as the secretary of the Parliamentary Committee of the Trades Union Congress. Mr. Pickard, M.P., was solicited to stand by a section, but he has refused. Mr. Fenwick, M.P., is being put forward by others, but he has evinced no desire for the post. Some had been looking to Mr. John Wilson, of Durham, but he has not signified any intention of standing. Mr. Trelfell, of Southport, is being vigorously supported by many, but he has alienated the socialists, who have determined to run a candidate. The choice will probably fall upon Mr. George Shipton in so far as the representatives of the older unions are concerned, and he will be supported by many of the younger unions. The emoluments are not great, the salary being 200*l*. a year; but it is the key to the situation, and therefore a determined effort will be made to carry a candidate representing the newer phase of fighting trade unionism.

A rather vigorous controversy has been going on in *Murray's Magazine* with respect to the relative and comparative merits and claims of the old and the new trade unionism. Mr. Shipton, the secretary of the London Trades Council, champions the old as against the new. The two replies in this month's magazine scarcely touch Mr. Shipton's contention, both the writers taking rather isolated passages, which are not given in full, instead of dealing with the whole spirit and intention of the article criticised. The position seems to be this. Mr. Shipton asserts that trade unions are based on the voluntary principle, and that the members rely upon individual effort, and upon mutual help by associative effort; while the newer movement whilst accepting the latter, seek to substitute legislation for voluntary regulation by employers and employed as to wages, hours of labour, &c. Judging by the speeches and action of the new leaders it seems that Mr. Shipton's contention is the right one, for they have over and over again declared that the political machine is to be run in the interests of a class as against all other interests. Singularly enough one of the writers of the replies avows this principle and defends it. Mr. Shipton does not say that labour has yet obtained its due reward, but he insists that labour as well as capital has duties as well as rights, responsibilities as well as prerogatives. Surely no thoughtful man amongst either the old or the new unionists will assert the contrary.

TRIAL OF A BABCOCK AND WILCOX BOILER.

We have been favoured by Mr. Michael Longridge with the following very interesting report of a trial recently made by him of a Babcock and Wilcox boiler:

Evaporative Tests of a Water-tube Boiler and Economiser.

Description of the Boiler and Economiser.—The boiler is a single-furnace Babcock and Wilcox boiler, consisting of 42 water tubes, each 16 ft. long by 4 in. external diameter, and a steam drum 21 ft. long by 2 ft. 6 in. diameter. The heating surface is said to be 840 square feet. The firegrate was 4 ft. wide by 2 ft. 9 in. long. The boiler is set in brickwork. The surface of the brickwork exposed to the air measures 7 ft. 3 in. in width, 11 ft. 3 in. in height, and 20 ft. in length. This length is less than the length of the boiler, because at the back end the brickwork casing is overlapped by the economiser chamber and flues, and is not exposed to the air. A large proportion of the front face of the casing is taken up by the ashpit and furnace doors, and by the large cast-iron door which gives access to the ends of the water tubes. The boiler was put down in September, 1886. The economiser (Lowcock's) consists of 48 pipes. Both boiler and economiser are housed and roofed, but the front of the building consists of large doors, which were open on the 22nd and 24th, but shut on the 23rd. There was also a passage through the boiler-house closed by small doors, which were frequently opened and caused a strong draught through the place. The air can play freely round the boiler, but the economiser is protected from loss of heat on one side and one end by the back end of the boiler and main flue, and on the other side and on the other end by the wall of one of the rooms of the works and by the flue, and therefore can lose comparatively little heat by transmission through the walls of the chamber.

OBJECT OF THE TRIALS AND CONDITIONS UNDER WHICH THEY WERE MADE.

The object of the trials was to ascertain the efficiency of the boiler and economiser under the ordinary working conditions. The rate of evaporation was therefore regulated by the requirements of the works, and the method of firing left, to a great extent, in the hands of the ordinary fireman, the company's inspector merely taking care that the grate was kept properly covered, that the coal was thrown on evenly on each side of the grate alternately, and that the draught was not excessive—a very necessary precaution, because the flue was led into a large chimney belonging to a mill close by, which discharged the gases from a number of large boilers. The draught was regulated by the damper at the tail end of the economiser, the dampers between the economiser and the boiler being kept wide open. The bye-flue damper was of course shut, and was practically air-tight. The brickwork surrounding both boiler and economiser was in good order and practically air-tight also.

The upper part of the boiler was cleaned internally on the 15th March and the lower on the 19th April, and all the tubes were swept externally on the 19th April.

The economiser was put down in May, 1887, and may be supposed to be fairly free from deposit.

The pipes in connection with the boiler and economiser were carefully examined by the writer, and the only possible channel by which unseen leakage might occur was closed by the insertion of a new plug tap in the pipe, in addition to an existing screw-down valve which might not have been tight.

DESCRIPTION OF THE VARIOUS MEASUREMENTS.

Feed Water.—The feed was supplied from the town main and measured in two cylindrical vessels, each containing 1000 lb. of water between marks upon the glass water gauges fixed to them. The pipes in connection with these vessels were fitted with plug taps and were so arranged that one vessel could be filled while the other was in communication with the suction pipe of the donkey pump, by which the water was forced through the economiser to the boiler. There was some leakage from the gland of the feed pump and from the blow-off cock of the economiser. The water in both cases was caught and measured. This is the reason why the feed to the economiser was larger than the feed to the boiler (see lines 17 and 18 of Table I.). The temperatures of the feed to the economiser and to the boiler were measured by thermometer.

Steam.—The pressure was taken from the pressure gauge upon the boiler. In order to ascertain how much water, if any, was carried over with the steam, a small valve was screwed into the stop valve casing and a piece of strong india-rubber pipe ½ in. bore and 2 ft. 3 in. long, attached to the outlet of the valve. After this pipe had been thoroughly heated by blowing steam through it, the end was put into a tin holding exactly 10 lb. of water at a known temperature. Then, by measuring the weight of steam or water added and the rise of temperature, the quantity of water mixed with the steam could be calculated. The tin was placed in a wooden box and surrounded with cotton waste. The thermometer was graduated 6½ deg. to the inch, and had been verified at Kew, and the scales used were beam scales sensitive to 5 grains under a weight of 15 lb. Two tests were made on the first day and two on the second. The first of these showed 1.1 per cent. of moisture, the other three showed superheating, the heat imparted to the water in the calorimeter being about 2½ per cent. in excess of the quantity which would have been imparted had the steam blown in been saturated. Considering the extreme difficulty of obtaining accurate results by the method employed it seems best to consider that the boiler produced dry saturated steam, and this course has been pursued in calculating the quantities of heat absorbed by the water in making out the balance-sheets.

Coal and Ashes.—The coal was Burgy from the 7-ft. seam of the Worsley district, and from the pits of the Bridgewater Trustees. Its analysis after being dried at 110 deg. Centigrade is:

Carbon	.7787
Hydrogen	.0478
Oxygen	.0971
Nitrogen	.0156
Sulphur	.0191
Ash	.0417
	1.0000

The calorific value of 1 lb. calculated from this analysis on the supposition that all the hydrogen is free, is 14,051 thermal units. But as the hydrogen is probably not free, but in the form of hydro-carbons of less calorific value, the heat developed by the combustion of 1 lb. of fuel was probably less than that given above. Therefore, although it is necessary to make use of the analysis for calculating the volume and weight of the chimney gases, it is better to rely upon calorimetric tests for determining the heating power. To this end samples were selected and tested. These yielded 13,769 units per pound of dry coal after corrections for the condensation of the steam arising from the combustion of the hydrogen in the calorimeter, and this value has been used in making out the balance-sheets.

The coal contained 5 per cent. of water. The coal was weighed and an account kept of the quantities put into the furnace at each firing and of the time. By means of these accounts the rate of firing was observed and plotted on the diagrams, Figs. 1, 2, and 3. The ashes drawn out of the furnace were also weighed. The weights were considerably greater than that given by the analysis of the coal. The differences have been assumed to be carbon unburnt. This carbon might have been burnt by throwing the ashes on to the fire, but as the tests were to be conducted under the ordinary working conditions this was not done.

Waste Gases.—Samples of the gases at the back end of the boiler and at the exit from the economiser chamber were collected continuously over mercury and analysed at the end of each day's work. The temperature behind the boiler was taken by a mercury thermometer filled above the mercury with compressed nitrogen, and behind the economiser by an ordinary thermometer. These temperatures were taken every fifteen minutes and have been plotted in Figs. 1, 2, and 3.

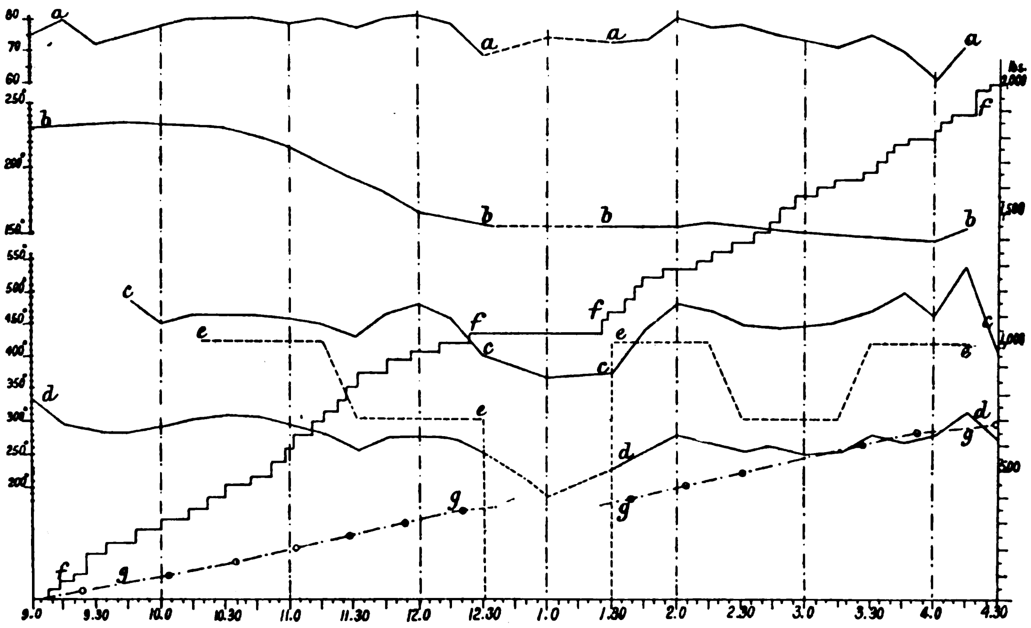
Method of Beginning and Ending the Tests.—The fires were cleaned between 8 a.m. and 8.30 a.m., the breakfast time, and made up for the works to recommence running at 8.30. They were then allowed to burn down, so as to be as low as possible at 9 a.m. At 9 a.m. the quantity of fuel on the grate was judged, the level of the water in the gauge glasses marked, and the tests begun. At 4 p.m. the fires were cleaned, made up again, and then allowed to burn down to the same thickness at 4.30 p.m. as at 9 a.m., while the water in the gauge glasses was brought up to the proper level. At 4.30 p.m. the tests were stopped. Thus the conditions at the end of the trial were as nearly as possible the same as at the beginning with one exception, the temperature of the water in the economiser, which was considerably higher at the start than at the finish. The effect of this will be explained presently. The fires were also cleaned in the middle of the day. An end was made at 4.30 p.m. instead of 5.30 p.m., the regular stopping time, because the state of the fires made cleaning necessary at 4 p.m., and it was thought best to have the same quantity of clinker on the bars (that due to half an hour's work) at the finish as at the start, especially as the duration of the trials, 9 a.m. to 4.30 p.m., with an hour's interval at mid-day, was sufficient to reduce the probable errors in reading the water gauges and judging the fires to very small amounts.

The water in the gauges was very steady and could be read within ½ in., a height which at the middle of the steam drum corresponds to less than 1 per cent. of the total feed, while the small area of the firegrate enabled the fires to be judged to within three or four shovels of coal.

The observations made and the results calculated from them are given on page 56 and in the balance-sheets.

TUESDAY 22nd APRIL

Fig. 1.

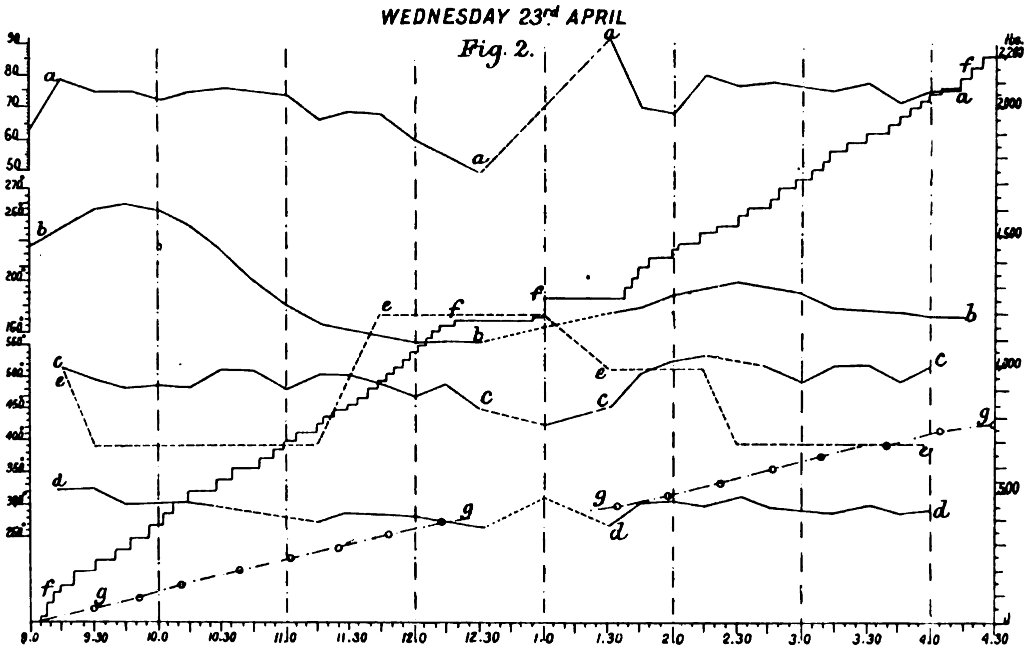


Weight of Coal burnt ——— Scale, 750 lbs. = 1 inch
Steam Pressure ——— " 60 lbs " " "
Temperature of Waste Gases — " 300° " " "
" " Feed Water From Economizer — " 150° " " "
Damper opening — Scale, 7½ ins. = 1 inch
Weight of Water — " 15,000 lbs. " "

(10,028 A)

WEDNESDAY 23rd APRIL

Fig. 2.



Weight of Coal burnt ——— Scale, 750 lbs. = 1 inch
Steam Pressure ——— " 60 " " " "
Temperature of Waste Gases — " 300° " " "
" " Feed From Economizer — " 150° " " "
Weight of Water — Scale, 15,000 lbs. = 1 inch
Damper opening " 7½ ins. = " "

(10,028 B)

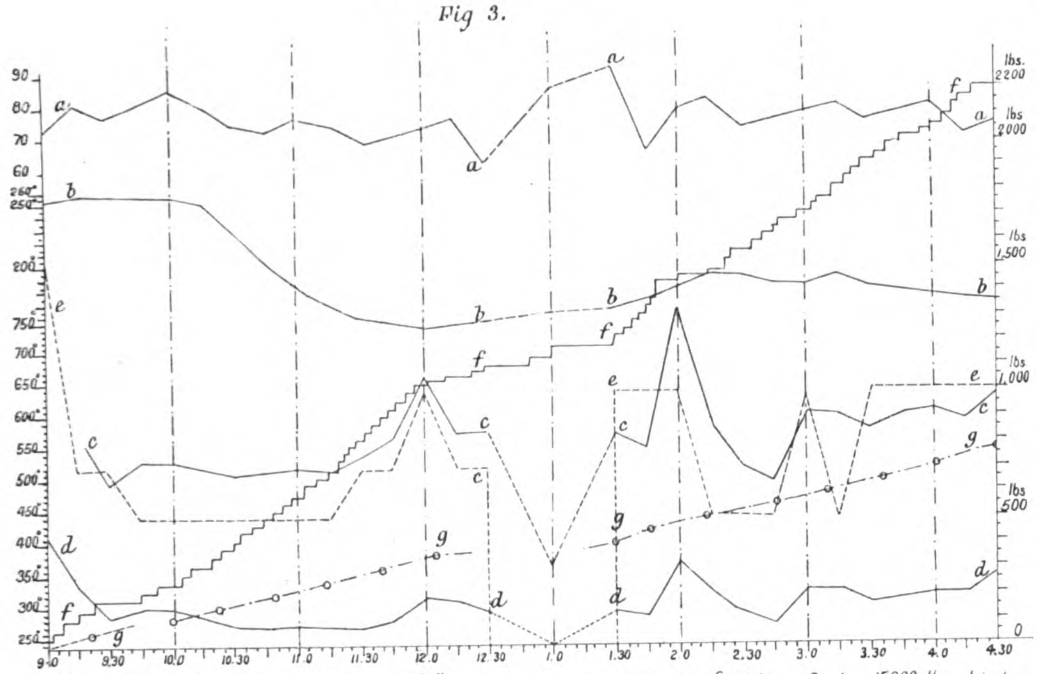
These figures require some explanation, and to render this explanation more intelligible the diagrams, Figs. 1, 2, and 3 have been constructed. They show the variation of the steam pressure of the temperatures of the feed to the boiler, of the gases leaving the boiler and economiser, of the position of the damper and the rate of firing on each day, also the time when each tank of feed water was emptied. This last line shows approximately, but not exactly the rate of feed, for at times the donkey ran slower than at others, and occasionally it was stopped. These diagrams demand attention. The top line in each marked *a a* represents the variation of the steam pressure to a scale (drawn at the left side) of 40 lb. to the inch. These lines are somewhat irregular, owing partly to the difficulty of keeping a steady pressure in a boiler of this kind, partly perhaps to changes in the load upon the engine, and in the draught which was produced as has been stated by the chimney of an adjoining mill, and was therefore dependent upon the firing of the boilers at that mill. On the 23rd, as will be seen from Fig. 2, the pressure was 12 lb. lower at the start than at the finish. This, however, would have very little effect upon the result of the trial, for the pressure was rising rapidly at the start, and reached 75 lb. per square inch, the same pressure as at the end a few minutes after.

The next lines marked *b b* show the temperatures of the feed from the economiser to the boiler to a scale of 100 deg. to the inch. They are particularly interesting, as they explain what at first sight would appear to be a mystery. If the heat lost by the gases in passing through the economiser be calculated from the figures in Table I., and compared with the heat imparted to the water in the economiser, it will be found that the water gained more heat than the gases lost, which is, of course, impossible. The discrepancy arises from not taking into account the difference in the quantity of heat contained in the water at the beginning and end of each trial.

During the breakfast half-hour the feed was stopped, but the water in the pipes continued to receive heat from the brickwork, and when the mill started again at 8.30 a.m. with clean fires and the damper fully opened to get the steam up, but little feed was pumped in (the boiler having been run up previous to the stoppage) until the test began. At the end of the trial, however, the water in the tail end of the pipes was absolutely cold, and the mean temperature of the whole quantity contained approximately a mean between that of the cold feed and of the hot water going into the boiler. The effect is seen in the lines *b b* on the diagrams, which show that the temperature of the feed to the boiler did not begin to fall till three tanks had been pumped into the economiser, or, in other words, till the whole of the water contained in the pipes at the start had been displaced; for the economiser held as nearly as could be calculated 2800 lb. and each of the tanks 1000 lb. of water. When this difference is taken account of, the two quantities, heat lost by gases and gained by water, become nearly equal, except on the first day's trial, which will be discussed presently. They are not quite equal because there is a difference in the quantity of heat contained in the brickwork at the beginning and end of the trial, but as there is no means of estimating the amount of this difference, it has been left out of the account, or rather included in the balances (see balance-sheets for the economiser). How far the boiler trials may have been affected by difference of initial and final states is also a matter of speculation, for the amount of the difference cannot be measured; its general effect would be to increase the balances of heat unaccounted for by adding to the heat supplied.

THURSDAY 24th APRIL

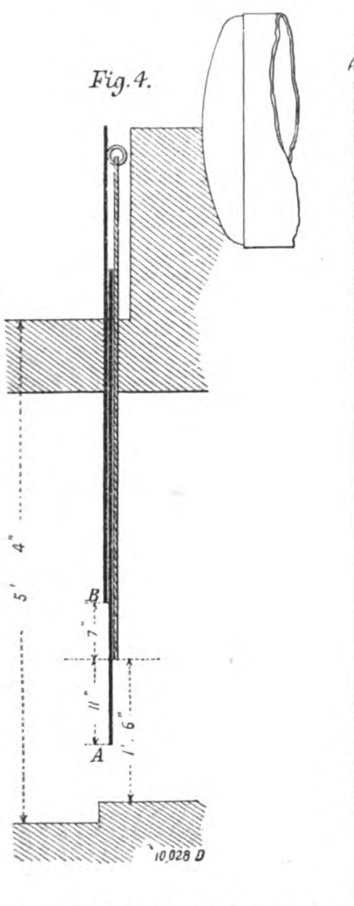
Fig 3.



Weight of Coal burnt — Scale, 750 lbs. = 1 inch
Steam Pressure — " 60 lbs. = " "
Temperature of Waste Gases — " 300° = " "
" " Feed Water From Economizer } — " 150° = " "
Weight of Water — Scale, 15000 lbs. = 1 inch.
Damper opening — " 7½ ins. = " "

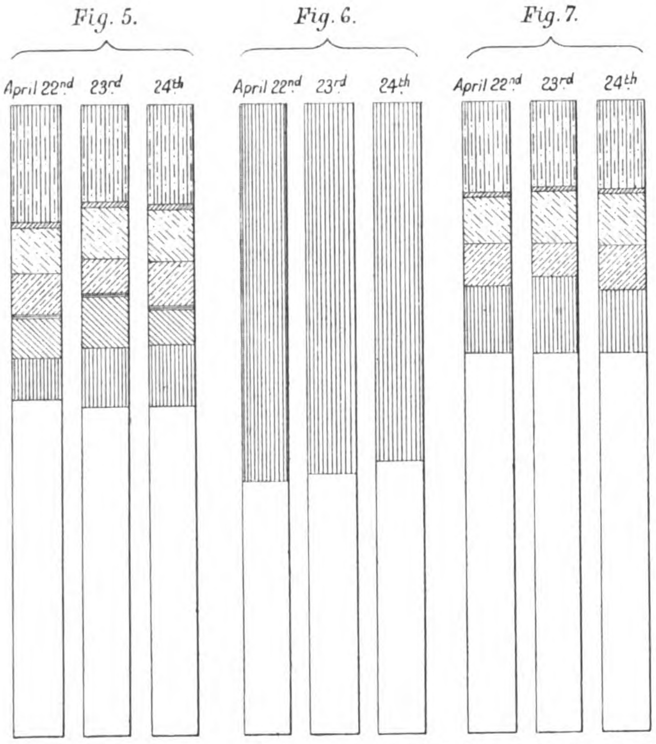
(10,028 C)

Fig. 4.



10,028 D

Fig. 5. Fig. 6. Fig. 7.



Heat transferred to Water
Heat lost in waste gases
Heat lost in unburnt air
{Heat carried off by superheated steam from Water mixed with coal
Heat lost by imperfect combustion
{Heat equivalent of unburnt carbon mixed with ashes
{Heat lost in Hot Ashes drawn from Fire.
{Heat lost by radiation & other losses

10028 E

The next lines *c c*, *d d* on the diagrams represent the temperatures of the gases leaving the boiler and the economiser. Of these, the only one that really calls for explanation is the line *c c* for April 22. It is much lower than the corresponding lines on the other days and much nearer the line *d d* showing the temperature after passing the economiser, and on referring to the balance-sheets for the boiler for that day, it will be seen that the heat lost by radiation and unaccounted for was much greater than on the two following days, while the deficiency in the heat lost by the gases in their passage through the economiser is also greater. On considering all the figures, one is almost forced to the conclusion that the thermometer which gave the temperature behind the boiler must have registered incorrectly; but this explanation is difficult to believe, for not only was the thermometer the same as was used on the two following days, but in exactly the same place; in fact, it was not moved at the end of the first day's trial, but was left in the flue all night and all through the following day, the only difference being that it and the damper were more carefully packed to prevent admission of air on the two last days than on the first, but this could hardly account for the difference, as the small quantity of air which may have entered on the first day could hardly affect the temperature near the bottom of the flue where the thermometer bulb was placed. This will be understood by looking at Fig. 4, which is a cross-section of the flue behind the boiler showing the positions of the damper, which remained unmoved throughout the three trials, and of the thermometer, the bulb of which is indicated by the letter A. A rough calculation of the results of the first day's trial made in the evening as soon as the gas analyses were completed, indicated clearly the discrepancy above described in the heat lost and gained in the economiser. Suspicion at once fell upon the thermometer, and in order to test it a second thermometer was inserted on the second day as a check upon the first. Both read the same to one degree. As both were new from the makers, the probability is that both were correct, and therefore it seems impossible that the indications on the first day can have been wrong. If then the balances of heat expended and accounted for on the first day's trial are incorrect, the reason why they were so must remain a mystery. Having the two thermometers in the flue together, the writer thought it advisable to make some observations of the difference of temperatures above and below the bottom of the damper. For this purpose the second thermometer was raised sufficiently to bring the bulb to B (see Fig. 4). The following are the temperatures recorded simultaneously by each:

	deg.	deg.	deg.	deg.	deg.	deg.	deg.	deg.	deg.	deg.	deg.
Thermometer A,	583	570	579	577	606	644	595	588	556	541	608
" B,	514	505	514	520	525	572	540	536	518	493	552
Difference ..	69	65	65	57	81	72	55	52	38	48	56

the mean difference being 60 deg. Fahr.

These observations were taken at intervals of about four minutes, and they show two things very clearly. 1. The importance of placing the thermometer directly in the current of the gases. 2. The importance of taking very frequent readings if absolute accuracy is to be insured.

One reference to line *c c* on the diagram, Fig. 3, for the 24th of April before proceeding. The excessively high temperature reached at 2 p.m. is curious. As soon as the engine started at 1.30 the pressure began to fall, the damper was lifted to 10 in., as shown by the line *e e*, drawn to a scale of 5 in. to the inch, four small charges of coal were thrown on, then a larger charge, and finally at 1.40, the largest charge of the day about 60 lb. Naturally the temperature at the back end of the boiler rose, but that it should have risen so much higher than at any time excited attention at the time, and is certainly rather curious. The rise of temperature behind the economiser at the same time, shown on line *d d*, is, of course, a natural consequence. The lines *e e* have been explained.

The diagonal stepped lines *f f* represent the quantities of coal burnt to a scale drawn on the right side of the diagrams of 500 lb. to the inch, each step representing one charge.

The other diagonal lines *g g* represent the quantities of ments W. A flexible tube R incloses the whole. The valve is so adjusted that a slight angular motion of the brake varies the free water passage through the slots (see Fig. 18); and the aperture at H, through which the water is discharged, being small and constant, the pressure of the water in the chambers W W is thus automatically varied.

The dynamometer is operated as follows: The chamber N N M being filled with oil, weights are suspended from the arm to give the desired load. The engine is started, and when up to speed a valve is suitably opened in the water pipe leading to the automatic valve V, which latter being open, allows water to pass to the compartments W W. The pressure of this water forces the copper plates against the sides of the revolving disc A—with which they were already in contact—causing sufficient friction to balance the weights upon the arm, which then rises. This motion operates the automatic valve, checking the flow of water to the brake and regulating the moment of the friction on the disc to the moment of the weights applied to the arm of the brake. The first trial of the machine gave remarkable results.

The topical questions were then taken up. The first brought little information; the second, as to the greatest number of times per minute a dash-pot apparatus can be lifted such as is used in the Corliss valve gear, brought out a variety of replies; like a good fish story the last man had the best chance, and starting at 100 the bidding finally reached 240, which ought to satisfy any reasonable man.

That evening was reserved for the chimney question. Professor Gale, from his name, was certainly entitled to a draught, and it seems as if his modest paper of the last meeting had exceeded the usual breeze and raised something of a cyclone. As this was a battle of the professors, and as some one at this meeting defined mathematics as an exact scientific language, it may be supposed that the thoughts followed this method of expression. The writer cannot say which one of the contestants came out ahead, but as Professor Wood's paper had the most formulæ in it, and the greatest number of sub-accents, it is probable his view is the correct one, especially as he supported the position of your great English engineer, Mr. W. J. Rankine. These four papers will make excellent vacation reading in hot weather and in a cool shady place. If any one doubts it he had better make the attempt. The gist of these papers may be summed up as follows:

PECLET'S TREATMENT OF CHIMNEY DRAUGHT, BY J. BURKITT WEBB.

This is a review of Peclet's mathematical treatment of the theory of chimney draught, for the purpose of making clearer this difficult subject, which has recently given a great deal of trouble to students and authors.

CHIMNEY DRAUGHT, BY DE VOLSON WOOD, HOBOKEN, N.J.

This is a paper written in defence of Rankine's statement that the maximum quantity of air drawn in a chimney occurs at a temperature of the heated gases of about 600 deg. Fahr., which statement has been frequently criticised as being in error. Professor Wood studies Peclet's and Rankine's formulæ and data, and draws the conclusion that in a properly constructed chimney, properly working, there is a temperature giving a maximum draught, and that this temperature is not far from that given by Rankine, although in special cases it may be 50 deg. or 75 deg. more or less. The analysis is not applicable to abnormal cases, such as a chimney too large in area and too small in height.

TESTS OF RECENT FORMULÆ FOR CHIMNEY DRAUGHT, BY WILLIAM KENT.

This is a criticism of formulæ for dimensioning chimneys, recently published by Professor Gale. Arithmetical computations are made by the use of the formulæ for certain assumed cases, producing such results as a chimney 8 ft. high and 2.21 square feet area for a boiler of 20 horse-power, 28 ft. high and 12.46 square feet area for 200 horse-power and 61 ft. high, and 41.62 square feet area for 1000 horse-power. These results, the author states, differ so greatly from the dimensions used in practice as to throw doubts upon Professor Gale's formulæ.

One thing of value, was, however, developed in the discussion, and that was Mr. Barrus' draught gauge, which consists essentially of an ordinary U-tube, made of glass, surmounted by two chambers. The tube is about $\frac{3}{8}$ in. in diameter, and the chambers 2 in. or $2\frac{1}{2}$ in. in diameter, depending upon the amount of magnifying desired. One chamber and the tube on one side of the zero mark are filled with oil, and the other chamber and the tube on the other side of the mark are filled with coloured alcohol, the upper portions of the chambers being empty and open to the air through the small tubes. On connecting the appropriate chamber with the flue of the boiler or chimney, the height of the liquids in the chambers is varied in about the same proportion as that in the ordinary U-tube gauge. The line of demarcation between the two different coloured liquids in the glass tube, however, is moved a much greater amount, depending upon the relation which exists between the diameter of the glass and that of the chamber.

REFRIGERATING MACHINERY.

"The Test of a Refrigerating Plant," by Professor D. V. Wood, was the next paper, and this had been prepared for the Erie meeting, but was lost in the mail. The plant consisted of two boilers, an ammonia compressor of two single-acting upright cylinders driven by a double-acting horizontal Corliss engine, fresh-water pumps, hoists, and electric dynamos; and in order that the test should involve only the refrigerating plant, it was made on a day when all the other machinery was not used, and only one of the boilers was fired. No brine was used, but the liquid ammonia and the ammonia vapour were circulated through the cooled cellars. The general arrangement of the parts has been already published by us (see ENGINEERING, vol. xlv., page 589). A sufficient quantity of oil is pumped into each of the compressor cylinders each stroke to more than fill the clearance spaces; a part of this oil passes out of the compressor with the ammonia, and afterwards is separated from the former in a "separator," and the remainder leaks through the stuffing and runs down the piston-rod. The volume of ammonia per stroke was considered as equal to the piston displacement less the volume of oil forced into the cylinder, although, on account of the leaking of the oil, the volume of ammonia somewhat exceeded this amount.

The temperature of the ammonia gas in the pipes was determined by inserting the bulb of a thermometer in a pouch filled with mercury, which latter was bound against the pipe on the outside. The correction to be made to the readings was determined by an experiment in the laboratory, in which the thermometer was placed as nearly as possible in the same condition as in the test, the heated fluid passing through the pipe being water, whose temperature was measured directly. The maximum difference between the readings of the outside and inside thermometer was about 2 deg. Fahr. Professor Mayer, according to experiments since made at the Institute, gives it as his opinion that if the mercury had been in contact with the pipe, and the pipe well covered by felt for a foot or two each side of the place of the thermometer, the reading of the thermometer would have been the temperature of the ammonia in the pipe—in which case no correction would have been needed.

The test lasted $11\frac{1}{2}$ hours, and the ammonia evaporated was 1669 lb. per hour. The heat removed from the cold room per pound of ammonia pumped was found to be 509.9 thermal units, and for the 1669 lb. per hour 851,311 thermal units, which figure being divided by 142, the latent heat of fusion of ice, gives an "ice-making capacity of 5955 lb. per hour, or 71.94 tons of 2000 lb. each per twenty-four hours. The average indicated horse-power of the engine was 91.13 lb., so the ice-making capacity was 65.79 lb. per horse-power. If 30 lb. of steam were used per indicated horse-power per hour the ice-making capacity was 2.19 lb. per pound of steam. And if 3 lb. of coal developed an indicated horse-power then the capacity referred to coal was 21.93 lb. per pound of coal.

The results are given in the following Table of efficiencies:

Efficiency of furnace and boiler (see above)	0.807
Efficiency of steam utilised by engine (see above)	0.0721
Efficiency of engine referred to coal ...	0.0582
,, compressor referred to engine (see above)	0.755
Efficiency of compressor referred to coal 0.755 × 0.0582	= 0.0439
Efficiency of refrigeration referred to compressor . $\frac{851311}{193645}$	= 4.39
Efficiency of refrigeration referred to indicated horse-power of engine ...	3.31
Efficiency of refrigeration referred to boiler 3.31 × 0.0721	= 0.233
Efficiency of refrigeration referred to coal 0.238 × 0.807	= 0.192

that is, for every thermal unit in the coal there was abstracted 0.19 of a thermal unit from the cold room.

Professor Wood's paper "On the Graphic Representation of Thermal Quantities," cannot be given in abstract, as it is a demonstration and is rather intended for mathematicians.

Professor Webb's paper "On the Length on our Indicator Cards," deals with errors in such length on account of the oscillation of the drum spring differing from the rate of speed of engine.

(To be continued.)

MODERN FRENCH ARTILLERY.
No. XXVIII.

MORTARS AND HOWITZERS.

THE series of mortars and howitzers made at Havre by the Forges et Chantiers de la Mediterranée on the Canet system comprise twelve different calibres, each divided into a long and short type as ollows:

Calibre	75	millimetres	2.95 in.
,,	84	,, ...	3.31 ,,
,,	10	centimetres	3.94 ,,
,,	12	,, ...	4.72 ,,
,,	15	,, ...	5.90 ,,
,,	19	,, ...	7.47 ,,
,,	22	,, ...	8.66 ,,
,,	24	,, ...	9.45 ,,
,,	27	,, ...	10.63 ,,
,,	30	,, ...	11.81 ,,
,,	32	,, ...	12.60 ,,
,,	34	,, ...	13.39 ,,

The long gun of each of these calibres is designated a howitzer, and gives an initial velocity to the projectile of 984 ft. per second; the short type, or mortar, is intended for lower velocities of about 200 metres, or 656 ft. The same kind of projectiles are fired from each class of gun, and in many cases, the mountings are equally well adapted for mortars and howitzers. For the small and medium calibres, the breech-closing mechanism is on the Canet helicoidal system, to be presently illustrated and described, but in the larger calibres, arrangements similar to those used for heavy coast defence, and naval guns, with mechanical appliances for reducing the labour of the men serving the piece, are introduced. The rifling of all these weapons is made with a progressive pitch, and those now being constructed are adapted for the use of the slower burning smokeless powders, the force of which, less violent at the moment of explosion, is more sustained, and thus necessitates a different arrangement of the steel employed. For naval service the mode of firing the charge is by percussion fuzes; for land service the friction fuze is more generally employed, but the arrangement of the breech mechanism is equally well adapted to both modes of firing.

Figs. 310 to 315 (pages 64 and 65), represent a 15-centimetre (5.90 in.) howitzer mounted on a carriage of peculiar form and provided with a special arrangement of hydraulic brake, which is worth describing, although it may not find a large application in practice. The gun itself is 12 calibres in length, and weighs about 1700 lb. In construction it closely resembles that adopted for the field guns made at the Havre works already described, and is built up with a central tube, a jacket, on which the trunnions are formed, and a reinforcing hoop at the breech. The rifling is cut with an increasing twist varying from 0.30 deg. to 8 deg., and the number of grooves is 48; the breech is closed by the Canet helicoidal arrangement above referred to. The projectile fired from this howitzer weighs 32 kilos. (70.4 lb.), and the initial velocity obtained with the normal charge of 6 lb. of brown prismatic powder is 984 ft. The most interesting feature of this arrangement is the carriage on which it is supported, and which was designed by M. Canet with the special object of utilising this class of ordnance on board ship to the best advantage by mounting it in such a way as to reduce to a minimum the strains on the deck to which it is secured. As will be seen from the illustrations, the trunnions of the gun rest in bearings made in the upper ends

MODERN FRENCH ARTILLERY; MORTARS AND HOWITZERS, CANET SYSTEM.

CONSTRUCTED BY THE FORGES ET CHANTIERS DE LA MEDITERRANÉE, HAVRE.

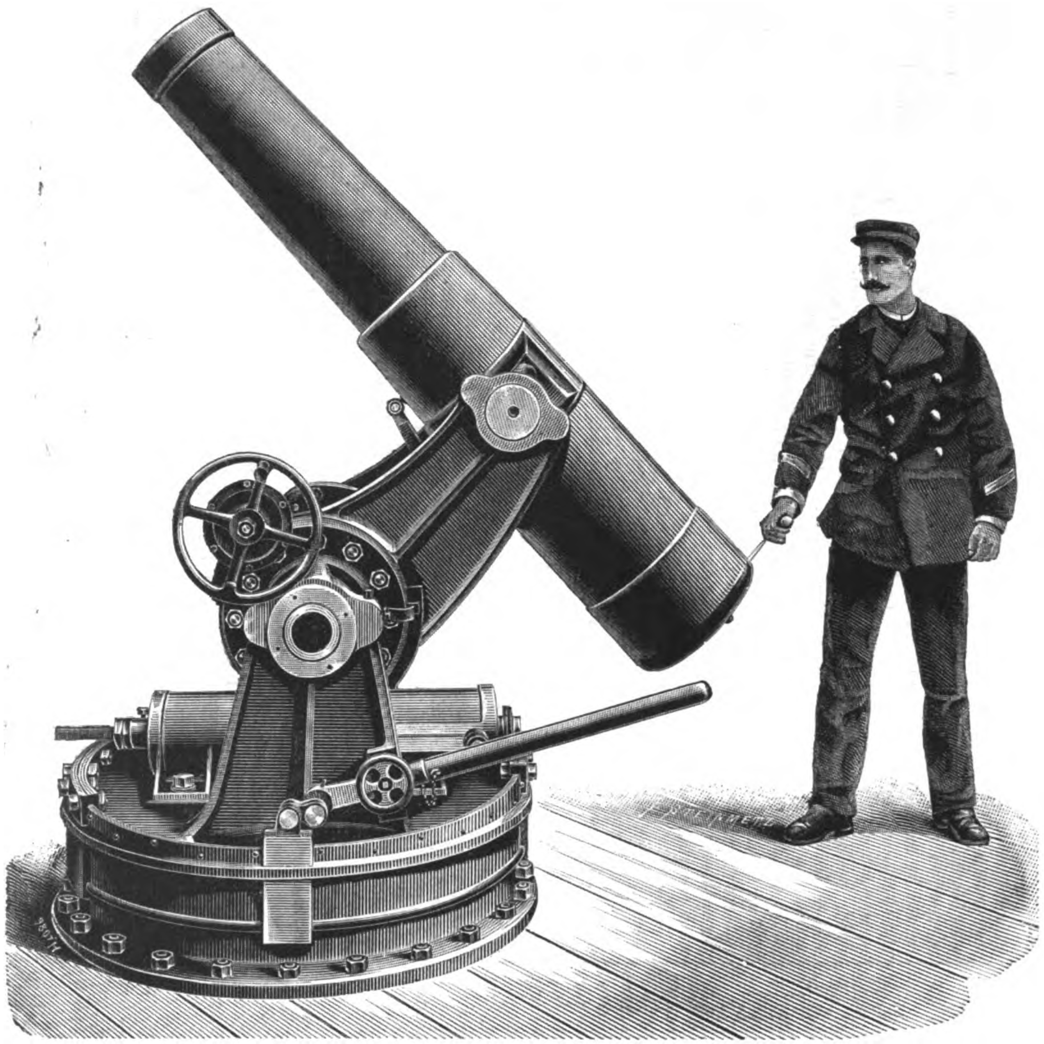


FIG. 310.

FIG. 321.

of the two steel swinging arms A, Figs. 311 to 315; these are mounted on trunnions that take their bearings in the blocks B B that are formed in one piece with the circular frame C, which is made of steel. The gun is also supported by two rollers *a* and *b*, of which that at *a* is seen in the drawings, which are mounted on the ends of a rod connected with the swinging arms A; this rod is held up in position by a spindle, the lower end of which bears upon a powerful coiled spring; by this arrangement when the arms A turn in their bearings and the gun is drawn back with them, it is maintained at a constant angle. The frame rests upon a circular bedplate, a ring of rollers not shown in the drawing being interposed between the two; the two clipping plates *i i* prevent the gun mounting from being thrown off its base. The arrangement of hydraulic brake is a very peculiar one, it is illustrated by a separate detail, Fig. 314. Upon the bearings B B is attached by nuts a shaft E, around which are made three radial projections as shown in Fig. 314. Around this shaft is placed a gun-metal drum, from the interior of which projects three converging ribs; for the greater part of its circumference this drum is surrounded by the cylinder G, which forms part of the balanced arms in which the trunnions of the gun rest. When the gun is in firing position, the liquid upon which the action of the brake depends is contained in the spaces *f* and *f*; when the piece recoils after firing, the balanced arms are thrown back dragging with them the drum, and the liquid is forced past the ribs to the other side, flowing around the ends and along the spaces left between these ribs and the shaft E; the form of these openings is so arranged as to preserve a constant resistance during the recoil. The lower side of the drum F is formed of two arms H, on which are attached two rods *g*, Fig. 315. These are connected by a crosshead *h*, which during the period of recoil compresses a series of Belleville springs which are placed within the horizontal cylinder I, and in which is thus stored up a reserve of energy which is utilised afterwards for bringing the gun back to firing position. The device for training the howitzer in elevation is shown upon the drawings. To the forward part of the cylinder G is bolted a casing K, through which passes an endless screw *k*. Upon this screw is a block which is able to move along a guiding groove made in G, and the rear end of which also enters a spiral groove formed on the outside of the drum F. This screw is actuated by the handwheel V and by differential gearing, and causes, when it is turned, the sliding block to operate on the drum F, which constitutes practically a fixed part of the mechanism, since it is supported by the liquid within the brake; but the drum G, and with it the arm A, and the gun, are forced to move through a certain angle varying with the movement of the wheel V. A scale of degrees is marked on the cover of the left-hand trunnion. It is by means of this endless screw and the sliding block that the drum F of the

MODERN FRENCH ARTILLERY; MORTARS AND HOWITZERS, CANET SYSTEM.

CONSTRUCTED BY THE FORGES ET CHANTIERS DE LA MEDITERRANÉE, HAVRE.

Fig. 313.

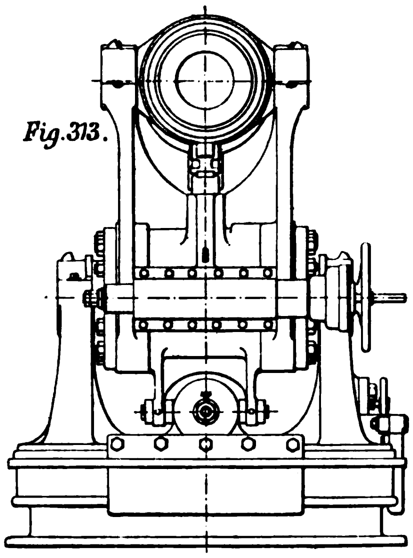


Fig. 316.

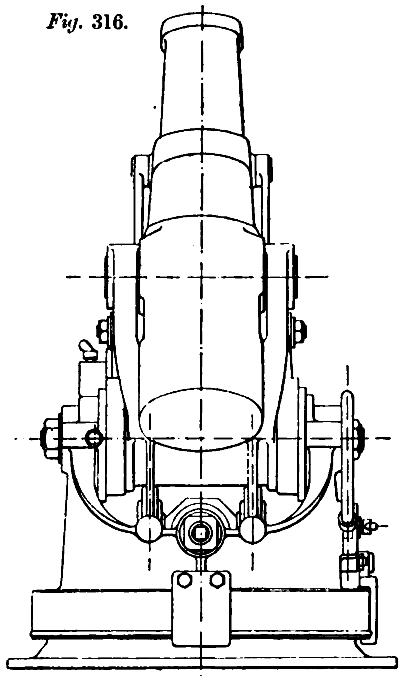


Fig. 317.

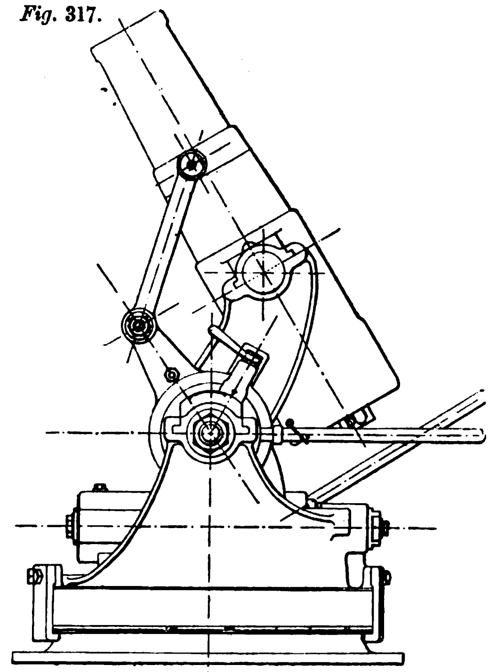


Fig. 311.

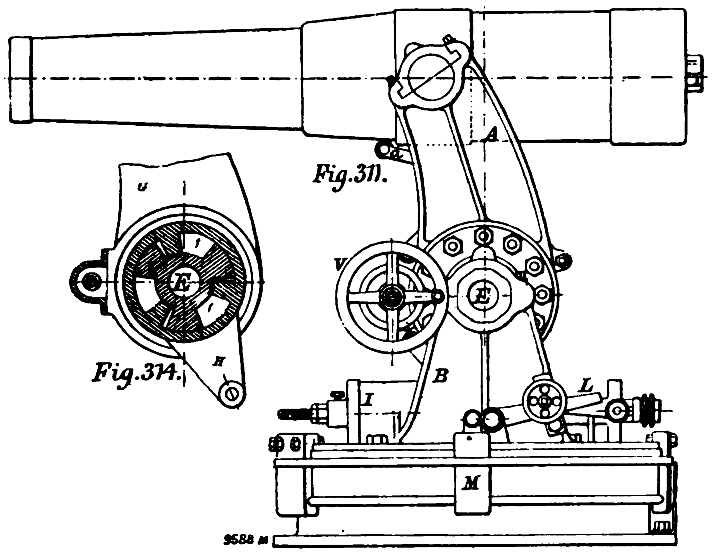


Fig. 314.

Fig. 318.

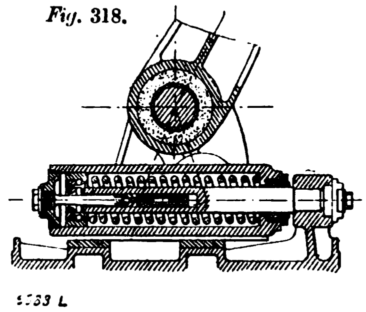


Fig. 319.

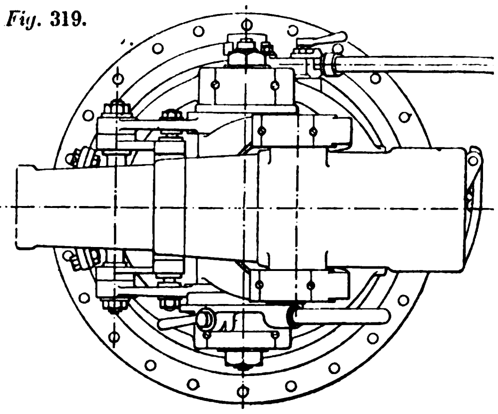


Fig. 312.

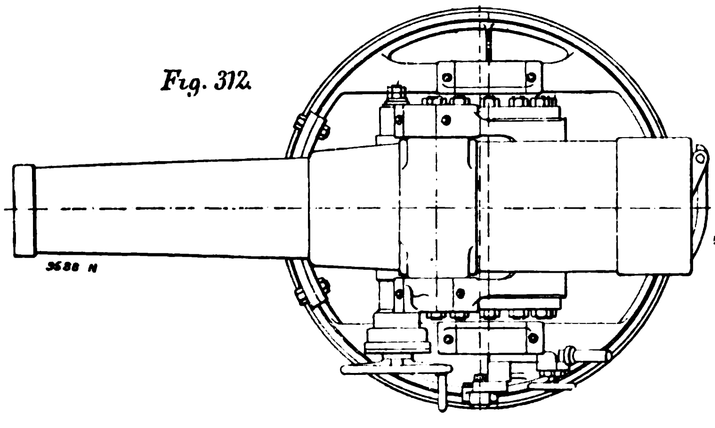


Fig. 315.

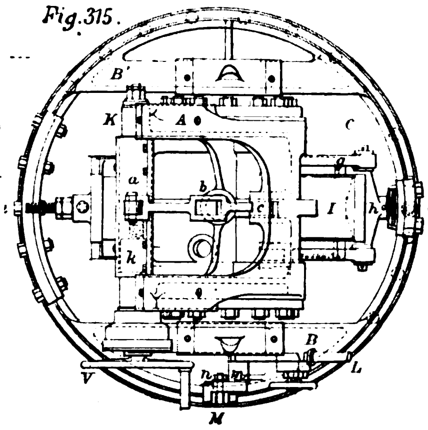
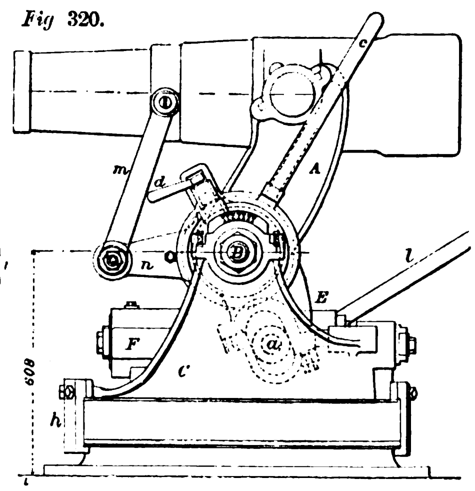


Fig. 320.



brake is drawn back with the arms A during the period of recoil. For training horizontally the carriage C is caused to revolve upon the pivot of the baseplate by means of the lever L, which turns upon the axis *m*, and carries an arm *m n*, to which is fixed a jaw M, that grips the carriage and the baseplate. This lock is unfastened by slightly raising the lever, and by turning the hand-wheel of the brake the lever can be lowered and locked in any desired position. When the jaw M is loosened, the gun can be easily turned around its pivot by pulling on the lever L. The carriage and baseplate are marked with a scale of degrees, so that the gun can be set at any desired angle and locked by the brake wheel. The weight of this gun mounting is about two tons, and the circular brake arrangement that we have described permits of an angle of fire ranging from 0 deg. to 60 deg.

A mortar, mounted in a somewhat similar way to this howitzer is illustrated by Figs. 316 to 321. It is constructed in the same manner as the howitzer, which we have just described, but it is, however, only eight calibres in total length, and weighs 960 lb.; it is rifled with forty-six grooves of increasing pitch, varying from 1 deg. 30 min. to 5 deg. 17 min.; the breech is closed by the Canet helicoidal mechanism. The weight of projectile fired from this mortar is 70 lb., and the powder charge is 3.3 lb.; the initial velocity is 656 ft. The form of carriage which is shown in the engravings is, like that of the howitzer, intended especially for naval service and to reduce as far as possible the strain on the deck of the ship. In general appearance the mounting resembles that of the howitzer, but the arrangements are somewhat different; the swinging arms A, upon which the mortar is carried, turn around a shaft B that takes its bearings in the two blocks C that are cast upon the frame; between the shaft and the arms is interposed a thick sleeve of rubber, the object of which is to deaden the shock on the firing platform; the balanced arms carrying the mortar are extended below the shaft by two shorter arms. In front of the trunnions the gun is supported by two jointed levers m n, the upper one of these two is fastened by a pin to a collar that is passed around the gun, the lower one turns around the shaft that supports the arms A. The amount of recoil is limited by a hydraulic brake of the Canet type; the nature of this arrangement has been already described; the body of the pump F is free to move upon two trunnions that take their bearings in recesses formed in the short arms of the mounting, the rod b of the piston is fixed to the frame, and a coiled spring rolled round the rod constitutes a reserve of energy for bringing the mortar back into firing position (see Fig. 317). As in the howitzer mounting, the carriage rests on a ring of live rollers, that bear on the fixed bedplate attached to the deck of the ship, and similar arrangements are also introduced for securing the carriage to the baseplate to prevent dismounting. In training for elevation the lever c is used to turn the clip n around the shaft carrying the balanced arms; this either raises or lowers the front of the mortar and a brake screw locks the whole system at any desired angle; a scale of degrees is marked above the shaft B. The mode of training for direction is similar to that we have described for the howitzer mounting. Table XXX. gives the ballistic particulars of mortars and howitzers from 22 cent. to 32 cent. calibre, made by the Forges et Chantiers Cie. on the Canet system.

TABLE XXX.—Ballistical Data of Coast Defence Howitzers, from 22 Cent. to 32 Cent. Calibre. Constructed by the Forges et Chantiers de la Mediterranee, Havre.

—			22 cm. Gun.		24 cm. Gun.		27 cm. Gun.		30 cm. Gun.		32 cm. Gun.	
Calibre			in. 8.66	mm. 220	in. 9.45	mm. 240	in. 10.63	mm. 270	in. 12.01	mm. 305	in. 12.60	mm. 320
Total length of gun			112.6	2860	122.8	3120	133.2	3510	156.1	3965	163.8	4160
Weight of gun			tons 2.883	kilos. 2930	tons 3.739	kilos. 3800	tons 5.333	kilos. 5420	tons 7.675	kilos. 7800	tons 8.886	kilos. 9 30
Weight of shot			lb. 220.5	100	lb. 286.6	130	lb. 410.06	186	lb. 595.2	270	lb. 683.4	310
Weight of charge			20.7	9.4	26.4	12	38.6	17.5	55.1	25	63.9	29
Initial velocity			ft. 984	metres 300	ft. 984	metres 300	ft. 984	metres 300	ft. 984	metres 300	ft. 984	metres 300
Energy			ft.-tons 1469.0	m. tons 455.13	foot-tons 1925.1	m. tons 596.45	foot-tons 2773.5	m. tons 859.35	foot-tons 3998.3	m. tons 1238.8	foot-tons 4590.9	m. tons 1422.3
Residual velocity at..	yds. 547	metres 500	ft. 951.2	metres 290	ft. 954.4	metres 291	ft. 957.7	metres 292	ft. 961.0	metres 293	ft. 961.0	metres 293
	1094	1000	921.6	281	928.2	283	931.5	284	933.1	286	933.1	286
	1641	1500	892.1	272	898.7	274	905.2	276	915.0	279	918.4	280
	2188	2000	862.6	263	872.4	266	882.3	269	895.4	273	898.7	274
	2735	2500	836.3	255	846.2	258	859.4	262	875.7	267	879.0	268
	3282	3000	810.1	247	820.0	250	839.6	256	856.0	261	862.6	263
Energy at	547	500	foot-tons 1371.0	m. tons 424.83	foot-tons 1810.9	m. tons 561.20	foot-tons 2608.6	m. tons 808.48	foot-tons 3812.7	m. tns. 1181.7	foot-tons 4183.8	m. tns. 1356.7
	1094	1000	1288.6	399.30	1712.6	530.77	2467.6	764.78	3632.2	1125.8	4170.9	1292.6
	1641	1500	1207.5	374.14	1605.5	497.54	2330.7	722.31	3456.8	1071.4	3906.7	1210.8
	2188	2000	1122.3	349.79	1513.0	468.92	2214.2	686.13	3309.6	1025.8	3828.5	1186.5
	2735	2500	106.12	328.83	1423.4	441.14	2160.0	650.89	3165.9	981.2	3664.0	1135.11
	3282	3000	995.3	308.44	1323.8	410.26	2005.1	621.42	3025.1	937.6	3527.3	1093.1
Energy per inch and per centimetre of circumference of shell	At muzzle		50.1	6.11	65.68	8.01	83.39	10.17	111.28	13.57	118.97	14.51
	547	500	46.74	5.70	61.83	7.54	79.05	9.64	102.08	12.45	113.47	13.84
	1094	1000	43.95	5.36	58.47	7.13	74.79	9.12	97.33	11.87	107.55	13.18
	1641	1500	41.16	5.02	54.78	6.68	70.60	8.61	92.57	11.29	102.91	12.55
	2188	2000	38.45	4.69	51.66	6.30	67.08	8.18	88.64	10.81	98.41	12.00
	2735	2500	36.16	4.41	48.55	5.92	63.63	7.76	84.79	10.34	95.94	11.70
	3282	3000	34.08	4.15	45.59	5.56	60.76	7.41	81.02	9.88	91.43	11.15
Thickness of penetration in wr'ght plate. (Gâvre formula)	At muzzle		in. 5.19	cm. 13.2	in. 6.29	cm. 16.0	in. 7.47	cm. 19.0	in. 9.17	cm. 23.3	in. 9.64	cm. 24.5
	547	500	4.91	12.5	6.02	15.3	7.20	18.3	8.62	21.9	9.29	23.6
	1094	1000	4.72	12.0	5.78	14.7	6.88	17.5	8.34	21.2	8.97	22.8
	1641	1500	4.52	11.5	5.51	14.0	6.61	16.8	8.03	20.4	8.66	22.0
	2188	2000	4.28	10.9	5.31	13.5	6.37	16.2	7.79	19.8	8.38	21.3
	2735	2500	4.09	10.4	5.07	12.9	6.14	15.6	7.55	19.2	8.22	20.9
	3282	3000	3.94	10.0	4.84	12.3	5.94	15.1	7.32	18.6	7.99	20.3
Range at different angles	deg. 5		yards 1485.4	metres 1360	yards 1514.7	metres 1385	yards 1564.0	metres 1430	yards 1574.8	metres 1440	yards 1580.2	metres 1445
	10		2777.9	2540	2821.8	2580	2914.5	2665	2936.2	2685	2952.9	2700
	15		3871.5	3540	3937.0	3600	4068.2	3720	4095.9	3745	4117.8	3765
	20		4779.2	4370	4866.6	4450	5036.2	4605	5063.6	4630	5091.0	4655
	25		5529.0	5050	5621.4	5140	5812.9	5315	5845.6	5345	5873.0	5370
	30		6097.1	5575	6212.0	5680	6419.7	5870	6463.1	5910	6491.1	5935
	35		6523.9	5965	6649.6	6080	6874.0	6285	6921.3	6330	6956.0	6360
	40		6813.7	6230	6944.8	6350	7185.4	6570	7234.5	6615	7267.3	6645
	Maximum		7475.0	6835	7633.6	6980	7907.0	7230	7956.1	7275	7994.8	7310

FOURNET'S COMPOUND OPHTHALMIC REFRACTOMETER.

The proper assistance for defective or for failing vision has to be determined in all cases, even when the spectacles are required for reading only, by first testing the distance-vision. The refractometer determines the correction only for distance-vision (refraction)—*i.e.*, the error for parallel rays, and is therefore distinct from the optometer, which is an instrument for measuring the *limits* of distinct vision.

An insight into what constitutes errors of refraction will enable us to understand the utility of the refractometer. The eye as an organ of vision is essentially an optical instrument. It follows that if the "principal or real focus" is not formed exactly on the retina, but either in front of it or behind it, there exists an error, which is called "error of refraction."

If the real focus is formed in front, that is, before the retina is reached, the eye is too deep, or the refraction too short; the error here is plus (+), and the correction has to be minus (−). If, on the contrary, the real focus falls behind the retina, that is, as if it were outside the eye itself, the eye is not deep enough or the refraction is too long; the error is then here minus (−) and the correction will have to be plus (+).

If we take the same value for these opposite signs we shall obtain zero, or a true refraction in the eye. For facility here, we shall term these errors "errors of depth."

We next have to direct our attention to the manner in which the principal focus is produced, be it formed on the retina, in front of it, or behind it; because, if that focus is not homocentric, but more or less extended or elongated in any of its meridians, we then have an error of symmetry which can also be plus (+), or minus (−). We shall here call these errors "errors of symmetry."

"Errors of depth" are corrected with the aid of spherical lenses, convex lenses that add to or concave lenses that decrease the natural convergence; and errors of symmetry are corrected with concave cylindrical lenses that *neutralise* or convex cylindrical lenses that *utilise* the natural symmetry. With regard to these last lenses the setting of the cylinder's axis to the required meridian, which may be at any angle, must be carefully observed; hence the necessity for the cylindrical lenses to rotate upon their central axes.

The above errors may exist separately or be associated. We now see that for the diagnosis of errors of refraction it is necessary to have four series of trial lenses of different degrees; one representing spherical curves concave ($s-$), one spherical curves convex ($s+$), one cylindrical curves concave ($c-$), and the other cylindrical curves convex ($c+$).

Having explained what constitutes "errors of refraction," and the series of lenses necessary to their correction, there remains to describe the process in general use when determining these errors. It consists, first, of an examination with the ophthalmoscope or with an optometer. Each one of these examinations gives only approximate results, that require to be proved, which is done in the following manner.

In a room of suitable size there are exposed types of graduating letters, that represent the visual acuity for their respective distances.

The subject standing at a certain distance from those letters, the operator presents successively before the eye, the lens of the degree obtained by the result of the above examination, and that of the degree stronger and weaker, to arrive at the exact number.

When dealing with errors of depth the verification does not offer much difficulty, but with errors of symmetry the verification becomes more difficult, and sometimes very fatiguing, as the operator previous to presenting the lens to the eye has to assure himself of the cylinder's axis and dispose the lens between his fingers in the particular position requisite to the case under examination, the same care having to be repeated with each lens. For these errors it frequently occurs that the proof occupies two and even three hours of time and exercise for a single eye.

To render the trial of the various lenses more easy and rapid Mr. A. Fournet of 18, Bentinck street, Welbeck-street, London, has invented the compound ophthalmic refractometer illustrated on page 61. This is an instrument by which any lens, or any required combination of lenses, can be placed before the patient's eye while he sits comfortably in a chair, and directs his gaze to the test types at the other side of the room. The lenses can be set at any height and applied to either eye, while the cylinders can be turned to the desired angle with absolute accuracy. The patient seats himself in the chair (Fig. 1) and makes himself comfortable, so that he can give his entire attention to the matter in hand. He obscures one eye by means of a spectacle frame having one black glass in it, leaving the other eye free. The lens frames are then adjusted to the right height by the crank angle at the back of the pillar, so that the horizontal diametrical line is level with the eye.

There are two frames; one contains convex spherical lenses and the other concaves. To each frame there can be applied a removable ring of lenses; two rings are provided, one containing convex cylinders, and the other concave cylinders. Thus each set of spherical lenses can be combined with either set of cylindrical lenses. The stem or stalk of each frame (Figs. 1 and 3) ends in a fork which is fixed to a dished metal plate having two empty sight holes (Fig. 3). On the opposite side of this plate are two guides (Fig. 4) between which there moves a slide having a boss on its opposite face (Fig. 3); the dished plate is slotted to allow the slide with its boss to move in the guides. Pivotted to a stud on the dished metal plate is a second circular plate with the central part cut away (Fig. 4), and around this plate is fitted, free to revolve, a ring containing spherical lenses spaced around it. The second plate can be secured by a catch in any of these positions, that is, it can be fixed concentric with the dished plate (Fig. 4) or eccentric to it to the right or left (Fig. 3). In the former case, vision is blocked through all the lenses except the two opposite the sight holes. The spherical lenses can, however, be pushed aside either way by the handle shown at the lower part of Fig. 3, to leave the cylindrical glasses alone before the sight hole. Similarly the cylindrical lenses can be moved away by the central slide to leave the spherics alone.

As already stated, the cylindrical lenses are fitted in removable frames which can be applied to the frames just described (Figs. 2 and 5). Each lens is fixed in a ring capable of revolving in holes formed in two plates, one at each side of it. This ring has teeth on its periphery (Fig. 5), and these teeth engage with a ring toothed both on its inner and outer peripheries. By when packed, to the various rooms, and finally they are delivered to the shipping house and packed into railway cars. Wherever automatic machinery could be used we found it. The great chimney, 225 ft. high and 25 ft. square, was decorated with pilasters, and in every possible place efforts were seen to make the appearance as attractive as possible, the interior of the buildings were scrupulously clean and the general effect outside was rather of the park order than of the manufactory. But the feature which proved the most attractive and interesting was that of profit sharing. We noted at once the general neat and attractive appearance of the employés, more especially that of the young girls. All looked pleasant and the men had an air of thrift and general prosperity. We soon saw such signs as the following posted in the shops: "The man who is drunk the night before cannot do a profit sharer's work the next day," and again, "Help us to earn a big dividend by saving all you can;" also this, "Remember all you save comes back to you as profit." Inquiry soon developed the fact that the financial affairs are managed thus: Every six months the net receipts above the cost are determined, then deductions are made as follows: 6 per cent. on the invested capital; a fixed salary to each of the firm who is employed in the business; a percentage of profit on the capital invested, the balance is then divided among the workmen in proportion to their wages. The last dividend was stated to be 15½ per cent. on the wages paid. Dividend day is a great holiday there, and the workmen have games, athletic sports, &c. This has continued for two and a half years; the amount paid May 3, 1890, was about 15,000 dols., and was divided between 450 to 500 workers. The head of this enterprising firm, Mr. Gamble, learned the trade in 1821, and the original establishment was a wooden kettle with a cast-iron bottom, from this—after partnership with Mr. Proctor in 1837—the business increased to a brick factory 32 ft. by 85 ft., one story high, equipped to make 1000 lb. of soap weekly. It was stated that all the younger employés were being steadily advanced according to their proficiency, their wages at first being 3 dols. per week were now 8 dols., 10 dols., and 11 dols. Of the 193 employés who participated in the first dividend 140 are still there, an interval of two and a half years, in which 60,000 dols. have been disbursed as dividends. There is also a building loan association for savings, and it has enabled eight men to buy lots and homes and twenty-two to partially do so, the payments being on the instalment plan. The association has 24,000 dols. in mortgage loans, of which 95 per cent. has come directly from the employés. The problem is an interesting one, and this plan goes far to establish harmonious relations between capital and labour. As there were in the party many large employers it is believed their visit here will not be without future results.

(To be continued.)

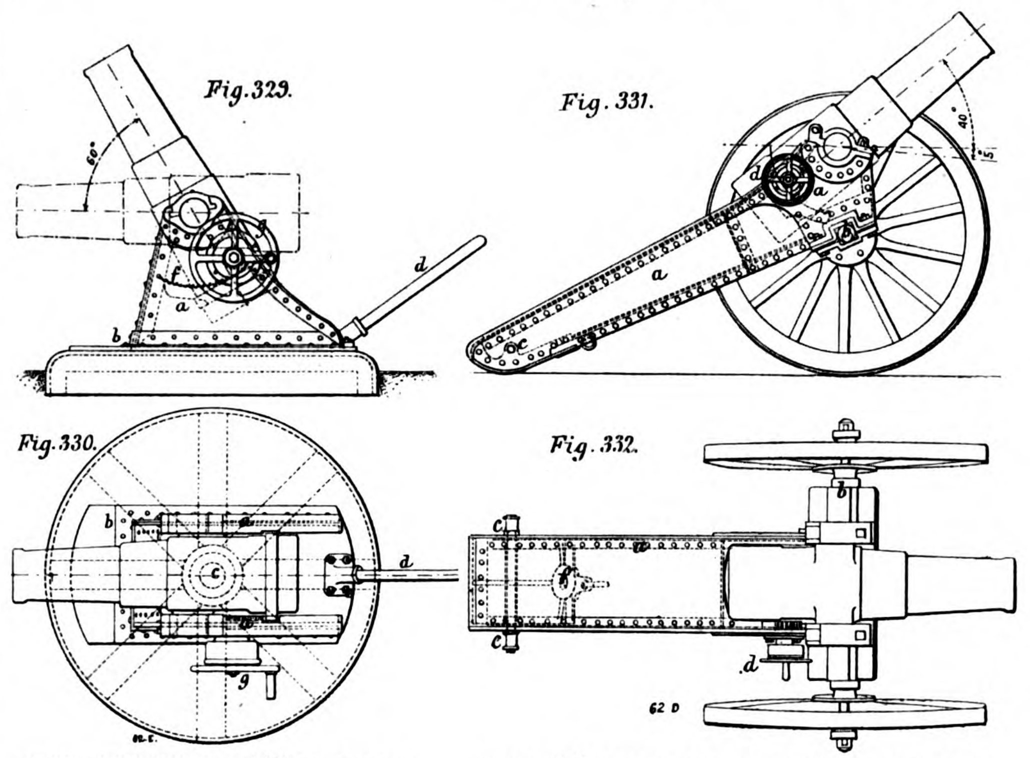
MODERN FRENCH ARTILLERY.
No. XXIX.

MORTARS AND HOWITZERS—*continued.*

FIGS. 322 to 328 (page 94) illustrate the breech mechanism designed by M. Canet and applied by the Forges et Chantiers de la Mediterranée to the smaller and medium calibres of mortars and howitzers.

It is on the helicoidal system and its principal parts are shown in Figs. 322 to 324; they are the steel block A and the bronze ring B. The screw threads on the block form two equal sectors, but instead of being cut in the usual manner, they are arranged so as to make two helicoidal belts as shown in Fig. 324. The threads chased in the seat of the gun are of course cut to correspond. In the middle of the plane surfaces of the block are cut two spiral grooves $c\,c^1$, shown in several of the views, which serve as guides for the friction wheels $d\,d^1$, fixed in the ring B (see Fig. 323); these grooves are parallel to the threaded sectors. On turning the locking lever through a quarter of a revolution the block is set free of its seat, and the rollers $d\,d^1$ turn in that part of the groove which is parallel to the threaded part of the block; but as the same motion is continued, the rollers enter the other part of the grooves and the block is withdrawn, the form of the grooves being so laid out that the block is clear of the gun by the time the rollers have reached the end of their path. The block is then supported only by the ring and can be easily swung back, so that the operations of opening the breech is effected by one movement; that of closing is of course the same except that it is reversed. Figs. 325 to 328 show the breech mechanism in four different positions and illustrate the percussion lock and safety apparatus.

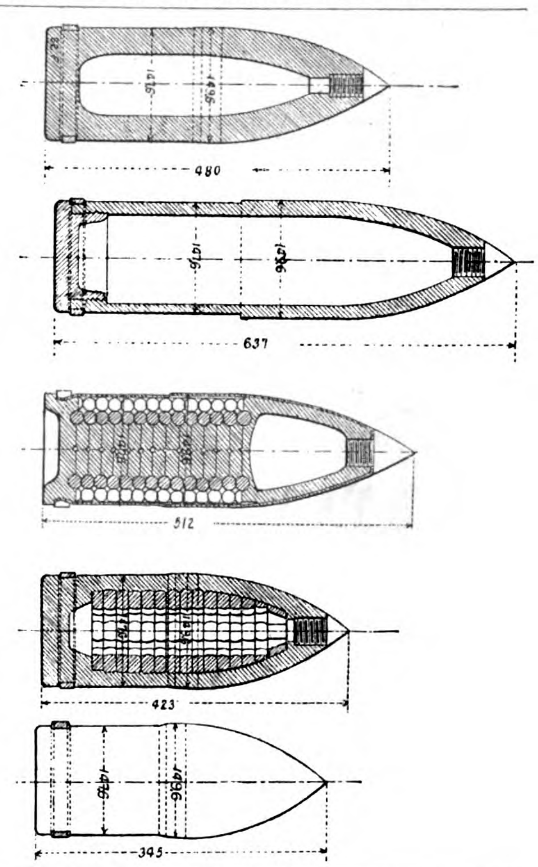
The main lever is horizontal when the breech-block is locked, and it is held in position by a catch; on the lever is the ordinary safety cam, and there is a second one D, Fig. 322, with two projections, one of which is held by a pawl. In a horizontal recess of the block the bolt is free to slide from right to left; this bolt comprises the rack *e*, the opening *f*, the striker, and the coiled spring *g*, inclosed in the cylinder *i*. The hammer F is free to turn upon an axis attached to the breech-block, and it has upon it an arm at the end of which are the teeth *h* gearing into the rack *e*; the detent *j* has a projection which presses against a stop shown in Fig. 322. When the main lever is lifted, the first projection on the cam D presses upon the head of the bolt and pushes it towards the left; if the lever is then released the bolt would be stopped by the safety catch; the bolt is pushed over to its full extent by the second projection, which also causes the striker to be lifted. The opening in front of the vent is then uncovered, and when the breech is closed, the fuze can be inserted; on pulling the lanyard attached to the detent *j* the bolt is liberated and the coiled spring throws it suddenly to the right; movement is also given by the rack *e* to the toothed arm of the hammer which is thrown forward



RIGID PLATFORM FOR 4.72-IN. MORTAR.   CANET 7.47-IN. MORTAR AND WHEELED CARRIAGE.

TABLE XXXI.—PARTICULARS OF AMMUNITION FOR 15-CENT. MORTARS AND HOWITZERS.

	kilos.	lb.
Fig. 337.—*Common Shell (Cast Iron).*		
Weight of cast iron ...	29.460	64.812
,, belt	0.410	.902
,, fuze	0.220	.484
Bursting charge	1.910	4.202
Total weight ...	32.000	70.400
Fig. 338.—*High Capacity Steel Shell.*		
Weight of steel	23.370	51.414
,, belt	.410	.902
,, fuze	.500	1.100
Bursting charge	7.720	16.984
Total weight ...	32.000	70.400
Fig. 339.—*Cast-Iron Shrapnel.*		
Weight of cast iron ...	24.320	53.504
,, balls	6.220	13.684
,, belt	0.410	.902
,, fuze	0.220	.484
Bursting charge	0.830	1.826
Total weight ...	32.000	70.400
Fig. 340.—*Mitraille Shell.*		
Weight of cast iron and steel	22.930	50.446
Weight of balls	7.550	16.610
,, belt	.680	1.496
,, fuze	.220	.484
Bursting charge	.620	1.364
Total weight ...	32.000	70.400
Fig. 341.—*Solid Cast-Iron Shot.*		
Weight of cast iron ...	31.590	69.498
,, belt	.410	.902
	32.000	70.400



BREECHLOADING MECHANISM FOR CANET MORTARS AND HOWITZERS.

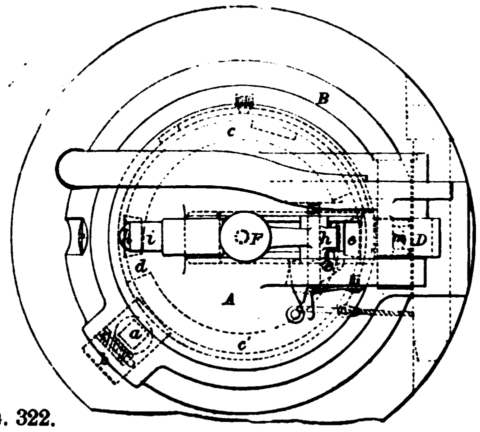


FIG. 322.

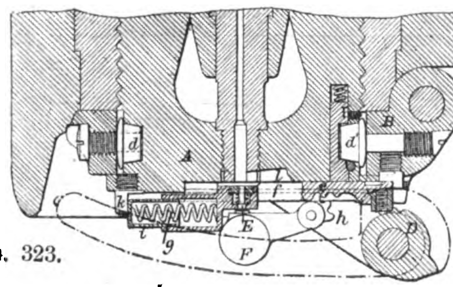


FIG. 323.

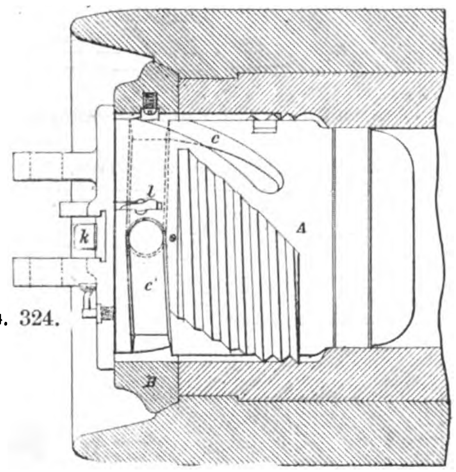


FIG. 324.

BREECH MECHANISM; CANET'S HELICOIDAL SYSTEM.

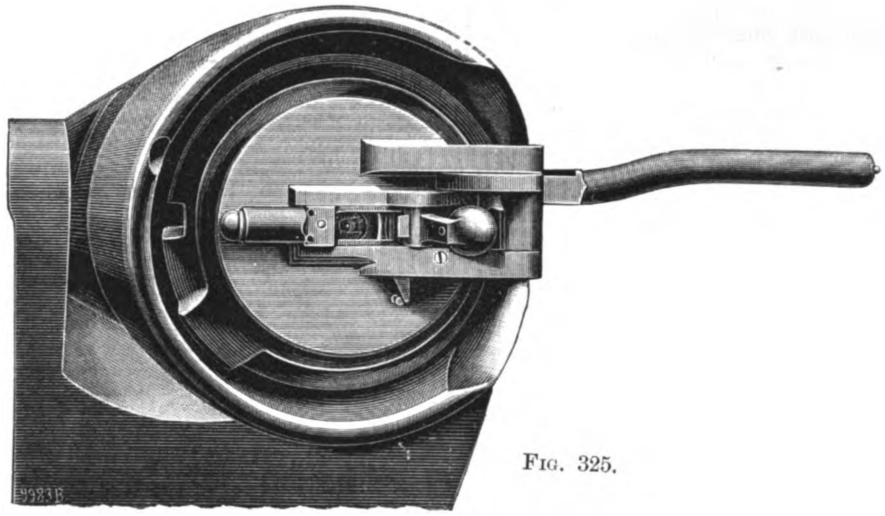


FIG. 325.

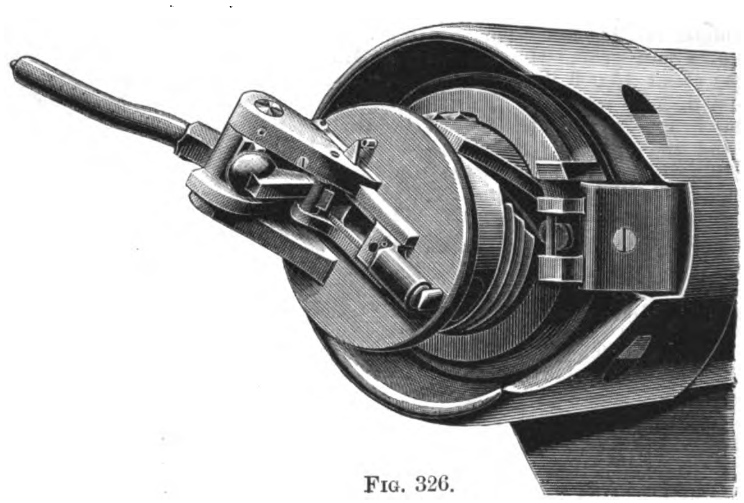


FIG. 326.

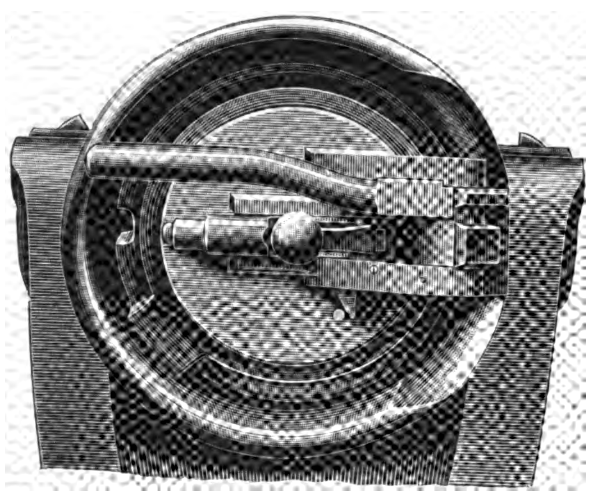


FIG. 327.

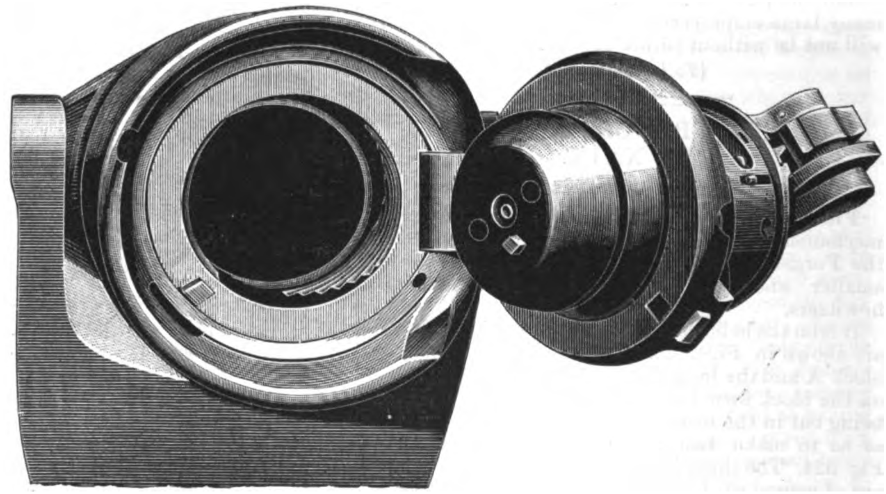
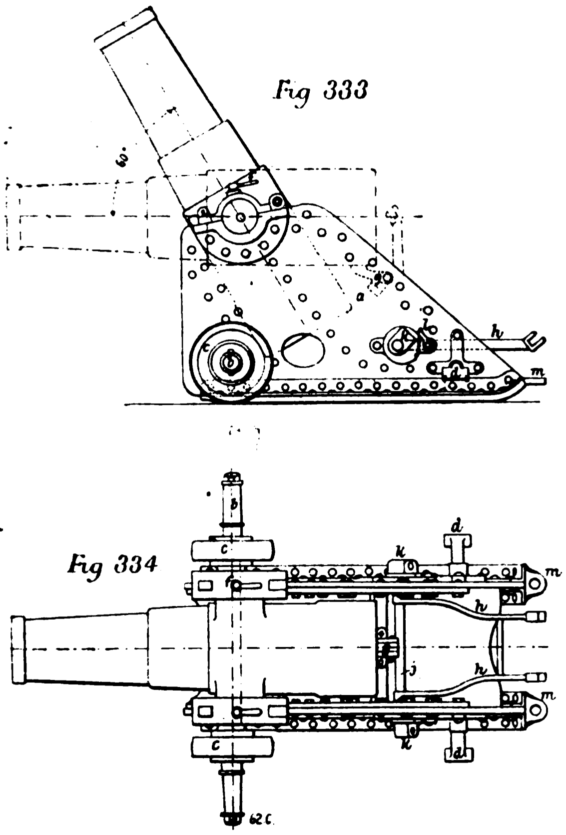


FIG. 328.

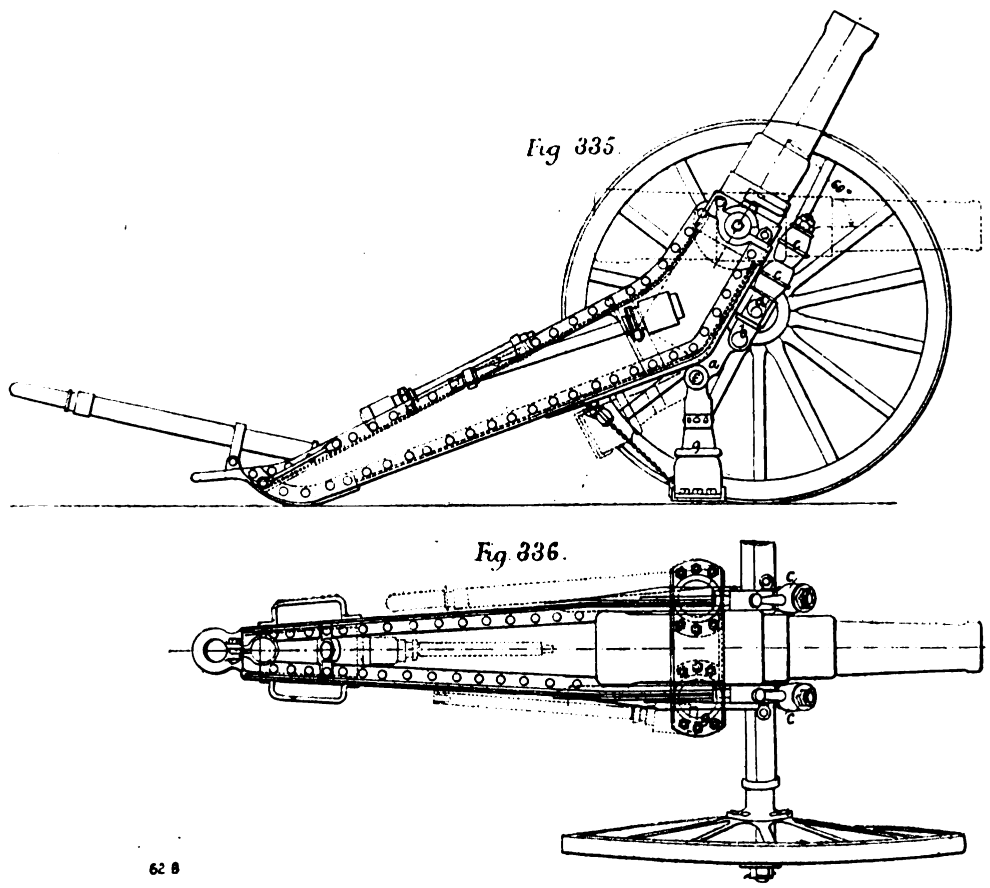
and strikes the fuze. This operation can only be performed when the breech is entirely closed, because it is only when in that position that the bolt can be thrown over. The system of obturation is that of De Bange with the Canet modifications.

Figs. 329 to 336 illustrate some different methods of mounting mortars and howitzers adopted by M. Canet for various services. Figs. 329 and 330 show the carriage for a 12-centimetre (4.72 in.) on a rigid platform. The carriage consists of two side frames *a*, strongly braced together in front, and bolted to an iron baseplate *b*; the structure rests on a platform, the construction of which is shown in Fig. 329; the edges are turned over to give it considerable depth and stiffness, and when it is placed in position, it is rammed firmly into the ground that it may be held securely. In the middle of the platform is a pivot *c*, around which the upper carriage is free to turn, the side frame being connected with plating to which the pivot is connected. To turn the gun through any desired angle a lever *d* is inserted in the socket shown in plan, Fig. 330, and the gun and carriage can thus be turned around the pivot. Training for elevation is effected by turning the handwheel, on the spindle of which is the Canet differential gear already described, that drives a pinion gearing into a curved rack bolted to the left side of the gun. This mounting is of the simplest character; it is at the same time very rigid and portable. For transport it can be either suspended from a special wheeled carriage, or set on any

THE CANET SYSTEM OF MOUNTING MORTARS AND HOWITZERS.



CANET 7.47 IN. MORTAR AND SIEGE CARRIAGE.



MOUNTING FOR A 3.94 IN. HOWITZER.

sufficiently strong vehicle that may be available. To place it in position all that is necessary is to excavate the ground to a slight depth, place the platform in the recess thus made, and ram the earth hard round it. For siege purposes this nature is especially well designed, on account of its portability and efficiency in comparison with its weight. The maximum elevation is 60 deg.

Figs. 331 and 332 show a Canet mortar of 19 centimetres (7.47 in.), mounted on a carriage formed of two side steel frames braced together, and provided with an axle on which are mounted two wheels. Thick rubber sleeves *b* placed between the axle and the wheel centres, help considerably to reduce the strain produced by firing. The mode of shifting the piece for direction is simply by means of levers, the ends of which are applied to the two pins *c* that are secured to the frames near the trail. For training in a vertical direction, the flywheel *d* placed on the right-hand side of the frame, is turned, actuating a pinion that gears in a curved rack. Near the end of the trail is a ring *f* by which the piece is coupled up to the limber like an ordinary piece of field artillery. The manœuvring for getting into firing position, and for travelling, are also the same as for field batteries. The mounting is light and easily handled. The recoil is taken up by means of shoe brakes; the height of the trunnions above the ground is comparatively small, so that the gun can be protected behind a low earthwork. The maximum elevation is 40 deg. For larger natures the mounting presents difficulties, because a considerable increase in weight is necessary, and at the same time facilities for transportation must be provided. Figs. 333 and 334 illustrate the carriage designed by M. Canet for a mortar of 24 centimetres (9.45 in.) The gun is supported by its trunnions on a steel frame formed of two plates strongly braced together. Passing through these plates is an axle *b*, on which can be placed two wheels for transport. When it is desired to set up the gun in firing position, the wheels are removed and the mounting is lowered to the ground, so that it rests on the underside of the frames which are made to act as slides, and on two rollers *c* which are mounted on the axle inside the wheels, a thick sleeve of rubber being interposed between the axle and the roller bodies, to absorb a part of the reaction during fire. Training for direction is obtained by means of levers passed under the projections *d* placed on each side of the frames. The mounting being thus lifted is free to turn easily on the rollers *c*. Training for elevation is a very simple manœuvre; the man detailed for this work raises and lowers the gun by hand, the balance being sufficiently good for him to do so, and when the desired angle is obtained, the gun is held fast by the screws *f*. This arrangement, though a primitive one, is very efficient. The weight of the projectile and charge being considerable, an ammunition hoist is added to the equipment. In loading, the gun is held in a horizontal position by means of a spring pawl *g*. The hoist consists of two arms *h* mounted on an axis *j*, at the end of which are two sockets *k*, in which the ends of levers are inserted; a spring pawl *l* prevents the spindle from turning the wrong way. At the ends of the arms is placed a cradle large enough to receive the projectile, and to raise the latter to the level of the gun, it is only necessary to turn the shaft by means of the levers working in the sockets *k*. At *m* are placed the rings by which the mounting is coupled to the limber. If it is desired to shift the position of this piece, it is raised with the carriage until the wheels can be replaced; the carriage is then attached to the limber, and the whole equipment can be made ready for transport in a very short time. The arrangement is certainly very simple, and it appears strong and efficient; it is, moreover, considering the weights involved, very easily shifted. It is specially claimed for the system that the type is very economical and serviceable, because it is adapted for the largest calibres of mortars and howitzers, and thus constitutes an easy and formidable means of attack.

Figs. 335 and 336 illustrate a method of mounting a 10-centimetre (3.94 in.) howitzer on a siege carriage. As these guns are designed to give an initial velocity of 300 metres (984 ft.) to their projectiles, the effect of recoil is considerable. This mode of mounting with elastic connections is based upon a type designed by General Engelghart, and which has been adopted by the Russian Government. The frame itself presents no peculiarities; it consists of steel plates braced together. Training for direction is effected by shifting the trail; the gun is elevated and depressed by hand, and the desired angle being obtained, it is held fast by a locking screw. The peculiarity in the arrangement consists in the mode adopted of connecting the gun and the carriage, the object being to reduce to some extent the traction, and to a larger degree the effect of recoil. The carriage is not mounted on its axle, but there is connected to its lower part a piece *a* to which is attached a rod *b*. Upon this rod are placed rubber blocks *c* that bear against the bar *d* mounted on the axle. On this same piece at *f* is an axis around which turns a spring recuperator *g* that takes a bearing on the ground. During fire the axle remains motionless; the mounting recoils and is lowered under the influence of the powder gases; its motion is limited by a double brake composed of the rubber blocks *e* that bear on the axle, and the recuperator *g* resting on the ground. When the effort of recoil is terminated the two elastic systems restore the energy they had absorbed and bring back the frame into firing position. In arranging the piece for transport the system *g* is removed and fastened beneath the frame, as shown by the dotted lines. The type is a simple one, and the results obtained by prolonged experiments in the Russian army are very satisfactory. It is found that the piece can be fired at extreme angles without any damage to the mounting.

BRIDGE OVER THE RIVER BELAJA.

THE Samara-Ufa Railway, which was opened for traffic in September, 1889, is an extension of the Orenburg Railway, and joins the latter at the station of Kinel. That part of this line, towards the town of Ufa, contains a number of heavy embankments, stone bridges, and iron structures of more or less magnitude, of which the bridge over the Belaga, near the town of Ufa, is the most important. This bridge consists of six spans of 360 ft. each, and has a total length of 2170 ft. The iron girders rest upon seven stone piers, all of which are built upon caissons. The five river piers (see Figs. 4 to 7 on page 40 *ante*) are built each upon one large caisson, but the two shore abutments (see Figs. 1 to 3) rest each upon three caissons, which are joined by stone arches. As in the case of the bridge over the River Wolga, of which we gave a very full account in our thirtieth volume, this bridge had to be carried sufficiently high above high-water level to enable the large river boats, carrying upwards of 6000 tons of timber, to pass underneath at all stages of the floods, and with the same object the plan of the piers is made of a

22-CENT. CANET MORTAR ON CIRCULAR CARRIAGE.

CONSTRUCTED BY THE FORGES ET CHANTIERS DE LA MEDITERRANÉE, HAVRE.

(*For Description, see Page* 139.)

Fig. 346.

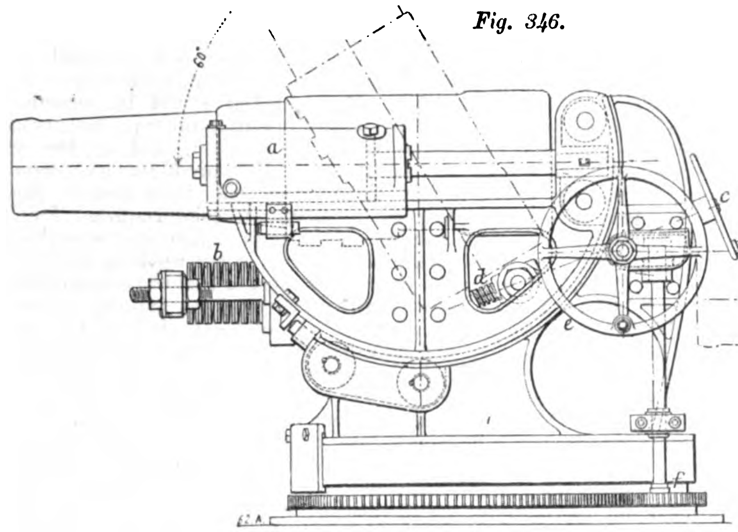
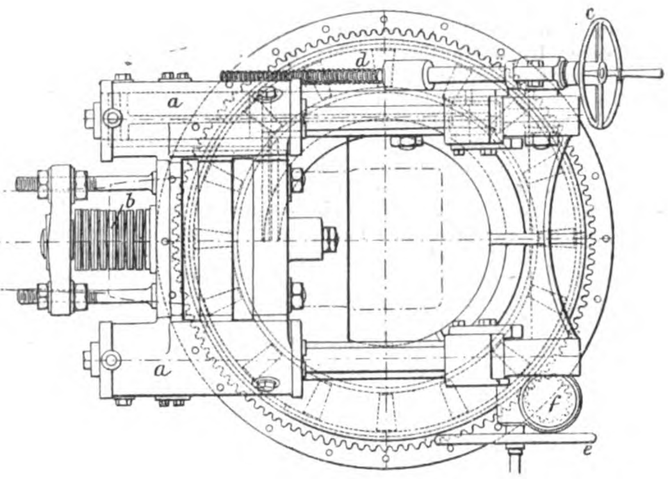


Fig. 347.



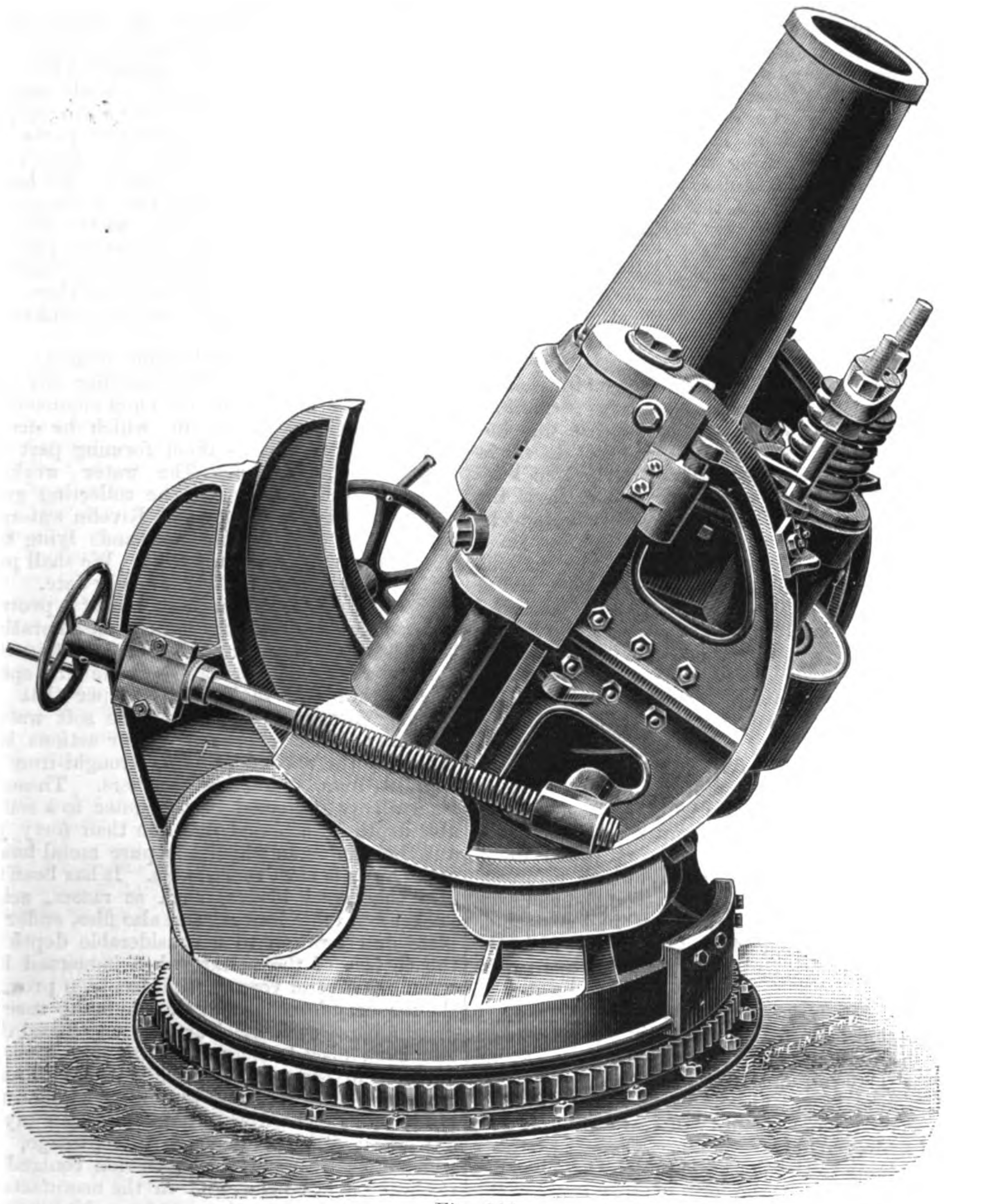


Fig. 348.

hardened. A large part of the plates for the Great Eastern were rolled in the Park Gate mills. Here also the rolling of armour plates was first carried on, the previous mode of production having been carried out by the hammer. Plates in those days were, however, only 4½ in. to 5 in. thick.

The present iron works consist of five blast furnaces, plate and sheet mills, bar mills, and their appurtenances, including coke ovens. The capacity of the iron works is 1400 tons of pig, 850 tons of plates and sheets, and 450 tons of bars per week. The steel works were opened in 1888. There are four 25-ton Siemens-Martin furnaces, with cogging mill, slab rolls, billet mill, plate mill, &c., and the necessary plant required for a business of this nature. The capacity of the steel works is from seven to eight hundred tons of steel, and from four to five hundred tons of plates per week.

There was no discussion on this paper, the President saying that it was not of a nature that lent itself to comment; but if any members, after visiting the works, wished to record any ideas on the subject, they would be at liberty to do so by writing to the secretary.

THE LOOMIS PROCESS OF MAKING FUEL GAS.

The next paper read was a contribution from Mr. R. N. Oakman, Jun., of London, and dealt with the above process of gasmaking. The Loomis process has met with some success in Sheffield, and the paper was therefore appropriate to the occasion. It should be stated that this system is not confined to the production of fuel gas, as the water gas made by it can be carburetted for illuminating purposes. The latter use, however, was not dealt with by the author. We propose publishing this paper in full, and will, therefore, only give the main points at present.

The fuel used is bituminous coal. The apparatus consists mainly of a cylindrical producer 7 ft. to 10 ft. in diameter and 12 ft. to 13 ft. high, lined with firebrick. Connected with this is a vertical multitubular boiler 17 ft. to 20 ft. high and 3 ft. in diameter. There are also an exhauster, scrubbers, gasholders, &c. The fuel is fed through a door at the top of the producer, air being taken in at the same door. This air is drawn down by the exhauster through the fuel, and the producer gas, thus obtained, is drawn through a superheater in the bottom of the generator, then up through the boiler, generating steam on its way. It then passes to the holders. After this operation has proceeded from four to six minutes the exhauster is shut off and the feed door is closed. Steam then passes through the superheater at the bottom of the generator, and flows up through the incandescent fuel. The water gas thus produced is taken to another gasholder. This operation takes about as long as the former. Water gas made by this process has a strong odour. The quantity of water gas produced per ton of coal ranges from 35,000 to 45,000 cubic feet. An example of working was given, admittedly an extreme case, in which, when heating steel in small forges, a saving of fuel of above one-third was made over that required when working with coal or coke. In melting steel in crucibles it is stated that there is a saving of fully 75 per cent. as compared with coke.

On the discussion being opened, the first speaker was Professor J. O. Arnold. He referred to the question of clinker, pointing out that the author had said that the combustion of coal in the generator was so nearly perfect that there was great freedom from clinker. This he was unable to understand, as the ash and incombustible matter could not be burnt, however favourable the conditions might be for consuming the fuel. He would like to know whether this system of gas producing had been applied to the manufacture of steel by the open-hearth process. The author had said that owing to the hydro-carbons taken up from the bituminous coal used for the water gas, the calorific power of the gas was increased. The important point, the speaker said, was the calorific intensity, but it would be interesting to know to what extent the calorific power of the gas was increased in the manner specified. Another point to which he would call attention was the analysis of water gas given by the author. This included carbonic acid, carbonic oxide, hydrogen, and nitrogen. All these were inodorous, but the author had stated that the water gas differed from other gases in possessing a peculiar and strong odour. If this was the case it must be due to the hydro-carbons from the coal. As, however, these did not appear in the analysis the latter was manifestly incomplete. This point required explanation. The paper also stated that this water gas had been proved to furnish the best heat for treating watch-springs; and this was furnished as an indication of its merits for heating steel. Professor Arnold would be glad to know whether this was owing to a chemical reason or physical causes, due to the more even heating of the steel. At the end of the paper it was stated that an economy of fully 75 per cent., as compared with coke firing, was obtained when melting steel in crucibles by using the Loomis gas for fuel. This, the speaker said, was a very remarkable statement; and the Sheffield people would be glad to hear more upon the subject.

Mr. Lupton, who spoke next, could not understand how the air was heated in the preliminary part of the process. It was said that the air drawn in at the charging door passed first through the charge of fresh fuel on the top and then through the hotter fuel below. But how did the lower part of the mass of fuel get hot? As the air was admitted at the top he should have expected the greatest heat to occur there. Was there any preliminary process of firing up from below, and, if so, where did the gas go? It would also appear that the steam would cool the fuel when admitted. Was this the case?

Mr. Hoyle, of the firm of T. Firth and Sons, at the request of the President, said that he was not in a position to give definite figures as to the saving effected by the adoption of the Loomis process, which had lately been introduced into their works. It was claimed that an economy of 75 per cent. was effected. That might be, but he felt he should be certainly within the mark in putting the saving in fuel down at 50 per cent. over the old way of melting steel in the crucible with coke. In the latter case 80 per cent. of the heat went up the chimney, and there was the loss due to letting down the fires at night and renewing them in the morning. When using gas, however, the work went on day and night, so that there was no loss from the latter causes. As a practical fact, the use of gas was so satisfactory that arrangements were in prospect to put in ten or twelve more sets of the apparatus, in addition to the two now in use. The matter was not definitely settled, as further experience had to be obtained; but everything pointed towards such a course. The experiments were very satisfactory, not only for the manufacture of crucible steel, but also in the Siemens furnace also. In the experiments so far made with the Siemens furnaces, they had used regenerators for the air supply only and not for the gas, but in connection with the crucible heating furnaces regenerators were used. The 50 per cent. saving in fuel referred to the cost of fuel, not to the weight. With the gasmaking plant they were able to burn small coal, whereas for the old furnaces it was necessary to use coke.

Another speaker asked if the gas had been applied to melting pig-iron, gun-metal, or brass. Mr. Lupton also asked at what temperature the producer gas left the generator to pass to the boiler. In reply to the latter question, Mr. Oakman said it would be from 2000 to 2500 deg.

Mr. Aspinall, of Horwich, said he had not tried water gas, but he would be glad to know whether it was more economical than producer gas used with regenerators. So far it had been compared only with the old system of heating by burning coke. He was using producer gas at Horwich for melting brass for castings. For small castings this metal was melted in crucibles in gas-heated furnaces, but for large castings an open-hearth furnace was employed.

Mr. John Head said he had not read the paper, and had been away whilst it was before the meeting. He was not acquainted with Loomis gas, but he knew it was no better than ordinary producer gas, and therefore he did not see the necessity for all the complications attendant on its production. If regenerators absorbed all the waste heat, there could be no saving beyond that in a process in which they were used. His own researches had shown that the producer gas obtainable from 100 tons of coal had as great a theoretical heating power as the water gas obtainable from 99½ tons of coal. But in the combustion of water gas steam was formed and subsequently condensed, and the heat expended in forming this steam could not be recovered in the regenerators. Water gas would, however, work more quickly, but it was a question whether this advantage could be utilised, as the bricks which were used for lining furnaces were not sufficiently refractory to stand any length of time with the more rapid working and higher temperature. A Siemens furnace would last generally six months, although it might remain good for as long as two years. It must be remembered that if it were worked twice as fast it would only last probably one-eighth the time. The speaker then proceeded to refer to the furnace which he had described at the Paris meeting of the Iron and Steel Institute, dealing with the question of cost of construction, when he was ruled out of order by the President.

Sir Lowthian Bell said that in the discussion on water gas fuel, held in Paris last year during the meeting of the Iron and Steel Institute,* he had raised many objections to the use of that description of gaseous fuel. These objections did not, however, all apply to the system described by the author. The statement had been made in Paris that the days of burning solid fuel were passed; but he would say that, unless there were good and strong reasons otherwise, the obvious loss of converting fuel into gas—say 30 per cent.—would render that course undesirable. Conditions however often did arise in which gas fuel might be favourably adopted, and the loss more than compensated for. For instance, in burning coal in the ordinary grate there was the loss of heat up the chimney—heat which the regenerative system, applicable to gaseous fuel, enabled them to recover. Water gas was the result of decomposing steam into carbon mon-oxide and hydrogen, and it was impossible to get from these more heat than was obtained by burning the coal directly. If a kilogramme of hydrogen were burnt, four times the heat due to burning a kilogramme of coal might be obtained, but in that case it would take four times the heat in the kilogramme of coal to get the hydrogen. This was the theoretical aspect, but of course there were all the losses actually experienced in the practical application of the process. It was said that a higher temperature could be got with the water gas, but it would be well to consider whether a higher temperature was wanted. All the heat required might be got from producer gas, and there was the difficulty of getting materials sufficiently refractory to stand the greater heat. Nevertheless water gas was useful for many purposes. For instance, in welding up boiler flues the cost of fuel was of no consequence compared to the benefit of easy manipulation and obtaining sound work. Then there was the instance, to which reference had been made in the paper, of making watch-springs. What could the price of fuel matter so long as an improvement could be obtained in the springs? and to this end a very pure gas was necessary.

Finally, Sir Lowthian would lay it down as an axiom that, in the matter of obtaining the greatest heat from a given amount of coal, to burn it as solid fuel was the best, to convert it into producer gas was the next best, whilst worst of all was to waste the heat of a large quantity of coal in the production of hydrogen gas.

In replying to the discussion Mr. Oakman said he had referred to the use of this gas by the Waltham Watch Company as an illustration of its application to fine work, but the same principles applied to the manufacture of files and other articles of that nature. For heating the springs in question the Waltham Watch Company had originally used ordinary gas, and had then taken to gasoline. They got better results, however, by the Loomis process. A question had been asked by Professor Arnold as to the analysis quoted. That had been made in Philadelphia, and gave the leading elements only, the olifiant gas not being included. This would amount to from 3 to 3½ per cent. The quantity of gas made by the apparatus in question was about 38,000 cubic feet per day, but this depended upon the coal. The thermal units per cubic foot of gas would be 250 to 400. In answer to the question of Mr. Lupton as to the way in which the generator was fired, when the fire was first started 2 ft. or 3 ft. of coal were put in and the fire was ignited at the top. Coal would then gradually be filled up to above the ports. The fuel bed would be incandescent to within 6 in. to 10 in. from the top. The greatest heat would be at the bottom, and as the air went in at the top the producer gas would pass away clean from the incandescent fuel. The average quantity of coke required for melting crucible steel in the old furnaces, was about 3 tons to the ton of steel, when working by the ordinary process. With the gas fuel the consumption of the same coal as was used for making the coke, was 1½ tons per ton of steel; but at the same time half its value was obtained in producer gas. He had not intended to allude to furnaces, but as the subject had been brought up he would say that the furnaces using this gas had been in use four to five months, and they appeared to stand perfectly well. The flow of gas was quite under control and the heat could be regulated from 1500 deg. to 5000 deg. Fahr., just as might be required. The author had no more belief than Sir Lowthian Bell in the universal application of water gas, but he was sure it was good for some things. He would not use it in steam boilers, or for melting pig; but he was of opinion that it might be applied with advantage to the puddling furnace. With regard to the clinker question, he did not mean by perfect combustion that the unconsumable parts of the coal would be burnt, but that the fires burn so freely that clinker was not formed. He had been told that air forced in at the top of the generator with blast would not succeed, as the ash would accumulate at the top. This, however, proved not to be the case, as the ash came through to the bottom. The combustion was so perfect that there was no trouble from the melting of ash into clinker at the bottom.

The Sheffield Water Works.

The last paper read at the meeting was one by Mr. Edward M. Eaton, the chief engineer to the Sheffield Water Works, in which he described these works, a visit to them forming part of the Thursday's excursion. The water works are owned by the corporation, the collecting grounds being the Ewden, Loxley and Rivelin watersheds, which form part of the moorlands lying to the west and north-west of the town. We shall publish Mr. Eaton's paper in full at an early date.

The discussion on this paper was of a protracted and somewhat desultory nature, degenerating at least into a conversation between certain of the members. Mr. C. Cochrane was the first speaker. The author had said in his paper that "the extreme energy displayed by these soft waters in attacking metals exposed to their actions is well shown by the specimens of a wrought-iron screw spindle, nuts, bolts, and washers. These have been wholly immersed in the water to a considerable depth for a period of more than forty years, and the manner in which the pure metal has been eaten away is most remarkable. It has been found also that steel blades, such as razors, scissors, pocket and table knives, and also files, suffer complete deterioration to a considerable depth from the surface of the metal, when immersed in the water for several years. This has been proved, by the recovery from time to time from the reservoirs of bundles of such steel articles which had doubtless been placed there in connection with trade outrages in times past. The steel was found to have been converted into plumbago, whole bundles of blades being capable of being scraped away with a penknife." Referring to this passage, upon which a good part of the discussion centred, Mr. Cochrane pointed out that in the manufacture of cast-iron water pipes the use of graphitic grey iron was not usual, it having been abandoned for the harder white iron. This was not due to the cause to which reference had been made by the author in the passage we have quoted.

Mr. E. P. Martin said that at Dowlais they had had much the same experience with regard to corrosion in the case of a boiler fed with very pure water. They had, however, put a few cartloads of lime into the stream from which the feed water

* See Engineering, vol. xlviii., pages 374 and 390.

was obtained, and from that time forth the trouble ceased.

Sir James Douglass said that it was not only pure water that would cause this change in iron. He had in his possession an old cast-iron gun which had been immersed in the sea for two or three hundred years. This was in much the same state as the articles described by the author, and could be cut by a knife.

Sir Lowthian Bell said that it would be unwise to draw general conclusions on too slender premises. Boilers would corrode in mysterious ways. The same boiler, made from the same iron and fed with the same water, would corrode in some parts and not in others. There was something, therefore, besides the purity of the water to be considered. The examples before the meeting, which had been referred to by the author, had gone in strips. The reason might be explained by the layers of cinder present setting up galvanic action in their neighbourhood.

Mr. Martin said that the paper was of a civil engineering rather than of a mechanical engineering nature, but the question of water supply appealed to both branches of the profession. He wished to draw attention of members to the gauging apparatus. He was aware that hourly records of supply had been taken at Wolverhampton, where the engines pumped direct, and there were no storage ponds, but he did not know that the system had been applied to a gravitation scheme. Speaking of the merits of the continuous supply system, the speaker said that in London the pipes had been made one-fourth smaller of late years. Formerly they had been designed to send through the whole supply of the day in a couple of hours. He had had experience of iron pipes turning to plumbago, but that was due to their being laid in made ground consisting largely of ashes. He would like to ask the author what the effect of this soft water was on lead pipes.

Another speaker asked the average of water pressure in the Sheffield mains, and whether water was supplied for power.

The President gave his experience in connection with the corrosion of marine practice. In the old jet-condenser days he had known the interior of the air pump converted into plumbago. When surface condensation came in the engineers would blow down too much and consequently get the water too pure. The result being corrosion of the boilers through the absence of scale. One of his old pupils, who had become a marine engineer, had been in trouble from this cause, and Mr. Tomlinson had advised him to put in the boiler a couple of bushels of lime. The result had been satisfactory, there resulting a thin coat of black scale and no other deposit. The air-pumps with surface condensation would be liable to get in the same condition as before, but it might have been from a different cause, as in one case salt water was used and in the other case fresh.

Mr. Cochrane suggested that the corrosion might have been due to the fatty acids from the lubricants. Mr. Tomlinson assented, and said he had advised water as a cylinder lubricant in place of oil.

At this point there was a good deal of conversation as to whether corrosion was due to fatty acids or purity of water, instances being advanced in support of both theories.

Sir Lowthian Bell reminded the speakers that rain-water was not pure water, as it contained ammonia.

In replying to the discussion the author said he could not follow the discussion into the question of the action of pure water when used for boiler feed, but he could give one instance with regard to Sheffield. There was in the town a Lancashire boiler, 28 ft. by 7 ft., which had been fed with the Sheffield water for forty years, and it was still in work. He could produce other instances of the suitability of the Sheffield water for boiler feeding purposes. In answer to the questions which had been asked, the author said that wrought-iron pipes could not be used with the Sheffield water, as they would be eaten through or choked up in three years; but cast-iron lasted well, although they were sometimes troubled with "tubercles" of oxide of iron combined with peaty matter, the cause of which was obscure. These formed in spite of a constant stream with a pressure due to a head of 400 ft. Under these tubercles the ordinary coating of scale was found to be intact. Within the last few years they had had much trouble with lead pipes, and the water did seem to act on lead in a remarkable manner, in fact, it seemed at first hungry for any impurity and would take up anything, and if the first thing was lead it would take up that. This, however, was a property common to other waters besides those of Sheffield. In some other places a lime treatment for this defect had been tried. In Sheffield they had met with some encouragement in the use of finely divided chalk. A curious feature about the action of the water on lead was that it was found to be more active at certain seasons of the year. There was no doubt that iron pipes were often affected by the acids in the made ground in which they were buried. Sulphur was the chief cause. Some of the iron which was made soft by remaining in the water became hard again when exposed to the air. He would like to ask whether this was the case with the cannon mentioned by Sir James Douglass. Sir James answered in the affirmative. The water pressure in different parts of the town of Sheffield varied with the locality. Generally it might be said to vary between 150 ft. and 250 ft., or up to 300 ft. head. In some spots, however, the pressure rose to 400 ft., but that they looked on as a dangerous pressure, and with it lead pipes lasted a very short time. The Sheffield water was used for power purposes, the motors being coupled direct to the mains, and the exhaust was measured to ascertain the consumption. The low-pressure meters they used in this way were not so liable to damage as high-pressure meters, especially in the case of frost. The speaker had known them to be frozen up for weeks without injury.

A vote of thanks was proposed by the President to the author and carried in the usual way.

The reading of the other papers on the list was adjourned until the next meeting, and the usual votes of thanks having been duly honoured the President declared the meeting closed so far as the reading of papers was concerned. Yesterday and to-day were devoted to excursions, about which we shall have something to say in our next issue.

MODERN FRENCH ARTILLERY.
No. XXX.

Mortars and Howitzers—*concluded.*

Figs. 342 to 345, on page 136, illustrate a 27-centimetre (10.63 in.) howitzer, and central pivotted carriage with hydraulic brake, on the Canet system; this is the model which has been adopted by the French War Department for coast defence, and also by the Minister of Marine. The hydraulic brake in some of the earlier types has the Vavasseur-Canet turning valve, of which a description will be given hereafter. The total weight of the mounting is about 20 tons; the bedplate weighs 5.7 tons, the underframe 9.5 tons, and the carriage 5 tons. The maximum recoil allowed is 33 in. The same type of mounting is employed for heavy coast defence guns, but certain modifications are introduced for the mortars and howitzers of large calibre. The mounting consists of three parts: The carriage proper, the underframe, and the baseplate. The main casting of the upper carriage contains the trunnion bearings and the brake cylinders. As will be seen from the drawings, the side frames are extended below the cylinders and are formed with slides that bear on the inclined surfaces of the underframe. The underframe is a massive casting of the form shown, with parallel sides terminating in a circular base, the whole being strengthened as far as possible by flanges; the tops of these sides form the slides, and projections at the forward end are provided for attaching the brake piston-rods, while some of the various devices for handling and loading the gun, are also connected to it. The baseplate is fixed to foundations, and carries the central pivot of the system. The underframe rests on this baseplate, a ring of rollers being interposed. In front of the mounting is fixed a chrome steel shield that affords considerable protection to the men serving the gun. Training for elevation is effected at the forward part of the frame, by turning a crank which controls a shaft mounted parallel with the slides, and which by means of suitable toothed gear acts on a quadrant secured to the side of the gun. The chain shown surrounding the lower part of the underframe is used in training the gun for direction, the chain passing from the groove in the frame over a wheel which is driven by gearing and a hand crank as shown. Graduated arcs on the carriage serve to show the exact position of the gun both in elevation and direction. In loading, the gun is lowered into a horizontal position, and the crank on the right-hand side near the back of the frame is turned. In this way the arms hinged to the frame are controlled; these arms carry at the end a holder large enough to receive the projectile, as shown in the various illustrations. By means of springs, so arranged as to be compressed during the downward movement of this crane, the effort of lifting it when loaded is reduced. Although the weights of the various parts are so considerable, they are so well balanced that the operations of training either for elevation or for direction, can be performed by one hand.

Fig. 349.

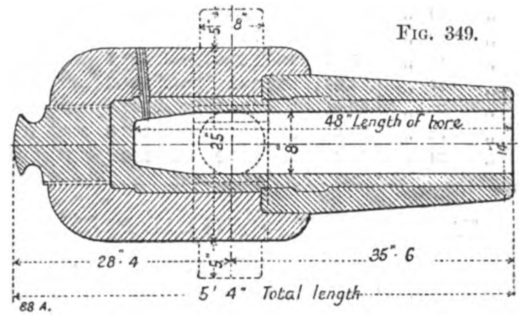


Fig. 350.

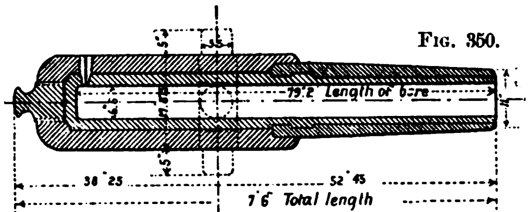


Fig. 351.

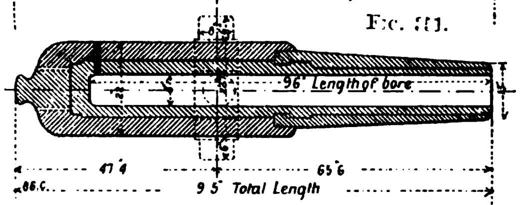
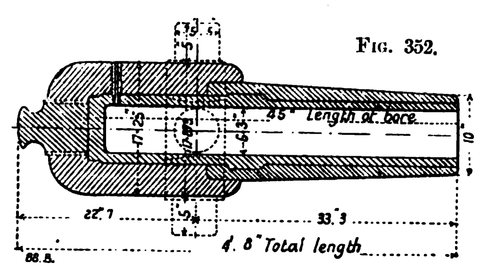


Fig. 352.



BRITISH SERVICE HOWITZERS.

One hundred of these carriages have been made by the Forges et Chantiers Company, at Havre, for the French Government, and in the severe tests to which they have been subjected, have given great satisfaction. In the earlier patterns the hydraulic brake was fitted, as already mentioned, with the Vavasseur-Canet turning valve. In the later types, however, this has been replaced by the Canet central counter-rod arrangement, which gives much more regular and satisfactory results. The large adoption by the French Government of this type of mounting appears to be an indorsement of the claim made for this system, that it is extremely simple, economical, and easily manœuvred.

Figs. 346 to 348, page 137, represent an entirely different form of mounting for a 22-centimetre (8.66 in.) mortar, especially designed for use on shipboard. It is a so-called circular carriage with central pivot, designed as far as possible to reduce the shock due to firing, on the deck of the ship. The system consists of a cradle in which the gun is secured by a slotted ring and keys, and to which are attached the brake cylinders, the piston-rods of which are bolted to the turning part of the mounting. This cradle is made of two cast frames strongly connected together; the upper part is flat and forms the slides on which the recoil takes place; the undersides are curved, so that this part of the mounting has the form of a semicircle. This frame takes its bearings in the curved slides of the underframe, which are shaped to the same radius as that of the moving frame. To elevate the gun, it, with the moving frame, is turned on the curved bearings, the movement being guided by two clips, one of

TABLE XXXII.—GENERAL PARTICULARS OF CANET HOWITZERS, CONSTRUCTED BY THE FORGES ET CHANTIERS DE LA MEDITERRANÉE, HAVRE.

Nature of Gun.	Calibre.		Total Length.		Length of Bore.		Diameter of Chamber.		Length of Rifling.		Number of Grooves.	Terminal Angle.	Weight of Gun.		Weight of Projectile.		Weight of Charge.		Initial Velocity.		Total Energy.		Thickness of Iron Plate Penetrated at Muzzle.		Maximum Range.	
	in.	mm.	in.	mm.	in.	mm.	in.	mm.	in.	mm			lb.	kilos.	lb.	kilos.	lb.	kilos.	ft.	m.	ft-tons	m. tons	in.	cm.	yards	m.
Howitzer, 75 mm.	**2.95**	75	**38.38**	975	**33.67**	855	**3.07**	78	**29.5**	750	22	Uniform rifling at 7 deg.	**249.12**	110	**8.82**	4	**.727**	0.33	**984**	300	**59.21**	18.34	**1.18**	3.0	**5796**	5300
„ 84 „	**3.31**	84	**42.8**	1090	**37.67**	957	**3.43**	87	**33.06**	840	26		**352.7**	160	**12.125**	5.6	**1.389**	0.53	**984**	300	**82.80**	25.65	**1.38**	3.5	**5965**	5400
„ 10 cm.	**3.94**	100	**51.10**	1300	**44.8**	1140	**4.09**	104	**39.4**	1000	30		**617.3**	280	**20.94**	9.5	**1.984**	0.9	**984**	300	**140.7**	43.58	**1.81**	4.6	**6080**	5500
„ 12 „	**4.72**	120	**61.4**	1560	**53.5**	1368	**4.87**	124	**47.2**	1200	36		**1058.2**	480	**36.15**	16.4	**3.307**	1.5	**984**	300	**242.8**	75.22	**2.36**	6.0	**6299**	5760
„ 15 „	**5.90**	150	**76.7**	1950	**67.3**	1710	**6.10**	155	**59.0**	1500	46		**2050.3**	930	**70.55**	32	**6.614**	3	**984**	300	**473.9**	146.70	**3.23**	8.2	**6670**	6100
„ 19 „	**7.47**	190	**97.2**	2470	**85.28**	2166	**7.67**	195	**74.7**	1900	58		**4166.7**	1,890	**143.30**	65	**13.23**	6	**984**	300	**962.6**	298.17	**4.52**	11.5	**7130**	6520
„ 22 „	**8.66**	220	**112.6**	2860	**98.76**	2508	**8.89**	226	**86.6**	2200	66		**6459.5**	2,930	**220.5**	100	**20.72**	9.4	**984**	300	**1469.3**	455.13	**5.19**	13.2	**7474**	6835
„ 24 „	**9.45**	240	**122.8**	3120	**107.7**	2736	**9.72**	247	**94.5**	2400	72		**8377.5**	3,800	**286.6**	130	**26.45**	12.0	**984**	300	**1925.6**	596.45	**6.29**	16.0	**7632**	6980
„ 27 „	**10.63**	270	**138.2**	3510	**121.2**	3078	**10.94**	278	**106.3**	2700	82		**11,949**	5,420	**410.1**	186	**38.58**	17.5	**684**	300	**2755.0**	853.39	**7.47**	19.0	**7906**	7230
„ 30.5 „	**12.01**	305	**156.1**	3965	**137.0**	3480	**12.36**	314	**120.1**	3050	92		**17,196**	7,800	**595.2**	270	**55.11**	25.0	**984**	300	**3990.0**	1238.8	**9.17**	23.3	**7956**	7275
„ 32 „	**12.6**	320	**163.8**	4160	**143.6**	3668	**12.99**	330	**126.0**	3200	96		**19,907**	9,030	**683.4**	310	**63.93**	29.0	**984**	300	**4592.0**	1422.3	**9.64**	24.5	**7994**	7310
„ 34 „	**13.4**	340	**174.0**	4420	**152.6**	3876	**13.86**	352	**133.9**	3400	102		**23,810**	10,800	**815.7**	370	**77.16**	35.0	**984**	300	**5480.1**	1697.6	**10.35**	26.3	**8147**	7450

TABLE XXXIII.—GENERAL PARTICULARS OF CANET MORTARS, CONSTRUCTED BY THE FORGES ET CHANTIERS DE LA MEDITERRANÉE, HAVRE.

Nature of Gun.	Calibre.		Total Length.		Length of Bore.		Diameter of Chamber.		Length of Rifling.		Number of Grooves.	Terminal Angle.	Weight of Gun.		Weight of Projectile.		Weight of Charge.		Initial Velocity.		Total Energy.		Thickness of Iron Plate Penetrated at Muzzle.		Maximum Range.	
	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm			lb.	kilos.	lb.	kilos.	lb.	kilos.	ft.	m.	ft. tons	m. tns	in.	cm.	yards	m.
Mortar, 75 mm.	**2.95**	75	**23.62**	600	**18.90**	480	**3.07**	78	**16.07**	408	22	Uniform rifling at 7 deg.	**132.27**	60	**8.82**	4	**.418**	0.19	**656**	200	**26.31**	8.15	**.71**	1.7	**3368**	3080
„ 84 „	**3.31**	84	**26.38**	670	**21.19**	538	**3.43**	87	**18.03**	458	26		**176.37**	80	**12.125**	5.6	**.573**	0.26	**656**	200	**36.80**	11.4	**.79**	2.0	**3401**	3110
„ 10 cm.	**3.94**	100	**31.50**	800	**25.20**	640	**4.09**	104	**21.46**	545	30		**308.64**	140	**20.94**	9.5	**.992**	0.45	**656**	200	**62.53**	19.37	**.98**	2.5	**3456**	3160
„ 12 „	**4.72**	120	**37.79**	960	**30.24**	768	**4.87**	124	**25.75**	654	36		**507.06**	230	**36.15**	16.4	**1.697**	0.77	**656**	200	**107.9**	33.43	**1.30**	3.3	**3532**	3230
„ 15 „	**5.90**	150	**47.2**	1200	**37.79**	960	**6.10**	155	**32.17**	817	46		**992.07**	450	**70.55**	32	**3.307**	1.5	**656**	200	**210.6**	65.24	**1.81**	4.6	**3641**	3330
„ 19 „	**7.47**	190	**59.8**	1520	**47.87**	1216	**7.67**	195	**40.79**	1036	58		**2094.37**	950	**143.3**	65	**6.834**	3.1	**656**	200	**427.81**	132.52	**2.52**	6.4	**3784**	3460
„ 22 „	**8.66**	220	**69.2**	1760	**55.44**	1408	**8.89**	226	**47.2**	1200	66		**3130.5**	1420	**220.5**	100	**10.362**	4.7	**656**	200	**658.3**	203.92	**3.07**	7.8	**3888**	3555
„ 24 „	**9.45**	240	**75.5**	1920	**60.48**	1536	**9.72**	247	**51.27**	1308	72		**4056.5**	1840	**286.6**	130	**13.23**	6.0	**656**	200	**855.8**	265.09	**3.54**	9.0	**3970**	3630
„ 27 „	**10.63**	270	**85.0**	2160	**68.04**	1728	**10.94**	278	**57.88**	1470	82		**5908.3**	2620	**410.1**	186	**19.18**	8.7	**656**	200	**1224.6**	379.29	**4.21**	10.7	**4111**	3760
„ 30.5 „	**12.01**	305	**96.0**	2440	**76.86**	1952	**12.36**	314	**64.97**	1650	92		**8311 3**	3770	**595.2**	270	**28.00**	12.7	**656**	200	**1777.4**	550.57	**4.99**	12.7	**4139**	3785
„ 32 „	**12.6**	320	**100.8**	2560	**80.64**	2048	**12.99**	330	**68.66**	1744	96		**9612.1**	4360	**683.4**	310	**32.19**	14.6	**656**	200	**2040.9**	632.14	**5.35**	13.6	**4166**	3810
„ 34 „	**13.4**	340	**107.1**	2720	**85.68**	2176	**13.86**	352	**73.00**	1854	102		**11530.1**	5230	**815.7**	370	**37.48**	17.0	**656**	200	**2436.9**	754.49	**5.78**	14.7	**4237**	3875

which is fixed to the frame, and through which slides a projection made on the edge of the moving frame; the other is attached to the latter, and slides over a rib in the fixed frame. The maximum angle of elevation that can be obtained is shown in Fig. 348. The underframe which terminates with a cylindrical base rests on a ring of rollers, that bear on the bedplate, and a strong broad clip prevents the mounting from being overturned. The arrangement of hydraulic brake with the spring recuperator *b*, is shown in the various figures, the action being similar to that already described. When the gun is fired the recoil compresses the springs, and the reaction brings the piece back to firing position. This is a modification of the Canet system, in which air is compressed during recoil in a central cylinder, the energy thus stored up being utilised for returning the gun to battery. The gun is raised or lowered by the long oblique screw *d* on the right-hand side of the frame. This screw has a bearing on the fixed part of the frame and works on a nut mounted on the turning portion. Training for direction is effected by means of a pitched chain driven by the handwheel *e* and working through an endless screw, a pinion on the axis of which is a second pinion gearing into the rack cut around the baseplate. The total weight of this mounting is about 3.5 tons.

Tables XXXII. and XXXIII. contain detailed particulars of all the different natures of howitzers and mortars, made on the Canet system by the Forges et Chantiers de la Mediterranée at Havre.

For the sake of comparison we may add some information on muzzle-loading howitzers in the British service, taken from the Official Handbook. Table XXXIV. contains the leading particulars of the different classes of howitzers.

Figs. 349 to 352 (see preceding page) are sections of the howitzers referred to in the Table. All are muzzle-loaders, and the earlier patterns are of small importance. The 8-in. gun shown in Fig. 351 is the most important of the series. In proportion as well as construction, the 8-in. howitzer of 70 cwt. resembles the 6.6 in. (Fig. 350). They are powerful pieces, and form the chief armament of a heavy unit of siege trains. The grooves of the rifling are exactly the same, and so is the twist at the muzzle; but at the breech it commences with one turn in

TABLE XXXIV.—General Particulars of Muzzle-loading Howitzers in the British Service.

Nature.	—	Length.				Chamber.			Rifling.	Grooves.			—
		Nominal.	Bore.		Rifling.	Length.	Diameter.	Capacity.	Twist.	Number	Width.	Depth.	
in.	cwt.	ft. in.	in.	calibre	in.	in.	in.	c. in.			in.	in.	cwt.
8	70	9 2.125	96	12	93.5	8	8	397	1 in 90 to 1 in 35	24	.7	.05	
8	46	.5 1	48	6	35.5	12.5	8	584	1 in 16	4	1.5	.18	2
6.6	36	7 4.5	79.2	12	76.7	5.075	6.5	169.5	1 in 94 to 1 in 35	20	.7	.05	
6.3	18	4 6	45	7	42.5	5.3	6.3	161.26	1 in 100 to 1 in 35	20	.5	.05	

90 calibres, instead of 1 in 94 and in the larger calibres, the number of grooves is increased from 20 to 24. The most modern of these, as well as of the 6.6 in., are of steel, the others are of wrought iron and steel. The 6.3 in. howitzer (Fig. 352) is the smallest of the series, and has mainly been used for India where large numbers are mounted.

Some of the types of carriages described in a recent number as being used for siege guns (see page 36 *ante*), are employed for the mortar and howitzer service. The mortar and howitzer beds call for no particular description. The types of howitzer mountings made by Messrs. Armstrong and Co., at the Elswick Works, are of a much more elaborate and modern type. We published one such mounting for an 11-in. howitzer, in a recent number (see Engineering, vol. xlviii., page 551). The carriage is of steel resting on a circular bedplate through a live roller ring; the lower part is cylindrical, and from it rise two vertical plate frames, one side of which forms the slides which are at an angle of 60 deg. Upon them rests a small cradle supporting the gun by the trunnions, to each side of the cradle are attached the ends of the brake piston-rods; the brake cylinders, set at an angle of 60 deg., are connected to the upright frame. Between the cylinders and in connection with them is an air chamber, and the action of the brake is somewhat similar to that already illustrated and described (see Figs. 301 to 305, page 36 *ante*). The energy of recoil is thus used to bring the gun back to firing position. The howitzer is trained for elevation by means of a handwheel and gearing, and it is loaded when in a horizontal position; the breech mechanism is of the Armstrong standard type. The following are the weights of the mounting:

	tons	cwt.	qr.	lb.
Carriage	0	16	1	0
Platform and cylinder ...	9	6	0	7
Loading crane	0	2	0	14
Pivot bracket	1	2	2	12
Roller and bolts	2	14	3	12
Total	14	1	3	17

The total weight of the howitzer is 10.6 tons, and it fires a projectile of 478 lb. with a charge of 44 lb.

Water in Queensland.—Artesian water has been struck at Corindah Station, near Aramac, Queensland, at a depth of 500 ft. The supply is about 150,000 gallons per day.

The Straits of Canso.—Some Boston capitalists are developing the foundations of a seaport at the east end of the Straits of Canso, Nova Scotia, five miles from Port Mulgrave, the present terminus of the Intercolonial Railway. An extensive water front has been acquired, to be known as Terminal City, and a line of steamships to Liverpool is to be established. When railway communication is completed, and wharves are built, passengers and mails from Europe will be delivered in New York or Montreal one day sooner than by any other route.

Wyoming.—The new State of Wyoming has practically inexhaustible supplies of coal, oil, and salt. On the line of the Union Pacific Railroad, 1,500,000 tons of coal are now mined yearly. At Mount Zion a company is expending 500,000*l.* in getting coal ready for shipment, when the railroad reaches that point. Numerous oil wells which have been bored have been closed with valves. The largest known deposit of coal covers 160 acres. It appears from measurements that the salt deposits yield over 30,000,000 cubic feet of salt for each foot in depth. They are fed by salt springs. The only use yet made of the salt deposits is noticeable at Laramie.

TABLE XXXV.—FORGES ET CHANTIERS DE LA MEDITERRANÉE. PRINCIPAL PARTICULARS OF QUICK-FIRING GUNS (CANET SYSTEM).

Type of Gun.	Calibre.		Total Length.		Length of Bore.		Diameter of Chamber.		Length of Rifling.		Number of Grooves.	Angle of Rifling.	Weight of Gun.		Weight of Shell.		Weight of Charge.		Muzzle Velocity.		Muzzle Energy.		Penetration in Wrought Iron.		Maximum Range.	
	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm			lb.	ks.	lb.	ks.	lb.	kilos.	ft.	m.	ft.-tons	m. tns	in.	mm	yards	m.
Quick-firing gun of 65 mm. bore, 30 calibres long	**2.56**	65	**76.7**	1950	**72.0**	1830	**2.67**	68	**65.3**	1600	20	Uniform rifling at 6 deg.	**661.3**	300	**8.818**	4	**1.212**	0.55	**1640**	500	**164.54**	50.97	**2.79**	71	**11,171**	10,215
Ditto 40 calibres	**2.56**	65	**102.3**	2600	**97.6**	2480	**2.67**	68	**85.4**	2170	20		**881.8**	400	**8.818**	4	**2.315**	1.05	**2165**	660	**286.67**	88.80	**4.17**	106	**13,681**	12,510
Ditto 50 ,,	**2.56**	65	**127.9**	3250	**123.2**	3130	**2.67**	68	**104.7**	2660	20		**1102.3**	500	**8.818**	4	**3.307**	1.50	**2559**	780	**400.38**	124	**5.27**	134	**14,953**	13,67⁵
Quick-firing gun of 75 mm. bore, 30 calibres long	**2.95**	75	**83.5**	2250	**83.0**	2110	**3.07**	78	**75.5**	1920	22		**1036.2**	470	**13.23**	6	**1.764**	0.80	**1640**	500	**246.81**	76.45	**3.35**	85	**11,384**	10,410
Ditto 40 calibres	**2.95**	75	**118.1**	3000	**112.6**	2860	**3.07**	78	**93.4**	2500	22		**1366.8**	620	**13.23**	6	**3.307**	1.50	**2165**	660	**430.09**	133.21	**4.21**	107	**13,971**	12,775
Ditto 50 ,,	**2.95**	75	**147.6**	3750	..	3610	**3.07**	78	**120.9**	3070	22		**1675.5**	760	**13.23**	6	**4.850**	2.20	**2559**	780	**600.62**	186.05	**6.33**	161	**15,310**	14,000
Quick-firing gun of 9 cm. bore, 30 calibres long	**3.54**	90	**106.3**	2700	**101.0**	2565	**3.70**	94	**90.5**	2300	28		**1763.7**	800	**22.046**	10	**2.866**	1.30	**1640**	500	**411.4**	127.42	**4.25**	108	**11,429**	10,450
Ditto 40 calibres	**3.54**	90	**141.7**	3600	**136.4**	3465	**3.70**	94	**118.1**	3000	28		**2358.9**	1070	**22.046**	10	**5.291**	2.40	**2165**	660	**716.75**	222	**6.29**	160	**14,054**	12,850
Ditto 50 ,,	**3.54**	90	**177.2**	4500	**171.9**	4365	**3.70**	94	**144.9**	3680	28		**2910.1**	1320	**22.046**	10	**7.936**	3.60	**2559**	780	**1048.0**	310	**7.99**	203	**15,410**	14,090
Quick-firing gun of 10 cm. bore, 30 calibres long	**3.94**	100	**118.1**	3000	**97.9**	2846	**4.13**	105	**100.4**	2550	30		**2447.1**	1110	**28.66**	13	**3.527**	1.60	**1640**	500	**534.81**	165.65	**4.72**	120	**11,493**	10,510
Ditto 40 calibres	**3.94**	100	**157.5**	4000	**151.4**	3846	**4.13**	105	**131.1**	3330	30		**3240.8**	1470	**28.66**	13	**6.613**	3.00	**2165**	660	**931.96**	288.62	**7.04**	179	**14,141**	12,930
Ditto 50 ,,	**3.94**	100	**196.9**	5000	**190.8**	4846	**4.13**	105	**160.8**	4085	30		**4021.4**	1820	**28.66**	13	**10.14**	4.60	**2559**	780	**1301.4**	403.12	**8.93**	227	**15,507**	14,180
Quick-firing gun of 12 cm. bore, 30 calibres long	**4.72**	120	**141.7**	3600	**134.4**	3413	**4.95**	126	**118.70**	3016	36		**4232.8**	1920	**46.29**	21	**5.07**	2.3	**1640**	500	**863.66**	267.5	**5.82**	148	**11,549**	10,560
Ditto 40 calibres	**4.72**	120	**189.0**	4800	**181.6**	4613	**4.95**	126	**158.4**	4023	36		**5599.6**	2540	**46.29**	21	**10.36**	4.7	**2165**	660	**1504.7**	466.09	**8.70**	221	**14,222**	13,005
Ditto 50 ,,	**4.72**	120	**236.2**	6000	**228.9**	5813	**4.95**	126	**194.7**	4945	36		**6944.5**	3150	**46.29**	21	**16.31**	7.4	**2559**	780	**2101.7**	650.99	**11.02**	280	**15,607**	14,270

TABLE XXXVI.—FORGES ET CHANTIERS DE LA MEDITERRANÉE. PRINCIPAL PARTICULARS OF QUICK-FIRING GUNS (CANET SYSTEM).

Type of Gun.	Calibre.		Total Length.		Length of Bore.		Diameter of Chamber.		Length of Rifling.		Number of Grooves.	Angle of Rifling.	Weight of Gun.		Weight of Shell.		Weight of Charge.		Muzzle Velocity.		Muzzle Energy.		Penetration in Wrought Iron.		Maximum Range.	
	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm			lb.	kls.	lb.	kls.	lb.	kls.	ft.	m.	ft.-tons	m. tons	in.	mm	yards	m.
Quick-firing gun of 14 cm. bore, 30 calibres long	**5.51**	140	**165.4**	4200	**157.1**	3990	**5.78**	147	**140.5**	3570	42	Uniform rifling at 6 deg.	**6724**	3050	**70.55**	32	**7.72**	3.5	**1640**	500	**1316.2**	407.75	**7.04**	179	**11,735**	10,730
Ditto 40 calibres	**5.51**	140	**220.5**	5600	**212.3**	5390	**5.78**	147	**183.5**	4660	42		**8906.6**	4040	**70.55**	32	**15.87**	7.2	**2165**	660	**2293.8**	715.46	**10.47**	266	**14,495**	13,255
Ditto 50 ,,	**5.51**	140	**275.6**	7000	**267.3**	6790	**5.78**	147	**226.4**	5750	42		**11,023**	5000	**70.55**	32	**24.69**	11 2	**2559**	780	**3203.5**	992.30	**13.31**	338	**15,946**	14,580
Quick-firing gun of 15 cm. bore, 30 calibres long	**5.90**	150	**177.2**	4500	**168.3**	4275	**6.21**	158	**150.2**	3815	46		**8267.3**	3750	**88.18**	40	**9.70**	4.4	**1640**	500	**1645.3**	509.68	**7.87**	200	**11,855**	10,840
Ditto 40 calibres	**5.90**	150	**236.2**	6000	**227.4**	5775	**6.21**	158	**201.0**	5105	46		**10,956**	4970	**88.18**	40	**19.84**	9.0	**2165**	660	**2867.0**	888.07	**11.69**	297	**14,689**	13,430
Ditto 50 ,,	**5.90**	150	**295.3**	7500	**286.4**	7275	**6.21**	158	**245.9**	6245	46		**13,588**	6150	**88.18**	40	**30.86**	14.0	**2559**	780	**4004.2**	1240.36	**14.88**	378	**16,163**	14,780

by want of encouragement, as to give up the attempt.

Though this is both a long and tedious sermon to hang on the text of Mr. Cole's little handbook, the matter we speak of is one well worth careful attention. It is truly remarkable how difficult it is to rouse opinion on a matter of this kind, which though it affects the credit and tone of a great government, has no immediate personal bearing on the individuals who decide such matters. If, for instance, the Viceroy's council were shown that an inferior class of medical man was being sent out, from whose ineptitude any one of them might suffer in his own person, or that of relatives, children, or friends, a remedy to restore the tone of the medical department would soon be devised we may be sure; yet an inferior or disheartened medical department could neither squander the resources or damage the prestige of the administration to one tenth the extent that an inefficient, because underpaid engineering department might easily do, without for a moment soiling its own hands.

The fact, if it be fact, that the Royal Engineer section of the department is more loyal, and for administrative work more capable than the civil engineer section, has absolutely no bearing whatever on this delicate subject. No Royal Engineer in or out of the Indian Government service ever has written, or is ever likely to write a book like Mr. Cole's, for he is too busy learning administrative work to tackle such technical details, and devote to them the years of close personal devotion that are necessary to obtain so much practical mastery. It is the engineers who know the work, that handle the men, and in so doing control the expenditure, and the more closely the Government of India relegates its civil engineers to out-door work, the more earnest heed should it take to maintaining their status and encouraging them in the arduous path of repressing the corruption, that but for their high-toned zeal, will assuredly sap the foundations of the whole administration.

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The Naval Annual, 1890. Edited by T. A. BRASSEY. Part I., LORD BRASSEY, K.C.B.; Part II., F. K. BARNES, M.I.N.A.; Part III., CAPTAIN ORDE BROWNE, late R.A.; Part IV., Statistics, Tables, Official Reports. Portsmouth: J. Griffin and Co.

Sewage Disposal Works: A Guide to the Construction of Works for the Prevention of the Pollution by Sewage of Rivers and Estuaries. By W. SANTO CRIMP. With Tables, Illustrations in the Text, and 33 Lithographic Plates. London: Charles Griffin and Co.

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Light, an Introduction to the Science of Optics. By E. WYNDHAM TARN. London: Crosby Lockwood and Son. [Price 1s. 6d.]

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Short Logarithmic and other Tables. By W. CAWTHORNE UNWIN, F.R.S., Memb. Inst. C.E. Fourth Edition. London: E. and F. N. Spon.

The Law of Trade Marks and their Registration, and Matters connected therewith; including a Chapter on Goodwill. By LEWIS BOYD SEBASTIAN, B.C.L., M.A. Third Edition. London: Stevens and Sons, Limited.

The Electrical Engineer's Pocket-Book of Modern Rules, Formulæ, Tables, and Data. By H. R. KEMPE. With numerous Illustrations. London: Crosby Lockwood and Son.

The Universal Mining Code for the Use of Mining Companies, Mining Engineers, Merchants, Agents, Shippers, Manufacturers, and all engaged and interested in Mining Affairs. By JAMES STEVENS and R. SYDNEY CORBETT. The Code Words specially selected to comply with the Telegraph Convention Rules, by GEORGE AGER, LL.D. London: 9, Fenchurch Avenue.

L'Assainissements des Eaux des Egouts de Paris. Moyen proposé pour rendre possible leur déversement dans la Seine. Paris: A. Schiffer.

The Law Relating to Civil Engineers, Architects, and Contractors. Primarily intended for their own Use. By L. LIVINGSTON MACASSEY and JAMES ANDREW STRAHAN, LL.B. London: Stevens and Sons, Limited.

The Gas and Water Companies' Directory, 1890. With New Sections—Electric Lighting, Rating, and List of Trading Firms. Edited by CHARLES W. HASTINGS. London: Hazell, Watson, and Viney, Limited.

MODERN FRENCH ARTILLERY.
No. XXXI.

QUICK-FIRING GUNS; CANET SYSTEM.

THE ordnance works of the Forges et Chantiers de la Mediterranée are not occupied by any means solely with the manufacture of guns of the smallest or of the largest calibres; on the contrary the skill of the director, M. Canet, has been especially directed to the production of intermediate natures, and particularly to those for rapid-firing guns which at the present time play so important a part in the armament of war vessels, and are not unlikely in the future to decide, even more than the guns of heavy calibre, the fortunes of naval battles. The problem of rapid-firing artillery has—chiefly on account of the development in the offensive powers of torpedo boats—received great attention from leading European nations. With the increasing size, accelerated speed, and more dangerous means of attack with which these vessels have been endowed, the necessity arose for possessing on board ship a means of repelling sudden attacks during the very short time which is available from the moment when the enemy is sighted, to that when he arrives within the limited range required for successfully launching a torpedo. It was with this object that machine guns such as those of Nordenfelt, Hotchkiss, Gardner, &c., were designed. Very efficient they were at the time, and probably quite able to silence the attack of the earlier torpedo boats; and very efficient they still remain when

FRENCH ARTILLERY; THE CANET SYSTEM OF QUICK-FIRING GUNS.

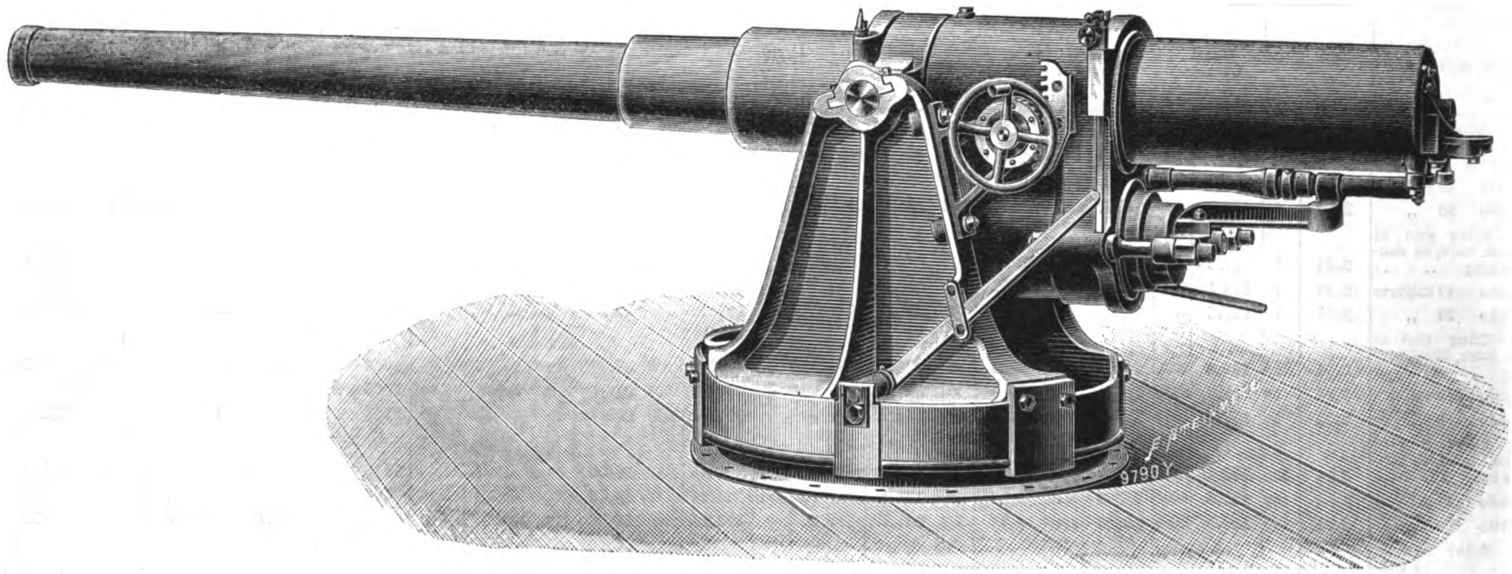


Fig. 372. Canet quick-firing 10 cent. (3.94 in.) gun on naval carriage.

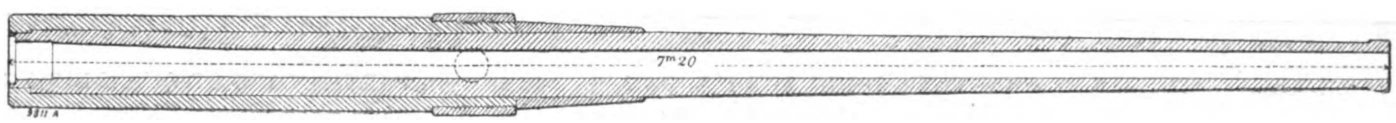


Fig. 353. 15 cent. (5.90 in.) Canet quick-firing gun.

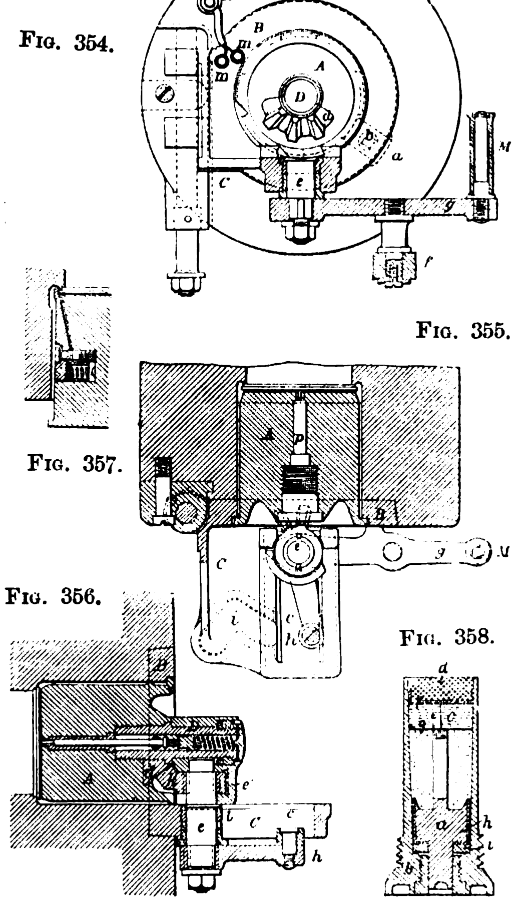


Fig. 354. Fig. 355. Fig. 357. Fig. 356. Fig. 358.

Breech mechanism of Canet quick-firing gun.

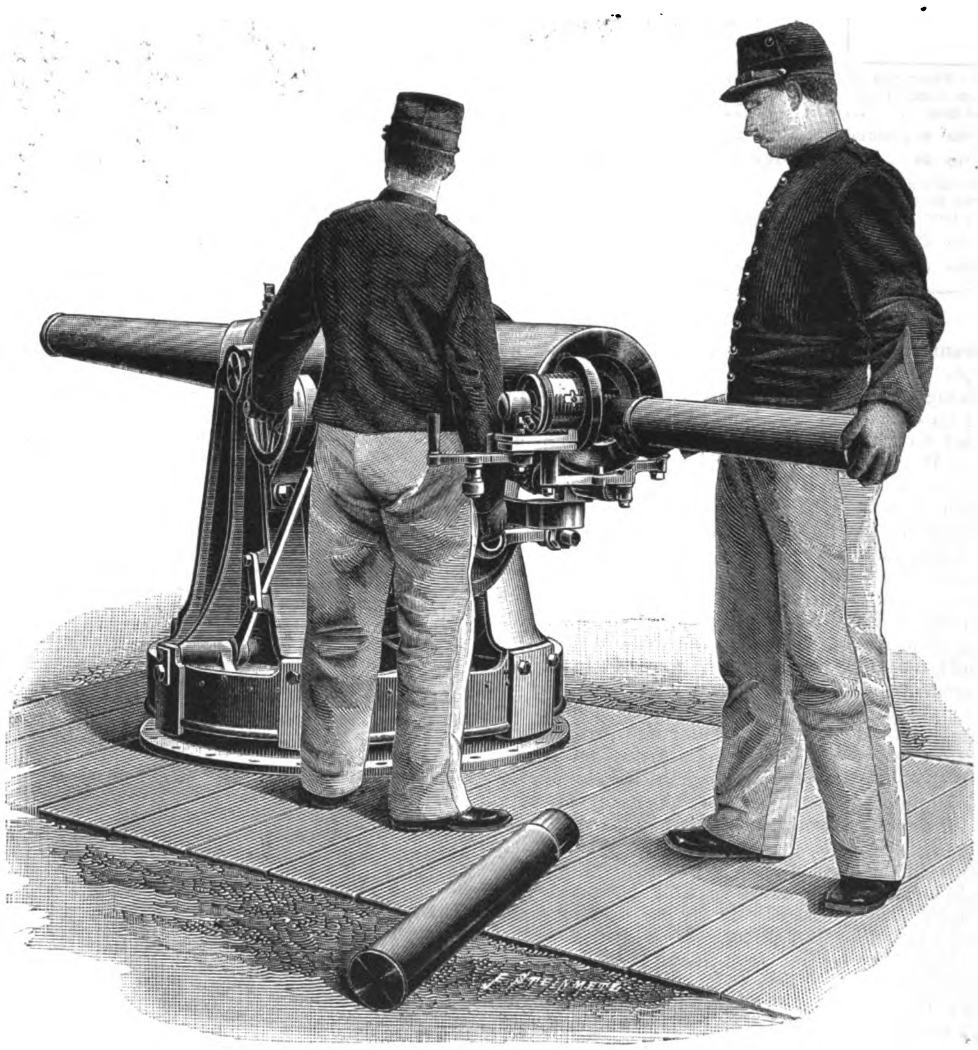


Fig. 373. Loading a Canet quick-firing gun.

those emergencies arise which call for the instant concentration of a hail of small shot and shell upon any point within a close range. But the day has long past when they can be relied upon successfully to repel the attack of a first-class torpedo boat, which with its greater size and thicker plates, can afford to disregard the storm of bullets that may be poured upon it when it arrives within striking range, and can thus fire its torpedoes with comparative impunity. Hence the necessity arose for a new type of gun—one which could fire well-directed shots of moderately heavy weight at a high rapidity, capable of considerable range, and of such penetrating powers that if the projectiles glanced off harmless against the protected portions of the object of attack, they should nevertheless be able to pass through thinner plates and to carry destruction with them not only to the *personnel* of a hostile ship, but also to its upper works, its batteries, the weaker portions of its turrets, and its machinery. As for ordinary torpedo boats, it was

FRENCH ARTILLERY; THE CANET SYSTEM OF QUICK-FIRING GUNS.

Fig. 359.

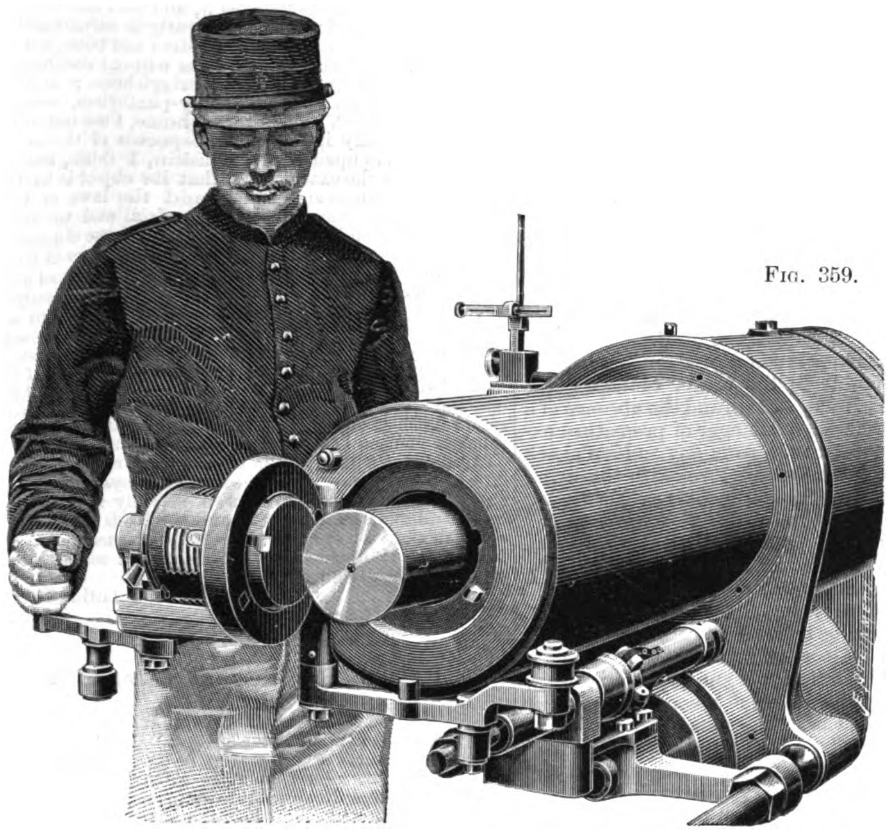
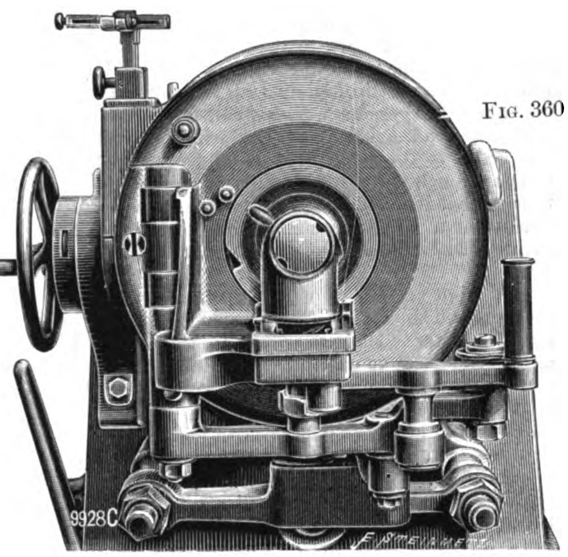


Fig. 360



BREECH MECHANISM OF CANET QUICK-FIRING GUN.

Fig. 361. Fig. 362. Fig. 363. Fig. 364. Fig. 365. Fig. 366.

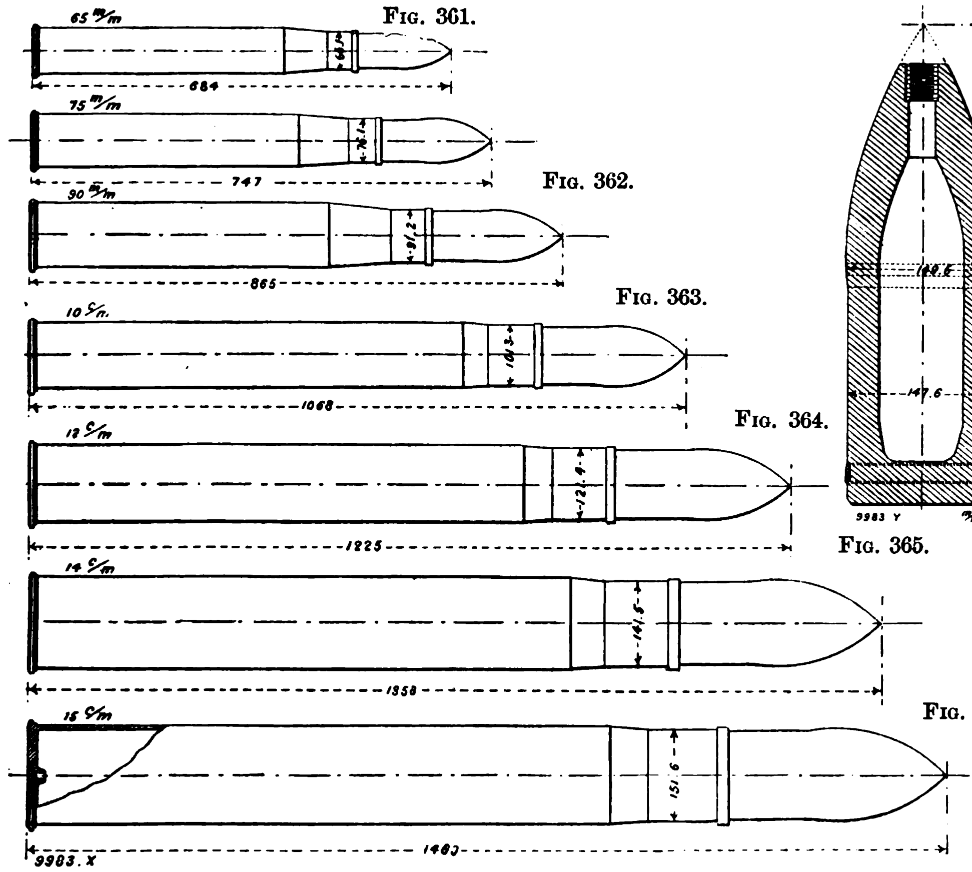


Fig. 367. Fig. 368. Fig. 369. Fig. 370.

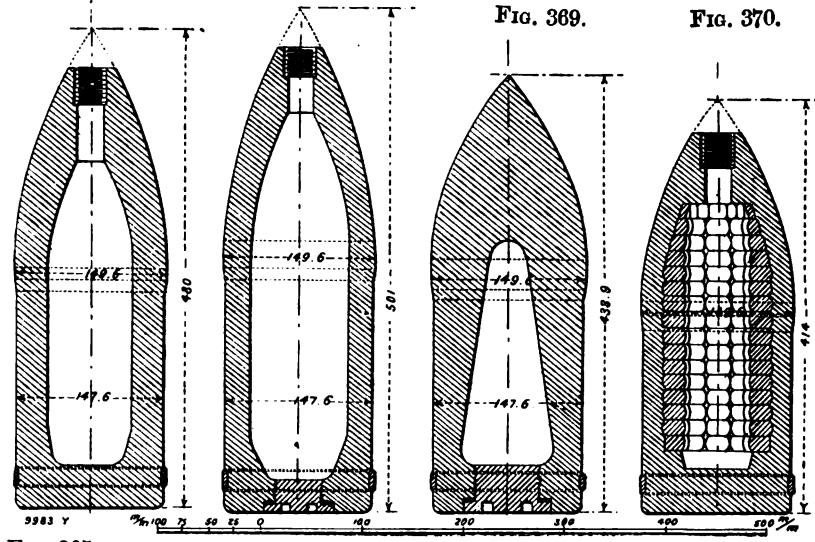
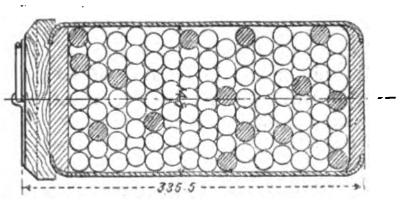


Fig. 371.



CARTRIDGES AND PROJECTILES FOR CANET QUICK-FIRING GUN.

intended that such vessels should not be able to live within the broad dangerous zone that such guns could command, and hence that ships possessing such an armament should be comparatively secure from torpedo attack. To the Hotchkiss Ordnance Company, whose guns we shall consider at a later period, belongs most, if not all of the credit, for this new departure in artillery construction. Guided by their experience, the Elswick Works commenced the manufacture of such guns, and were not long before they produced weapons surpassing in calibre and range any that had been made up to that date. At first these guns were designed chiefly, if not wholly, to repel torpedo attack, but it speedily became evident that they were capable of far higher uses, and it is difficult to conceive more generally destructive weapons, for their size, than the Armstrong 4.5-in. rapid-firing guns, such as are mounted on the Italian warship Piemonte.

The rapid-firing guns constructed by the Forges et Chantiers de la Mediterranée on the Canet system, are calibres of 2.64 in., 2.95 in., 3.54 in., 3.94 in., 4.72 in., 5.51 in., and 5.9 in. We need not describe in detail the smaller sizes, because the principle on which they are constructed is identical throughout; M. Canet is advancing boldly in the direction of applying the system of rapid firing, to guns of much larger calibre; it is evident, however, that for the present, at all events, comparatively narrow limit must be set to this advance on account of the short time that the type of ordnance has been developed. The special features in the Canet system of rapid-firing artillery, are the method of constructing the gun itself, the system of opening and closing the breech, the arrangement of the carriage, and the mode of working. The gun consists of a steel tube (see Fig. 353) extending for the whole length of the piece; this tube is reinforced by a long steel jacket, over which again is placed a ring that carries the trunnions, or the special bearings by which the gun may be mounted in a cradle, or in some cases a casting which forms the piston of the recoil brake; in front of the jacket is shrunk a long conical ring. Each calibre is made in three types, 30, 40, and 50 calibres long. The mode of construction was specially studied with a view of giving to these formidable guns a uniform transverse and longitudinal strength throughout; all the different parts are made of very high-class steel, forged and tempered, and annealed after tempering; the metal is subjected to the same tests as the steel furnished to the French Government for naval guns, that is to say, that it must fulfil the following conditions:

Minimum breaking strain, 38 tons per square inch. Elastic limit, 20.32 tons. Extension, 14 per cent.

The high initial velocity imparted to the projectiles, and the ballistic qualities in general of these guns, are due to the form given to the bore, which allows the gases to expand under most favourable conditions; to the weight of the projectile and that of the powder charge; to the nature of the powder employed, and to the character of the rifling. The rapidity of fire is obtained in two ways; by simplifying the manipulation of the opening and closing of the breech, and by simultaneously inserting the projectile, the powder charge, and the fuze by the use of metallic cartridges. The method of closing the breech of these guns has been already referred to, but we may briefly repeat the leading particulars of the mechanism, which comprises a screwed block with interrupted segments and three movements; the disengagement of the threaded sectors from the corresponding sectors in the breech of the gun, the traversing towards the rear of the breech-block, and turning the latter out of the way of the bore upon the axis of the console; all these operations are performed by a single lever, which is turned from right to left in a horizontal plane.

Figs. 354 to 360 illustrate the standard breech-loading mechanism of the Canet quick-firing gun. The breech-block A is made with four equal sectors of interrupted screw threads, and is supported by the bronze ring B, which is made unusually deep; the outside periphery of the latter is slightly tapered, and it fits into a corresponding recess cut in the breech of the gun; the ring is alternately locked to the body of the gun when the breech is closed, and to the block when the latter is withdrawn from its seat, by means of the sliding spring latch a and b, recessed in the breech and the block being made to receive the latch according to its position. The ring is made in one piece with the bracket C, that is hung by a pin to the left-hand side of the breech; in the front of this bracket is a longitudinal groove c. As shown in Fig. 356, the back of the breech-block is recessed, and in the lower part of this recess are cut the bevel teeth d. In the centre, the block is extended backwards, as shown, by a tube containing the exploder; around this is placed the loose sleeve D that is supported by the spindle e carried on the bracket. On this spindle are secured, a segment cut with bevel teeth k gearing into the teeth on the block, a block l that can slide in the groove c of the bracket, and a double-armed lever, one of which g terminates in the working handle M, while the other carries a small roller h that can move in a horizontal slot i cut beneath the bracket, and shown in dotted lines in Fig. 355; this slot is partly curved from the centre of the pivot e, and partly straight but forming an angle with the bore of the gun. On pulling the handle M from right to left, the lever g turns, and through it the gearing d k moves the block round through one-eighth of a turn; during this time the block l does not move in the slot in the bracket, but the roller h passes over the curved part of the slot i and arrives at the straight portion against which it bears, while the continued effort on the lever M, starts the block l in its slot and withdraws the block from its seat in the gun, the roller h gradually travelling down the straight part of the slot i. As soon as the roller reaches the bottom of the slot, the continued movement of the lever M forces the block and ring to turn on the hinge pin and thus open the breech. For closing it, all that is necessary is to push the lever M from left to right. In a modified arrangement, on the lever g, for the larger calibres, a pin is fastened carrying a roller f which connects with the mechanism for bringing the gun back to firing position. Figs. 361 to 371 show the forms and relative sizes of the cartridges used in the Canet quick-firing guns, and Fig. 358 is a section of the electric fuze fixed in the base of the cartridge shell. The plug a of this fuze is insulated from the body by an envelope of thin rubber h and a hard rubber washer i; the stem of the plug terminates in a platinum point c that establishes metallic connection, and the space around it is packed with gun-cotton, paper wads separating it from the firing charge in the body of the fuze and the wax plug at the head.

Firing by electricity is considered, under certain conditions, preferable by the maker of these guns, as the discharge is more certain and the absence of a percussion fuze removes all danger of premature explosion which might result from any sudden shock to the fuze. The wire is cut level with the firing cap on the base of the projectile and remains always in contact with a needle placed in the centre of the block and held up by means of a spiral spring (see Fig. 356). Upon this needle, and insulated by strips of ebonite, is mounted a metallic insulated conductor placed perpendicular to the bore of the gun. A plate spring is used to establish connection between this conductor and the terminal mounted on the breech of the gun (m m, Fig. 354), and it is only at the moment when the breech is completely closed that this connection is made and it is possible to fire the gun; a second terminal is used to fix the return wire to the body of the piece. The two wires united in one cable are joined to a circuit-closer mounted upon the frame.

The cartridge cases are extracted by two hooks recessed in opposite sides of the breech-block, as shown in Fig. 357. These hooks are held up to their work by spiral springs, and as the breech is closed the hooks close over the rim on the cartridge case and hold it until it is withdrawn with the block. Figs. 372 and 373 show the general appearance of the Canet quick-firing gun mounted on a naval carriage, and Tables XXXV. and XXXVI. (page 153) give the principal data of several of the calibres of this type of ordnance.

THE EDUCATION OF ENGINEERS.

TO THE EDITOR OF ENGINEERING.

SIR,—As you indorse "P.'s" appeal by publishing it, and thus absolve correspondents beforehand from the charge of advertising, the following particulars may be offered to your readers respecting a school, the methods of which, in many respects novel, seem to be peculiarly well suited to the mental and physical training of lads destined for engineering. This is "the new school," opened last autumn by Dr. Cecil Reddie, at Abbotsholme, Rocester, Staffordshire—though actually on the Derbyshire side of the Dove. A newspaper article brought it to my notice, and a careful visit of inspection led to my placing there a boy of twelve. Two later visits, and the boy's return after one term's work, have led to the decision to send two of his brothers as well. Latin is not taught to the younger boys, and only to the seniors sufficiently to assist them in the study of their own and other modern languages: it is not followed as a means of mental discipline. Science, as "P." recommends, takes its place for that purpose, coupled with practical hand work, systematically carried out in the workshop, in the garden, and on the farm. The house is a fair-sized mansion of modern build, well found with conservatories and orchard houses, &c., and with a considerable estate attached, through which winds nearly a mile of the River Dove, providing good bathing, and some day, it is hoped, boating, when the boys have themselves carried out certain projected works in the way of dams and cuts. Bookwork begins early, and is over before the dinner-hour; the rest of the day is divided between the workshops, cricket, and other games, field or garden work, and, in the evening, music, and a social gathering in—actually—a "drawing-room," where also ladies are to be found. The handicraft work is carried on in connection with the Guild of Arts and Crafts, and good engravings and other objects of beauty are everywhere. In all the school subjects the blackboard, and models and specimens, are used where possible, and it is clear that my boy has come back after one term with a better foundation for scientific training than I have been accustomed to find as the result of years of the ordinary perfunctory miscalled science-teaching of schools. Another unnatural thing about him (seeing that he is not a gushing youth by nature) is his liking for the masters. "They take so much trouble with us; they explain everything so." Indeed, his first letter from the school, more graphic than graceful, said, "it is like all holidays, they teach us in such an interesting way," and this is the key to what I think is going to be a great success. Hygiene is one of the subjects of study, and physiology as affecting health, and in matters of dress, diet, discipline, and exercise the school reflects the opinions certainly unconventional and possibly peculiar, but as I think mostly very wise, of the energetic man who has founded it, and who has collected round him a staff of masters apparently as earnest as himself. Companionship between masters and boys, without espionage; hardiness and manliness without roughness or brutality; earnestness without priggishness; and reasonable gentleness without namby-pambyism, seem to have been attained. Absent from home, I am not able to refer to the really interesting prospectus of the school, but it sets forth (quoting from Ruskin, I think, but I do not remember the exact words) that its object is to teach habits of gentleness and justice, and the laws of bodily and mental health and their application, and to fit boys to earn their own living in after life. These objects seem to me in fair way of fulfilment, and after years of fruitless search I believe I have found a satisfactory school at last. It is not a cheap school, of course, but it is less costly than any of the public schools, even including many to which the title scarcely applies. If there are any other schools at all similar in principles or practice they are unknown to me, and certainly not from want of inquiry, for I share "P.'s" views completely, except that while abandoning classical study as a system of mental training, I would retain Latin as an aid to the understanding of modern tongues. When I last saw the school, some underground culvert or drain had burst in the orchard, and great works of engineering were in progress. The boys, in flannels, and not much of them, wallowed joyfully waist-deep in water and mud. A dam arose and the floods were curbed, and I thought I had never seen Kindergarten principles better applied in practice. The boys had something to talk over that evening.

Yours faithfully,

Weymouth, August 5, 1890. M. R.

BOILER INSPECTION v. BOILER INSURANCE.

TO THE EDITOR OF ENGINEERING.

SIR,—An anonymous letter headed "Boiler Inspection v. Boiler Insurance" appeared in yours of the 25th inst. I do not intend to reply to that letter, as the writer does not write over his own name, and therefore I shall not deal with the exaggerated statements it contains. My only reason for addressing you, and which caused me to write to Mr. Fletcher in April last, is that he, and his Association, have caused unfounded alarm in the public mind.

As regards the figures given by Mr. Fletcher, any one who takes the trouble to analyse these will at once perceive that my charge is sustained. There are many cases included in the list such as were properly not reckoned nor counted as explosions of steam boilers in years gone by. I have before me the annual lists given by Mr. Fletcher in his December reports for the years 1874 to 1880 inclusive, and find as follows. I also append figures from my own reports:

Steam Users' Association's Reports.

	Number of Explosions.	Persons Killed.	Persons Injured.
Totals for seven years 1874 to 1880 inclusive	257	437	628
Average	36.7	62.4	89.7
Totals for five years 1885 to 1889 inclusive	236	142	260
Average	47.2	28.4	52

"National" C.E.'s Reports.

	Number of Explosions.	Persons Killed.	Persons Injured.
Totals for seven years, 1874 to 1880 inclusive	308	432	688
Average	44	61.7	98.3
Totals for five years, 1885 to 1889 inclusive	170	118	257
Average	34	23.6	51.4

I give a greater number of explosions for the seven years 1874 to 1880, doubtless owing to our better facilities for obtaining details than he had, nevertheless the number of killed and injured are as great in his returns as mine. This will doubtless arise from my obtaining particulars of explosions which he did not hear of, and which were not accompanied by fatal results, and hence would not be so likely to be reported in the newspapers. The average number of persons killed by steam boiler explosions for the seven years referred to in Mr. Fletcher's returns and my own are very similar, being no less than 62 per annum. I have had the list of explosions and persons killed and injured taken from the last five years' reports issued by the Steam Users' Association, their chief engineer having discontinued issuing any reports, and find that, although the average number of explosions there given for the five years referred to is much greater than for the seven years above referred to, the *loss of life is less than half*, or only say 45½ per cent. of that given for the seven years' period referred to. This proves that a large proportion of the total now given by Mr. Fletcher are occurences which are not worthy of the name of explosion, and in fact cannot with any consistency be designated explosions of steam boilers. These figures speak for themselves. If the explosions have increased in number, as Mr. Fletcher would have us believe, we are to be congratulated that these are of comparatively mild character, as shown by the great comparative reduction of the loss of life and injury to persons.

I have gone through Mr. Fletcher's returns in his printed reports from 1874 to 1880, the seven years referred to, and find no failures of tubes in boilers of the locomotive type recorded as being boiler explosions, which they are not; but from personal knowledge I know that such computed, so that any portions of them can be laid out with refinement in full size as may be required.

Fig. 3 represents the development of the intersection of one face with the soffit, the two halves of the curve being symmetrical, and, of course, applicable to both faces. One set of ordinates, therefore, answers for each of the four quadrants. It now becomes necessary to show how this development is to be obtained without projecting it. Let A a B, Fig. 4, be the half of a semicircular arch, the obliquity of which is B D C, and suppose it is required to produce the development D e E by means of ordinates obtained by calculation.

Let the arc A B be divided into a convenient number of parts and its development B E into the same number. Suppose a to be one of the divisions of the arc and b its corresponding division in the development, such that $Eb = Aa$.

Also let

$$\begin{array}{ll} AC, \text{ the radius} = r & Cc = r \sin \epsilon \\ \angle ACa = \epsilon & cd = r \sin \epsilon \cot \Theta - bc \\ \angle CDD = \Theta & Eb \times \tan \beta = bf \\ \angle BED = \beta & be - bf = fe \end{array}$$

Thus, having found a sufficient number of distances fe, corresponding to divisions of the arc A B or to its development B E, and consequently to D E also, let D E be divided into the same number of parts, as shown in Fig. 3.

At each of the divisions draw the ordinates fe, Fig. 3, making all the angles Dfe each equal to the complement of B E D, which is the intradosal angle before treated of, and upon these ordinates set off the distances fe, as previously calculated; then the curve D e E, drawn through the points thus obtained, will be the development required.

Only one-half the development is shown, because the ordinates for the second half are equal to those on the first half, but applied on the contrary side of the line D E.

The paper received careful attention as its subject demanded, and a spirited discussion ensued, especially on the statement that its cost was less than that of a helicoidal arch. The author explained that in the present arch there were more stones of a uniform dimension, a stepped arch would have had less effective diameter, increased area of foundation, and would present greater difficulty in binding adjacent ribs so as to secure uniform loading.

TAKING CROSS-SECTIONS IN ROCK CUTTINGS.

Mr. F. W. Watkins presented a paper entitled "On a Method of taking Cross-Sections in Deep Rock Cuts by Triangulation." The cut in question was half a mile long and 100 ft. deep, and the excavation was made in benches; two steam shovels were used and the material was removed by cars on an auxiliary temporary track. "Starting in at the upper levels, making a cut or trench, backing down, to make one or more cuts to widen out the excavation, and then going back to start in again at a lower level, and continuing this process until the grade of the roadbed was reached. This of course resulted in a very ragged cut during construction. In the deepest part of the cut the elevations of the top of the sections at the final slope stakes, and of the roadbed at the bottom, were easy to obtain by levelling, but at the 'intermediates,' on the steep earth and rock slopes, many places could only be reached by ladders, or by lowering a man with a rope, which, it being the winter season, was attended with some danger. Triangulation by horizontal and vertical angles was then resorted to, and the cross-sections were taken with ease and accuracy. From four to six sections were to be taken in each 100 ft. The centre line of the double track roadbed was taken from a base line, and centres and grade pegs carefully marked for each station and section. A transit with a vertical circle and horizontal level tube attached to the telescope was then set on the centre line, from 150 ft. to 200 ft. from the cross-section to be taken, and the elevation of the centre of the telescope above the grade measured. Two men were stationed at the slope stakes for the section to be taken, on each side of the cut, and carried between them a long piece of twine, at the middle of which a small bright plumb-bob was suspended. This plumb-bob was drawn across the cut, lowered and raised to touch each point desired for the section, and the horizontal and vertical angles to that point measured with the transit and recorded in the field book. A simple multiplication of the length of the base line for that section into the natural tangents of the horizontal angles gave the distances out from the centre. The horizontal base line for the vertical triangulation would be the hypotheneuse of the right angle triangle of which the centre line base and 'distance out' were the two sides, or equal to the secant of the horizontal angle for a radius equal to the base. Dividing the 'base' by the cosine of the horizontal angle gives the secant, or horizontal base, for the vertical angles. This calculated base, multiplied by the natural tangent of the vertical angles plus the height of instrument, gives the corresponding elevation of the points selected for the cross-section." No discussion followed, hence the method was probably satisfactory.

After this came a purely mathematical paper read by title, "Determination of Stresses in Elastic Systems by the Method of Least Work." The last part of the title sounded well, but an inspection of MS. revealed mathematics of a high character, and it was evident the method of least work to the author would prove one of greatest work to the Convention, hence the invitation to discuss was not accepted. After this a diagram showing the temperature of water at various depths up to 70 ft. was exhibited. There was a notable change between 20 ft. and 30 ft., but otherwise the ratio seemed constant.

(To be continued.)

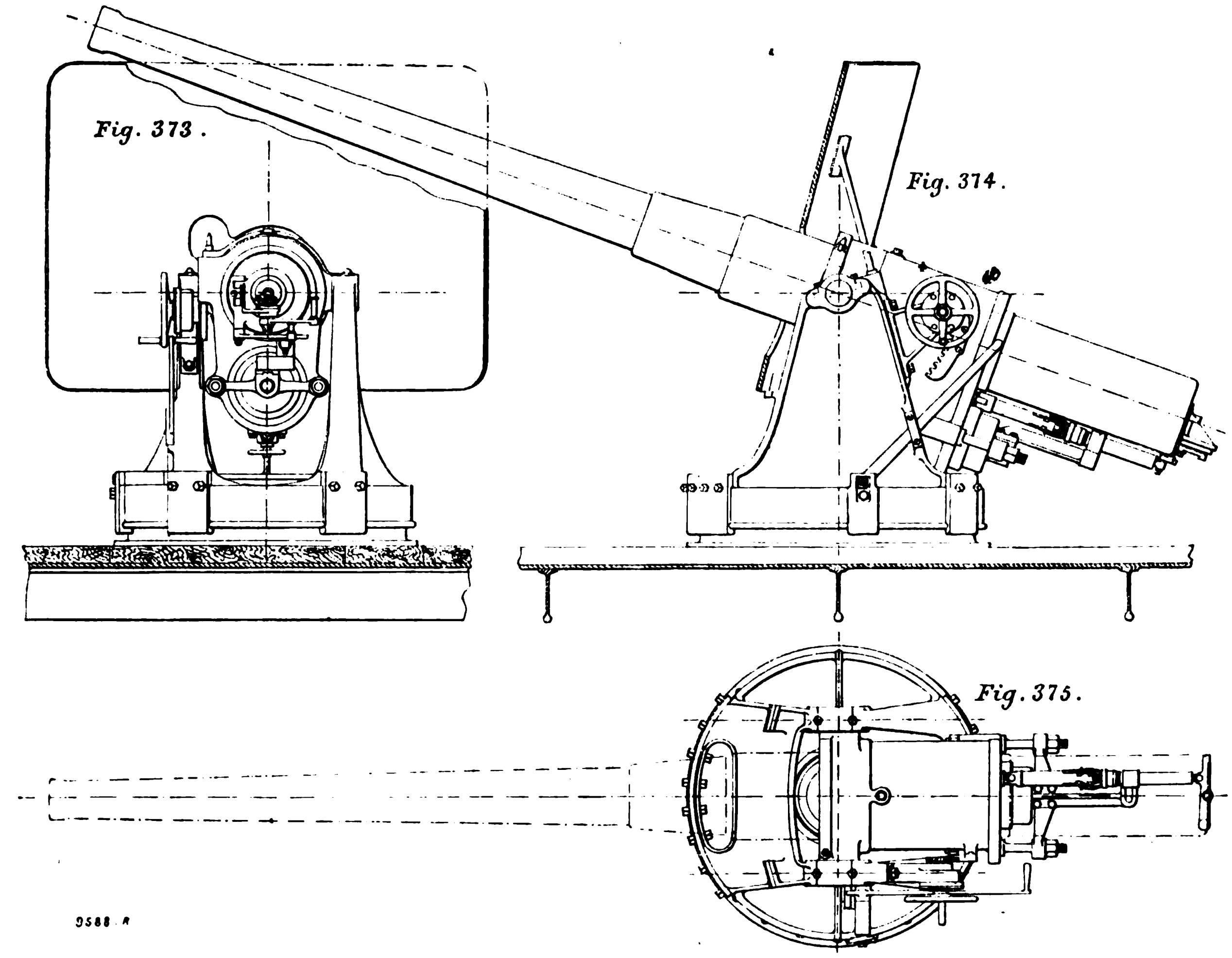
MODERN FRENCH ARTILLERY.
No. XXXIII.

THE CANET SYSTEM OF QUICK-FIRING GUNS—*continued.*

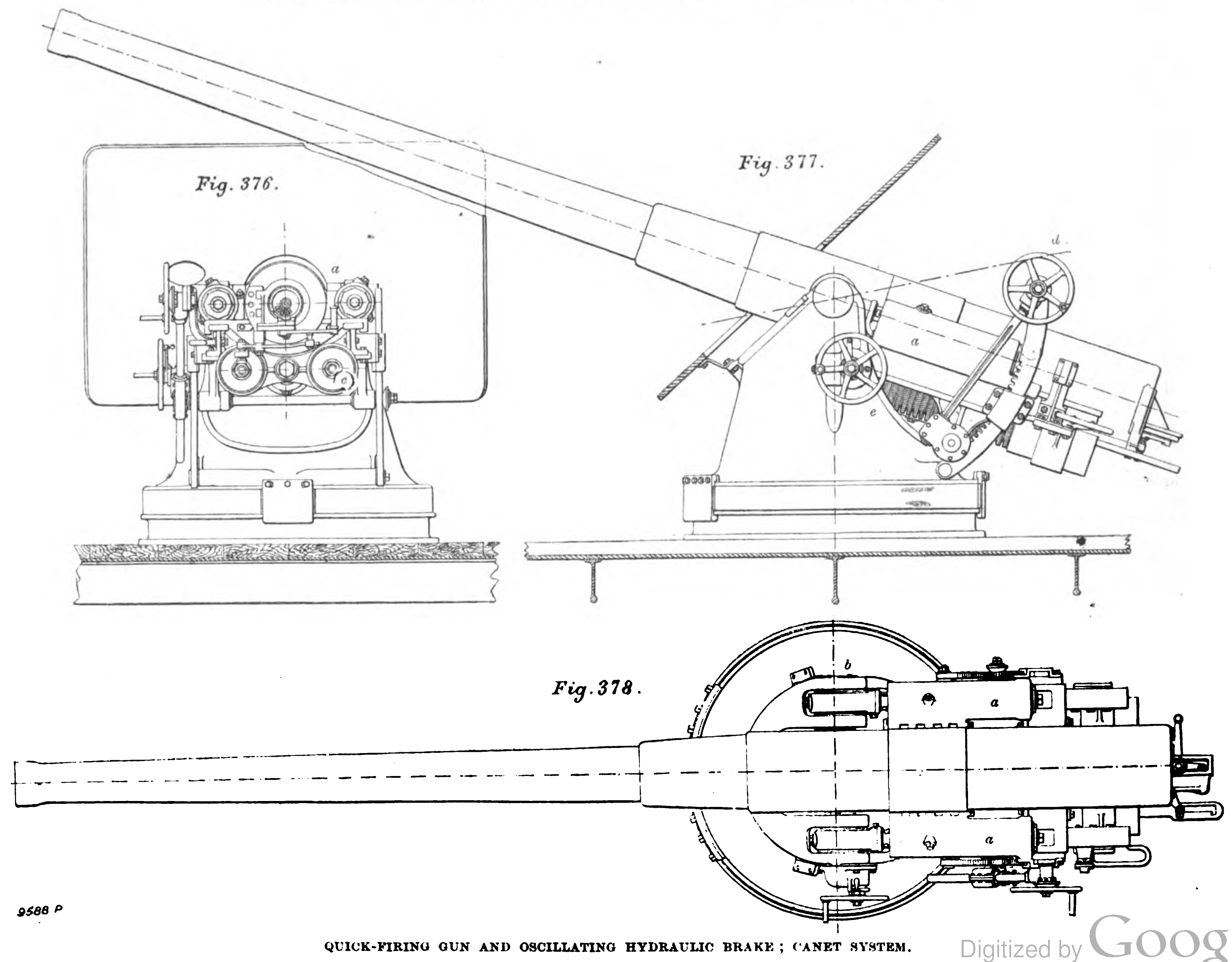
IN certain types of rapid-firing guns it has been found advisable to make such modifications in the design that the opening of the breech shall be effected automatically during the recoil after firing. This arrangement has the serious drawback of setting free the breech-block from the bore while the gases in the powder chamber are still at a sufficiently high pressure to project the block violently to the rear, or at all events to discharge the empty cartridge with sufficient velocity to cause frequent accidents. In one method adopted in the Canet system for carrying out this object, the opening of the breech on the contrary is effected automatically during the return of the gun from the firing position; by this means the serious causes of accident just mentioned are entirely avoided; when the gun has been brought back by the reaction of the recoil to its firing position, the breech is opened, and all that remains to be done by the men serving the gun is to remove the empty cartridge already half-extracted, to recharge and close the breech. This automatic action is produced by the following arrangement: On a fixed point of the frame is articulated to one of its ends a long tube placed horizontally and almost parallel to the axis of the gun. This tube is held in the middle of its length by an arm fast to the frame, and within it is placed a rod attached to a lever which is free to turn around a centre secured to the back of the gun. A spiral spring placed within the tube and around the rod, presses constantly against a shoulder formed in the forward part of the latter, and holds the lever at the rear end of the gun against a stop placed on the back of the gun at the height of the breech-block. At the moment of firing this lever follows the displacement of the gun and draws out the rod within the tube, the spiral spring constantly holding it against the stop during the period of recoil, while the tube remains fixed. When the recoil is completed the gun coming back to a firing position draws forward the working arm and the interior rod; at a certain point in its travel the shoulder upon the rod strikes against a spring latch which has been depressed by the rod during its recoil movement. As soon as this contact takes places, the rod remains motionless but the tube and the gun continue to advance, taking with them the axis of the working lever, while the other end of this lever is held fixed by the locked rod; the lever therefore turns around its axis and acts upon an arm mounted on the same spindle as that of the lever for manipulating the breech and which has been already referred to; the effect of this combination is precisely the same as if the man working the gun turned the lever by hand—the breech is opened and the empty cartridge is extracted. A short time before the return motion of the gun into firing position is accomplished, a finger screwed into the body of the piece is brought into contact with the rod which is dragged forward with it; this rod strikes against the tail of the latch and raises it; the spiral spring within the tube, constantly pressing against the shoulder of the rod, forces the latter forward as soon as the latch is withdrawn, taking with it the lever at the end and resetting it to its original position. Another smaller spring then withdraws the latch of the striking lever and also brings that back into place. The operations of loading and of closing the breech are performed by hand.

With guns of the calibres under consideration it was evidently impossible to employ carriages unprovided with means for taking up the recoil; accordingly, M. Canet has designed mountings in which the recoil is reduced to the lowest practical limits and is absorbed by hydraulic brakes especially adapted for use on shipboard. In one arrangement the gun is placed within a sleeve mounted in the frame upon trunnions; this sleeve operates as a brake cylinder, and upon the gun is fixed a ring, which, working within the cylinder, operates as the piston of the brake. During the period of recoil, the distance of which is reduced to 13.78 in., the oil or other liquid which fills the free space between the sleeve and the gun passes from the rear to the forward side of the piston, being forced through the narrow clearance left between the piston and the side of the sleeve. The contour of this side has been calculated in such a way as to vary the discharge opening, at each instant to correspond with the variations in the energy of the recoil, in order to secure a constant resistance and not to throw too great a strain upon the carriage. The fluid forced from one side of the brake to the other, on account of the difference in the diameter of the gun in front of and behind the trunnions, is driven upwards past a spring-loaded valve into a receiver within which is a plunger loaded by springs that abut upon a crossframe mounted on the carriage. When the recoil is completed the liquid under pressure flows back again into the brake cylinder through a small opening formed in the valve, and thus slowly brings the gun back into firing position. It is during this return movement that the opening of the breech is effected, as just described. The arrangement of the brake is such that the carriage can be fixed rigidly upon the underframe if it is found desirable to do so during heavy weather; this underframe rests upon a baseplate by means of a crown of coned wheels, and all the forward parts of the underframe are shut in and protected by the inclosing plate. In addition to this it carries an inclined curved shield which protects the gun and the man serving it. Upon the left side of the brake sleeve is a toothed sector for controlling the elevation or depression of the gun; this sector gears into a pinion which is worked by a special device mounted on one of the side plates of the frame. The pointing apparatus comprises an eccentric wheel that acts upon a pinion gearing into a second pinion with internal teeth and connected to the working spindle by friction cones which prevent any shocks resulting from firing the gun from being transferred to the pointing apparatus. This device enables the necessary operations of elevating and depressing the gun to be executed with great rapidity, and the work involved is claimed to be much less than that of all other appliances hitherto devised for the same purpose. Training the gun for direction is effected by means of a hand lever mounted on the platform of the lower frame and which carries at its lower end a spring brake acting on the baseplate. When it is desired to point the gun, a slight pressure exerted on the end of the lever causes the whole system to revolve in either direction according to whether the lever is pulled over either to the right or left; as soon as the lever is released the brake comes into action and holds the frame securely in the desired position. The operations are very easily carried out even in rough weather. Figs. 373, 374, and 375, page 340, illustrate this mode of mounting and brake; they also show the arrangement of training gear and the shield attached to the carriage. As we have stated in a previous article, the Canet rapid-firing guns use four classes of projectiles: steel shell with a bursting charge and combined time and percussion fuze; common cast iron shell with bursting charge and percussion fuze; case shot filled with hardened lead bullets, a bursting charge and combination fuze; a case shot with zinc shell and wooden base. The first classes are surrounded with a copper belt to take the rifling. They are set in brass cartridges, the form of which has been carefully designed to obtain perfect obturation and to prevent expansion during fire.

MODERN FRENCH ARTILLERY.



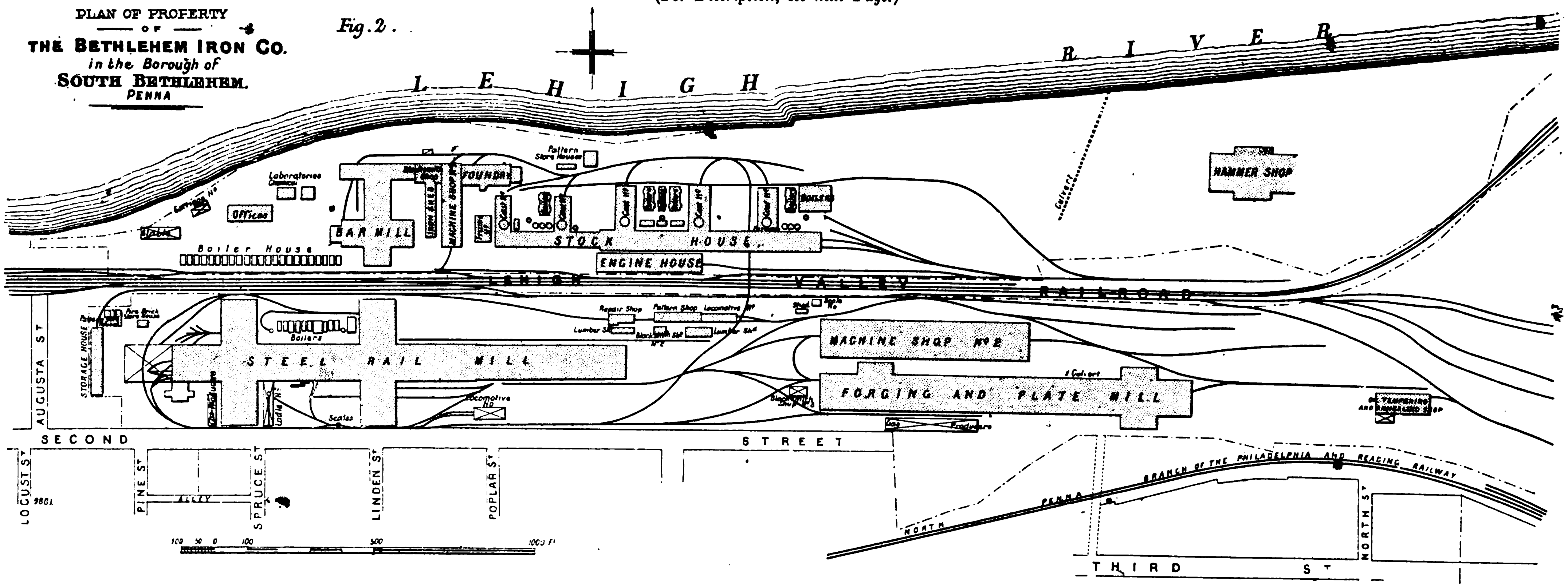
QUICK-FIRING GUN AND CARRIAGE WITH ANNULAR HYDRAULIC BRAKE; CANET SYSTEM.



QUICK-FIRING GUN AND OSCILLATING HYDRAULIC BRAKE; CANET SYSTEM.

PLAN OF THE BETHLEHEM IRON AND STEEL COMPANY'S WORKS, BETHLEHEM, PA., U.S.A.

(*For Description, see next Page.*)



The base of the cartridge case carries the electric fuze, which contains no fulminating powder nor any other material which can explode in service from the action of any sudden shock. It is found in practice that the obturation is so efficient that the powder chamber never requires washing even after a long series of firing.

The method of serving these rapid-firing guns is as follows: The captain of the gun satisfies himself first of all that the brake cylinders are charged with oil or glycerine and that all the various parts are in perfect working order. The pointer takes up a position on the left side of the carriage opposite the sights, his right hand being on the lever for controlling the direction, and the left hand on the wheel for elevating or depressing the gun; his sole duty is to attend to this part of the work. The other numbers, placed about 5 ft. behind him, are charged with the work of loading and of firing. For the first round these numbers open the breech by hand and close it again after having inserted the cartridge containing the projectile and the charge. Then the gun is fired by pressing on the button of the circuit closer; the cannon recoils and during its automatic return into firing position, the breech is opened and the empty cartridge case is extracted. One of the firing numbers takes hold of the case and removes it, the others load the gun a second time, and the number on the right-hand side closes the breech by simply throwing over the lever from left to right. During this time the pointing number has continuously followed his work without being affected by any other part of the operation; not by the firing, because the brake sleeve does not move, nor by the manœuvres of the firing numbers who are placed a considerable distance behind him. With practised men the rapidity with which the 10-centimetre gun can be aimed and fired is from ten to twelve rounds a minute.

The advantages claimed for the Canet system comprise in the first place high ranges and penetrating power. This class of artillery is not intended to fill the rôle of accessory war material which is only destructive for torpedo boats and objects possessing similar powers of resistance, such as the upper works and light protections of a hostile fleet. It constitutes, on the contrary, a powerful armament even for ships of the first order which can be formidable against armour-plated vessels, especially when supplemented by machine guns of 47 or 57-millimetre calibre. It should be observed that this class of weapon has been designed especially in view of utilising the new smokeless powders which doubtless before long will be placed in general service. The force of these powders is such that with guns of the long type the initial velocity is about 3000 ft. per second, which will give a greatly increased striking and penetrating power than has been already obtained.

The speed of working the gun is another advantage claimed; this is due to three causes: the automatic closing and opening the breech as the gun returns to the firing position, the closing of the breech and the various manipulations connected with it being effected by one lever turning always in the same direction, and the perfect nature of the obturation which entirely prevents all fouling of the gun, even after a long-continued firing. Absolutely security is also claimed on account of the firing device adopted, and which renders it impossible for a premature discharge to take place. In this class of gun—which is nothing less than an armour-piercing weapon—it is especially necessary that firing should be made impossible until the breech-block has been closed and locked. The number of parts in the gun and mounting are reduced to the lowest possible limits consistent with efficiency and safety; there is also in the design a studious avoidance of the use of springs, wedges, or similar devices which are liable to break or shake loose, and so throw the whole gun out of gear. The recoil brake, for which absolute efficiency is claimed—a claim that appears to be fully justified by exhaustive trial—is certainly reduced to a very elementary and simple form, and possesses the signal advantages of great compactness and of forming a part of the gun itself.

The rapid-firing guns of 12 and 15 centimetres are mounted on carriages of a somewhat different type to that of the 10-centimetre just described, although the leading principles involved are much the same. The carriage of the 12-centimetre gun which was at the Paris Exhibition last year consists of a cradle in which the gun rests, and this cradle carries two brake cylinders *a a*, Figs. 376, 377, and 378, the axes of which are on the same level as that of the gun; the pistons of these cylinders are connected forward to a horizontal pivotting bar *b* carried upon the lower frame and around which the whole system rests. The return to firing position is effected by means of a spring reaction arrangement which brings back the gun into its original position with a comparatively short movement of the springs *c c*; this reaction device is mounted on the carriage beneath the gun as shown. The operation of training for elevation is performed by a handwheel *d* turning a shaft and pinion gearing into two toothed sectors *e* mounted on the frame; lateral training is done either by hand or by means of a lever arranged as already described. The carriage of the 15-centimetre gun is on a horizontal underframe. The gun is connected by the trunnions to the carriage carrying the brake cylinders and the spring reaction mechanism; this carriage recoils on horizontal slides fixed to the underframe which is provided with rollers. It resembles in its details the Canet carriage of the 14-centimetre gun which gave such good results on board the French boat Gabriel Charmes. The underframe rests upon a baseplate, spherical bearings being interposed between the two. We shall give a detailed description of this mounting in another article.

THE BETHLEHEM IRON WORKS IN PENNSYLVANIA STATE.

One of the papers to be read at the forthcoming meeting of the Iron and Steel Institute in America is on the progress in the manufacture of war materials in America, and within recent years this progress has been very marked. Until quite recently guns of heavy calibre, such as the 8-in. guns for the warship Chicago, described in last week's issue, could not be constructed in the States, but about four years ago the Bethlehem Iron Company decided to add to their extensive works an ordnance and armour-plate department, in which weapons of great size and of the most destructive character could be manufactured. The story of progress, above referred to, to be narrated to the British society, will be in great measure complete, and for this, as well as for the remarkable efficiency of the plant at the Bethlehem establishment, it is particularly appropriate that the works should be the objective point of one of the excursions of the Institute.

Bethlehem, a town on the banks of the Lehigh River, 87 miles from New York, and 55 miles from Philadelphia, is unlike many other American towns in respect that it has a history. It was founded by the Moravians in 1741, and since then has been one of their principal settlements. It has silk, paint, and flour mills. It is noted for its excellent schools, and in South Bethlehem, where the works of the Iron Company are situated, there is the Lehigh University, founded in 1866, and other episcopal institutions. West of the town, and divided from it by a creek, there is another borough—West Bethlehem, having within its boundaries silk and planing mills, machine shops, and dye works. The population of the three boroughs does not exceed 20,000, and a great proportion of these find employment in the iron works.

The Bethlehem Iron Works, which the members of the Iron and Steel Institute will visit about the 14th October, and of which a plan is given on the preceding page, were planned as early as the year 1857, when a charter was granted to the senior partner of A. Wolle and Co., of Bethlehem, for a company styled the Saucona Iron Company, but subsequently, in 1859, the name was changed by Act of Assembly to the Bethlehem Rolling Mills and Iron Company.

Four years ago the work of erecting complete hydraulic forging machinery for the manufacture of the largest guns, and the heaviest shafting and armour plates, was commenced, the proposition having come from Mr. W. H. Jaques, formerly secretary of the Senate Ordnance Committee, and who is now associated with the Bethlehem Company as the director of the naval department. The construction of the plant is now finished, and the works, which are very complete, represent American enterprise and genius.

The raw material is converted from its crude state into the finished product within the works. These are very extensive, covering ground 1¼ miles in length by one-quarter of a mile in width. The buildings are partly of hard grey stone from adjacent quarries and partly of brick, and the roofs cover an area of 18 acres. The general arrangement of the works, and the conveniences in the way of railway accommodation, will be seen from the plan. The works consist of offices having extensive drawing rooms; boiler-houses, which, by the way, are all detached with the boilers set so as to provide for expansion in any direction without subjecting them to any injurious strains; blast furnaces, puddle mills, merchant steel mill, Bessemer department, department of construction and repairs, ordnance and armour-plate department; chemical and physical laboratories, containing Riehle and Emery testing machines of 100,000 lb. and 300,000 lb. capacity; mines, quarries, &c.

There are six blast furnaces, one of which is situated at Bingen, on the Philadelphia and Reading Railroad, six miles from Bethlehem. The heights generally are 70 ft., the bosh 16 ft., and in one case 19 ft., and the hearth 10 ft. The fuel used in melting is anthracite coal from the upper Lehigh region, with a mixture of Connellsville coke. The most recently constructed furnaces are each provided with three Whitwell firebrick regenerative stoves 20 ft. exterior diameter and 60 ft. high. These are said to give excellent economical results. A railway for the transportation of fluid metal connects the furnaces with the converters, thus permitting the making of Bessemer steel by the direct process. The annual capacity is 160,000 tons. The casting-house of each furnace is at a right angle and forms a wing to the stock-house, which is a continuous building running parallel with the line of furnaces, and is 60 ft. wide. Two lines of rails run the whole length of the building, and are carried on trestles 12 ft. above the floor level. The spaces between the casting-houses are used for cinder yards on one side, while on the other are located the boilers and hot-blast stoves. The engine-house built in front of the stock-house is 327 ft. long by 60 ft. wide, and in it are seven horizontal blowing engines, five of which are compound with cylinders 30 in. and 54 in. in diameter respectively, by 80 in. stroke, while the other two are single condensing engines with cylinder 54 in. by 80 in. stroke. In each case the blowing cylinders are 80 in. by 80 in. stroke. In the compound engines the blowing engines work at high speed and under high pressure of blast with noticeable smoothness and noiselessness. They blow at as high a pressure as 20 lb. of air.

The puddle mill contains three double doubles, four double, and one single puddling furnace, with boilers over. It was intended originally for iron rails, but since the supersession of these by steel rails, merchant iron and muck bars have been produced, the latter exceedingly low in phosphorus for remelting at the open hearth furnaces for high quality steel for ordnance and shafting. The merchant steel mill is principally used for the rolling of smaller sections of rails and special grades of Bessemer steel into billets.

The Bessemer steel rail mill is of stone with iron and slate roof, having a continuous lantern. The nave is 1512 ft. long and 111 ft. wide, and the transepts, including the crossing of the nave, are 386 ft. long and 111 ft. wide. The clear height in each case is 29 ft. In the western portion is the converting department, with four 7-ton vessels arranged in a straight line across the mill, with an iron platform on cast-iron columns surrounding them. The iron and spiegel cupolas are behind, and have two platforms one above the other for charging and tapping respectively. Three vessels are worked alternately, while one is off for repairs, the iron cupolas are run four on and four off, and the spiegel cupolas two on and two off to facilitate repairs. The vessels are wrought-iron shells 8 ft. in diameter, and the body is completely lined with natural stones of mica schist, roughly hewn to shape, and the nose is lined with firebrick. Mica schist was adopted after careful experiments, and except some slight repairs, one of the linings is said to be good for 30,000 tons of ingots. The vessel bottoms have seventeen firebrick tuyeres with twelve holes ⅜ in. each, and between the tuyeres are set, end on, bricks similar to the lining in the blast furnaces, as near together as they will stand, and the small space between backs and tuyeres is rammed with ordinary gannister bottom stuff. With this arrangement oven drying is only needed four hours, and the bottoms stand twelve to fourteen heats quite uniformly. The output of the converting department averages 4000 tons of ingots per week of eleven shifts, but the plant has been worked at a higher rate of production. The annual capacity is 225,000 tons. The heats of ingots run from 7 to 8 tons according to the weight of rails. Fourteen-inch ingots are bloomed down to 7 in. square, and cut into single and double-rail blooms for the rail mill. The stock ladles, molten metals, ingots, &c., are moved on narrow-gauge rails, with frequent turntables, switches, hydraulic lifts, &c., and there are numerous hydraulic cranes for casting pits, &c.

The blowing machinery is in the upper transept next the Lehigh Railroad. There are two Bessemer engines. The smaller has two cylinders 36 in. in diameter and 60 in. stroke coupled direct, with two blowing cylinders 48 in. in diameter placed back of the steam cylinders on the same bedplate. The larger and newer engine constructed because of the inadequacy of the other, has two steam cylinders 56 in. in diameter by 66 in. stroke, and two blowing cylinders 60 in. in diameter. Running with 50 lb. steam pressure it maintains a blast pressure of 40 lb. of air. The cupola blast is obtained from a set of Baker blowers, coupled direct to the shaft of a compound engine running at 90 revolutions. The pressure is about 1¼ lb. at the blowers, and 12 oz. at the tuyeres. This plant is duplicated. A Worthington duplex and two Worthington compound duplex pumps are located in this transept and supply the water pressure of 300 lb. to the square inch for operating the cranes, hoists, &c. In the opposite transept are two Pernot furnaces with their accompaniments. Outside is the ladle-house. The freshly-lined ladles are placed on cars and run into position on rails; when in position a cap is lowered, forming a combustion chamber of the ladle, and a stream of gas and air, in regular proportions, admitted through the centre of the cap, causes more rapid drying and hotter ladles than with the old method of building fires in them. The vessel bottom repair shop is located in the upper end of the mill, and there are hydraulic cranes for handling and ovens for drying. In a brick foundry adjoining the mill, having a cupola and two cranes, ingot moulds are manufactured, six to eight being used per day.

In the main portion of the mill are six Siemens reheating furnaces, three on each side, with hydraulic cranes for charging and drawing the ingots, rails being provided with connections to the casting pits and the blooming train. There are two blooming mills, two engines, and three sets of rolls. The smaller engine is 36 in. in diameter by 60 in. stroke, coupled direct to two sets of three-high 32-in. rolls, each with tables controlled by power. The large mill is also three-high, the rolls are 48 in. in diameter and 10 ft. long; the engine has a cylinder 65 in. in diameter by 8 ft. stroke, and 90-ton flywheel. The ingots are cut into rail blooms in steam hammers. There are four heating furnaces for the rail mill, similar to those in the blooming mill already described. The rail mill consists of three sets of three-high rolls 24 in., driven by an upright compound engine, with cylinders 36 in. and 56 in. in diameter, by 50 in. stroke. From this mill the rail passes to the hot saws and thence to automatic straighteners, hot beds, cold straighteners, drill presses, and then to a line of driven rollers, which carry the rails to the cars for shipment. A new 28-in. mill rolls heavy sections and long lengths. This train is driven by three high-speed compound engines on one shaft, connected with the middle roll and driving direct. The aggregate power is 8000 horse-power. The tables are worked automatically by water or air. In the heating furnaces in this department, gas produced from crude petroleum oil has been used instead of coal gas made in Siemens producers. The department of construction and repairs includes pattern, foundry, machine and smith shops, and amongst the heavier plant are a 120-in. planer, a 16-ft. boring mill, three heavy lathes, and two large universal drills, one having 14 ft. span.

The ordnance and armour-plate department includes gas producers, open-hearth furnaces, for casting ingots of 100 tons, hydraulic forging press for the largest forgings required in warships and for guns; plate rolling mills, pneumatic and hydraulic cranes, 60 ft. span, capable of lifting up to 150 tons, a 125-ton single-acting steam hammer, bending press, &c. The building is to the east of the works, and is 1155 ft. long by 111 ft. wide, and is shown on plan as forging and plate mill. The machine shop No. 2 is 641 ft. long by 116 ft. wide, and in it is a planer, in which plates 13 ft. by 13 ft. by 50 ft. 10 in. can be planed, a 10-ft. face-plate lathe, boring mills, &c. The shops are lighted by electricity, and the entire plant supplied with rail communication. The casting and forging plant was manufactured at Whitworth's establishment at Manchester, and designed by Mr. Gledhill, managing director of that firm; the heavy tools were constructed from designs by Mr. Gledhill and Mr. Fritz; and all were erected under the latter's direction.

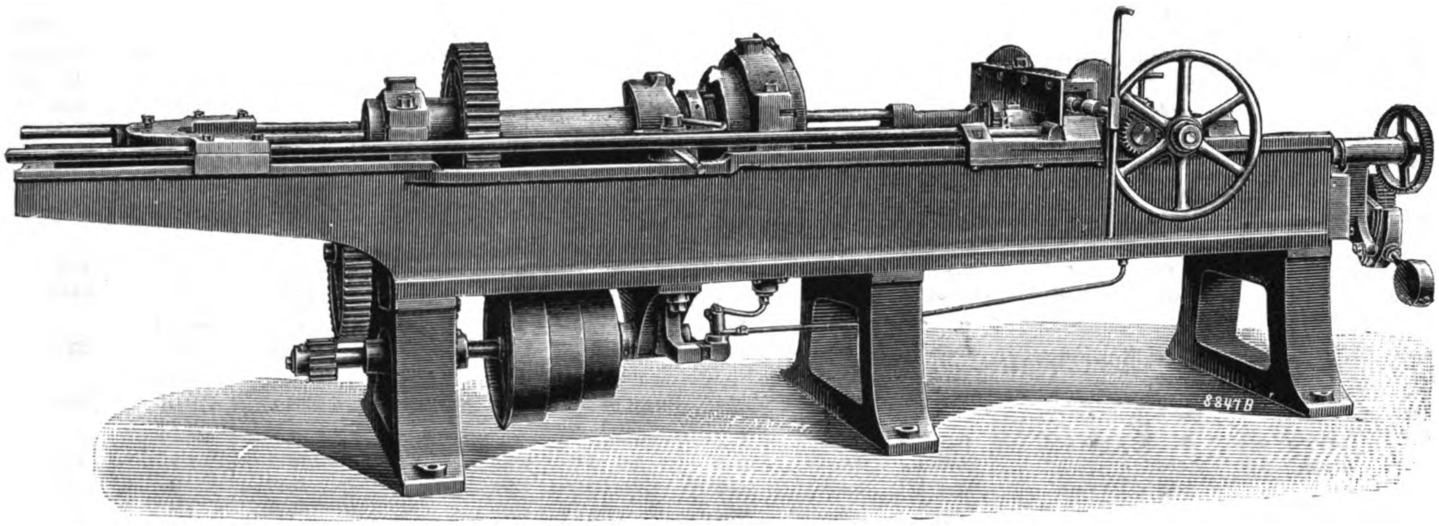
The company has manufactured the heavy shafting and armour of several warships for the United States Navy, and forgings for 4 in., 6 in., 8 in., 10 in., and 12 in. guns, both for Army and Navy. At the Maritime Exhibition at Boston held a year ago, the company exhibited heavy castings manufactured for the Calumet and Hecla mines. Other exhibits included a tube for a 10-in. breechloader, the dimensions being 27 ft. 2 in. long, the largest outside diameter 20½ in., and the weight 23,000 lb.; a strengthening hoop of the 12-in. breechloading rifle for the United States Army having a cylindrical hollow forging 6 ft. 3½ in. long; outside diameter, 47½ in.; inside diameter, 38⅜ in.; weight 12,940 lb.

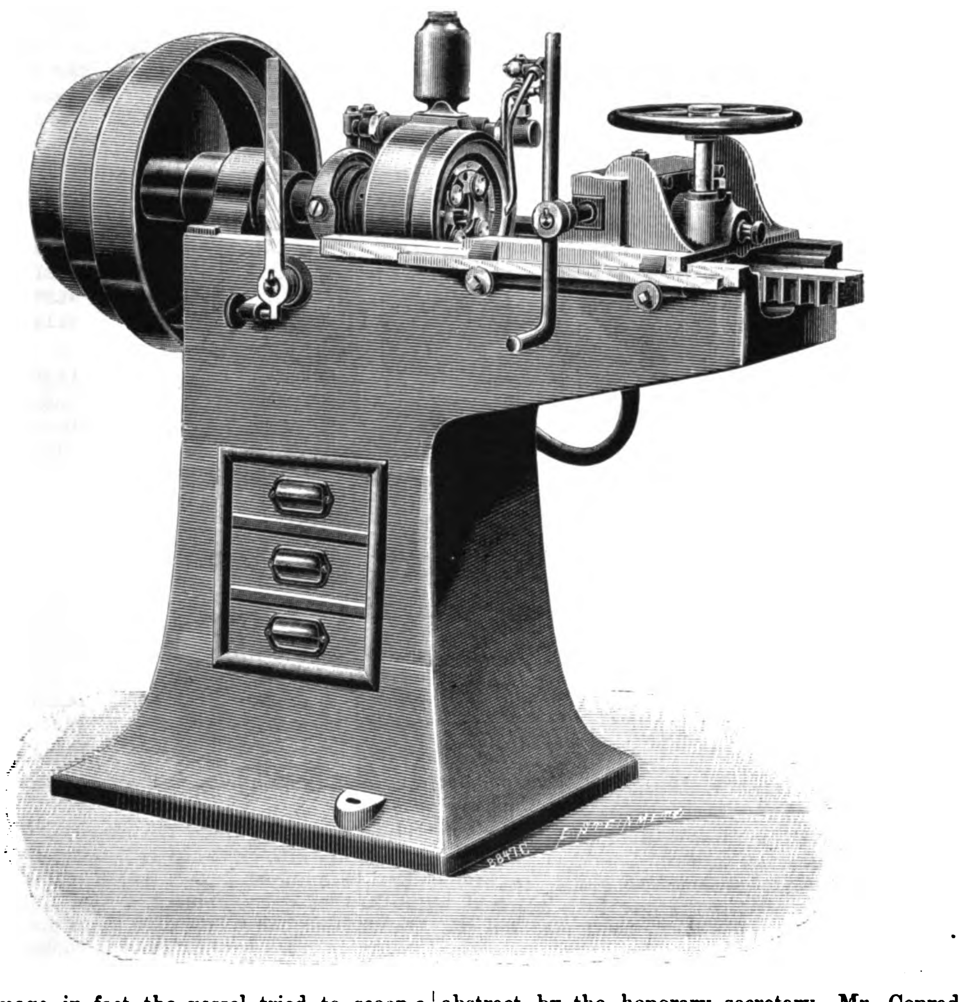
In addition to the war material (including hollow and other forgings for shafting, guns, armour, shields, and conning towers), special and miscel-

BARROW'S SCREWING AND TURNING MACHINES.

CONSTRUCTED BY MESSRS. THOMAS SHANKS AND CO., ENGINEERS, JOHNSTONE, N.B.

(*For Description, see Page* 310.)





doing damage, in fact the vessel tried to scoop a passage for herself by inducing a rapid current of water. As the draught fully laden was but 3 ft. 6 in., he thought the boat was well adapted for working up to a wreck in shoal water. The time occupied in raising steam to 120 lb. was 20 minutes, but the speaker did not say whether this was when starting with all cold.

The President having proposed a vote of thanks to the author, in doing which he spoke of the great promise of the boat, the next paper was taken. This was on

THE VICTORIA TORPEDO,

and was a contribution from Mr. G. Read Murphy. We have so recently described and illustrated this weapon* that it is unnecessary for us to go over the same ground again, especially as the paper was, in the absence of the author, only read in brief abstract by the honorary secretary, Mr. Conrad W. Cooke. A paper on

ALUMINIUM BRONZE FOR ARTILLERY AND SMALL ARMS,

by Mr. J. Dogger, was next taken. The author commenced by saying that as early as 1859-60 guns were cast in aluminium bronze by the French and Bavarian Governments, and favourably reported upon by the authorities, but the then high price of aluminium prevented its use for guns. The cost of aluminium bronze in 1860 was 4s. 11d. per lb.; to-day it is on the market at 1s. 4d. per lb. The results of mechanical and physical tests point to the fitness of this alloy for artillery and small arms under the altered condition of explosive, the recent trials of artillery using the smokeless powder, by the German authorities, proving that steel guns were seriously injured by the new ammunition, and a return to bronze for guns is advocated by their artillerists; but in the properties essential to good gun-metal, aluminium bronze surpasses the "steel bronze" or the tin bronze used in the Uchatius system of gun fabrication.

Experiments have shown that aluminium bronze maintains its strength through a high range of temperature, it being capable of being heated up to 500 deg. Fahr. without injury to its strength. No liquation or separation of the metals takes place, as is the case with tin bronze, neither does it alter in composition or quality even after repeated re-meltings, and thus obsolete and unserviceable guns would still retain their value as scrap metal, and would readily be utilised for new ordnance. Its low melting point, 1600-1700 deg. Fahr., would be favourable to good results, using the Rodman method of cooling the casting from the inside. Its resistance to corrosion, its non-liability to crystallise under repeated shocks, as shown by a needle in a Springfield rifle bearing 11,000 discharges without injuring the needle, would make it valuable for rifles and small arms. These alloys having a tensile strength of 114,000 lb. to 72,000 lb., and elongation from *nil* to 47 per cent. and elastic limit from 20,000 lb. to 80,000 lb., and likely to have these values increased by a process similar to those of Dean or Uchatius, would give us a gun likely to stand the severest test of active service. The cost of a finished gun (at the present price of aluminium and copper) would be about 196*l*. per ton. These new alloys would enable us to provide rapidly in any emergency the artillery and armament necessary for public safety and our national honour.

In the discussion which followed, Dr. Anderson (Director-General of Ordnance) said that it was an extremely difficult matter to cast aluminium bronze perfectly sound in large masses, at any rate so sound as to be looked upon as reliable. He would like to know whether in the future guns of 100 tons weight would be cast in one piece; and whether the author considered that aluminium bronze differed from all other metals so that it would make the various portions of the gun come into play to resist the pressure inside the bore, in the same manner as guns that were built up. If the guns could not be cast so as to present these properties the guns would have to be made of a much more valuable material. He thought that the aluminium bronze might prove valuable for lining the guns. He was not aware that any trials had been made with aluminium bronze in the shape of large guns. Dr. Anderson wished to know if 12 per cent. aluminium bronze could be used.

Captain Noble corroborated the remarks of Dr. Anderson. He understood it was proposed to make large guns cast in one piece. He did not think that any reasons had been given to show why that was likely to be successful. They would have to take 10 per cent. of aluminium to approach the tensile strength provided by our own Government; that was to say, they would have to come to tensile strains of over 90,000 lb. per square inch; but that would only come to about the mean of what the

* See page 246 *ante*.

MODERN FRENCH ARTILLERY. (*See Page* 297.)

(See Page 297.)

TABLE XLI.—BALLISTICAL PARTICULARS OF 12-CENT. (4.72-IN.) AND 14-CENT. (5.51-IN.) CANET QUICK-FIRING GUNS (MODEL 1889).

—			12-Centimetre Gun.						14-Centimetre Gun.					
Length of Gun			30 Calibres.		40 Calibres.		50 Calibres.		30 Calibres.		40 Calibres.		50 Calibres.	
			in.	mm.	in.	mm.	in.	mm.	in.	mm.	in.	mm.	in.	mm.
Calibre			**4.72**	120	**4.72**	120	**4.72**	120	**5.51**	140	**5.51**	140	**5.51**	140
Total length of gun			**141 7**	3600	**189.0**	4800	**236.2**	6000	**165.4**	4200	**220.5**	5600	**275.6**	7000
Length of bore			**134.4**	3413	**181.6**	4613	**228.9**	5813	**157.1**	3990	**212.2**	5390	**267.3**	6790
			tons	kilos.	tons	kilos.	tons	kilos.	tons	kilos.	tons	kilos.	tons	kilos.
Weight of gun			**1.891**	1920	**2.500**	2540	**3.101**	3150	**3.002**	3050	**3.976**	4040	**4.922**	5000
			lb.		lb.		lb.		lb.		lb.		lb.	
„ armour-piercing shell			**46.3**	21	**46.3**	21	**46.3**	21	**70.5**	32	**70.5**	32	**70.5**	32
„ charge			**5.07**	2.30	**10.36**	4.700	**16.31**	7.40	**7.72**	3.50	**15.87**	7.20	**24.69**	11.20
			ft.	metres	ft.	metres	ft.	metres	ft.	metres	ft.	metres	ft.	metres
Muzzle velocity			**1640**	500	**2165**	660	**2559**	780	**1640**	500	**2165**	660	**2559**	780
			foot-tons	metre tons	foot-tons	metre tons	foot-tons	metre tons	foot-tons	metre tons	foot-tons	metre tons	foot-tons	metre tons
„ energy			**863.7**	267.5	**1505.0**	466.00	**2102.0**	650.99	**1316.5**	407.75	**2294.1**	710.46	**3204.1**	992.30
	yds.	m.	ft.	metres	ft.	metres	ft.	metres	ft.	metres	ft.	metres	ft.	metres
Remanent velocities at	**547**	500	**1496**	453	**1958**	597	**2313**	705	**1502**	458	**1978**	603	**2336**	712
	1094	1000	**1343**	411	**1772**	540	**2093**	638	**1374**	419	**1808**	551	**2136**	651
	1641	1500	**1227**	374	**1601**	483	**1893**	577	**1263**	385	**1653**	504	**1952**	595
	2188	2000	**1135**	346	**1450**	442	**1712**	522	**1168**	356	**1509**	460	**1785**	544
	2735	2500	**1066**	325	**1315**	401	**1548**	472	**1099**	335	**1381**	421	**1630**	497
			foot-tons	metre tons	foot-tons	metre tons	foot-tons	metre tons	foot-tons	metre tons	foot-tons	metre tons	foot-tons	metre tons
Total energy at ..	**547**	500	**706.9**	219.57	**1231.4**	381.36	**1717.1**	531 82	**1104.8**	342.12	**1915.0**	593.04	**2669.9**	826.82
	1094	1000	**583.6**	180.74	**1007.4**	312.0	**1406.3**	435.54	**924 6**	286.34	**1596.9**	495.17	**2232.0**	691.22
	1641	150	**433.3**	149.67	**822.7**	254.81	**1150.2**	356.23	**780.5**	241.75	**1337.8**	414.30	**1864 5**	577.41
	2188	2000	**413.6**	128.10	**675.0**	209.04	**941.4**	291.56	**667.4**	206.70	**1114.5**	345.12	**1558.5**	482.67
	2735	2500	**364.9**	113.02	**555.5**	172.06	**769.7**	238.38	**591.0**	183.04	**933.4**	289.08	**1301.0**	402.87
Energy per inch and per cent. of circumference of shell	At muzzle		**59.13**	7.21	**103.07**	12.57	**143.99**	17 56	**77.08**	9.4	**134.32**	16.38	**187.70**	22.89
	547	500	**48.55**	5.92	**84.30**	10.28	**117.60**	14.34	**64.70**	7.89	**112.19**	13.68	**156.36**	19.07
	1094	1000	**39.94**	4.87	**68.97**	8.41	**96.35**	11 75	**54.12**	6.60	**93.65**	11.42	**130.69**	15.94
	1641	1500	**33.04**	4.03	**56.34**	6.87	**78.81**	9.61	**45.76**	5 58	**78.31**	9.55	**109.21**	13.32
	2188	2000	**23 29**	3.45	**46.25**	5.64	**64.46**	7.86	**39.12**	4.77	**65.27**	7.96	**91.27**	11.13
	2735	2500	**25.01**	3.05	**38.05**	4.64	**52.73**	6 43	**34.60**	4.22	**54.69**	6.67	**76.18**	9.29
			in.	cm.	in.	cm.	in.	cm.	in.	cm.	in.	cm.	in.	cm.
Penetration in wrought-iron ..	At muzzle		**5.82**	14.8	**8.70**	22.1	**11.02**	28.0	**7.04**	17 9	**10.47**	26.6	**13.31**	33.8
	547	500	**5.07**	12.9	**7.51**	19.1	**9.52**	24.2	**6.21**	15.8	**9.21**	23.4	**11.69**	29 7
	1094	1000	**4.40**	11.2	**6.49**	16.5	**8.26**	21.0	**5.47**	13.9	**8.11**	20.6	**10.27**	26.1
	1641	1500	**3.86**	9.8	**5.62**	14.3	**7.16**	18.2	**4.84**	12.3	**7.12**	18.1	**9.05**	23.0
	2188	2000	**3.46**	8.8	**4.87**	12.4	**6.21**	15.8	**4.36**	11.1	**6.23**	15.9	**7.95**	20.2
	2735	2500	**3.15**	8.0	**4.25**	10.8	**5.39**	13.7	**3.97**	10.1	**5.51**	14.0	**7.00**	17.8
	deg.		yards	metres	yards	metres	yards	metres	yards	metres	yards	metres	yards	metres
Ranges at different angles	**3**		**2,176**	1,990	**3,188**	2,915	**3,882**	3,550	**2 187**	2,000	**3,221**	2,945	**3,931**	3,595
	5		**3,325**	3,040	**4,680**	4,280	**5 555**	5,080	**3,346**	3,060	**4,735**	4,330	**3,638**	5,155
	7		**4,319**	3,950	**5,933**	5,430	**6,9 :4**	6,340	**4,358**	3,985	**6,015**	5,500	**7,043**	6,445
	10		**5,638**	5,155	**7,535**	6,890	**8,651**	7,910	**5,692**	5,205	**7,644**	6,990	**8,804**	8,050
	15		**7,458**	6,820	**9662**	8,835	**10,892**	9,960	**7,546**	6,900	**9,809**	8,970	**11,105**	10,155
	20		**8,913**	8,150	**11,319**	10,350	**12,613**	11,535	**9,044**	8,270	**11,515**	10,530	**12,871**	11,770
	25		**10,068**	9,205	**12,599**	11,520	**13,932**	12,740	**10,203**	9,330	**12,832**	11,735	**14,228**	13,010
	30		**10,936**	10,000	**13,555**	12,395	**14,921**	13,645	**11,100**	10,150	**13,817**	12,635	**15,245**	13,940
	35		**11,549**	10,560	**14,232**	13,005	**15,605**	14,270	**11,016**	10,730	**14,507**	13,265	**15,943**	14,580

Government prescribed for built-up guns, and with that tensile strain the elastic limit of the bronze was very much below what the steel provided by the Government demanded. If the aluminium bronze stood the test of erosion as was claimed for it, it might be used as a liner for guns. The speaker had some years ago made an experiment which had been described at a previous meeting, held at Newcastle, of the British Association. He had taken a cylinder of bronze and another of cast-iron, both having the same limit of strength, say 20 tons. These had been tested to destruction. The cast-iron burst early, whilst the bronze went beyond the conditions due to theory. He was of opinion that the series of explosions put the cylinder in the condition of a built-up gun. As to erosion, 27 years before Sir Lowthian Bell had given him some 10 per cent. and 5 per cent. aluminium bronze, and he had tested this with regard to erosion. He had then found the best results in the latter respect to be given by steel. This was contrary to the then generally received opinion, but he had put in a copper vent and found it soon washed away.

Mr. Dogger in reply said it was true that no trials had been made with big guns of aluminium bronze, but he claimed for the metal that it was superior to the tin bronze used for artillery, and the German manœuvres showed that steel guns were injured by smokeless powder, whilst tin bronze guns were not. He was aware that it would be impossible to cast big guns in one piece, and they would have to be built up, for sound castings of that large size could not be got. He had been asked if 12 per cent. aluminium bronze could be used: after 11 per cent. the metal was uncertain, but up to that it was very good. The melting point of the bronze was 1600 deg. to 1700 deg. Fahr.; and in casting large heads had to be used.

Telemeters and Range Finders.

The last paper taken at the sitting was a most interesting contribution by Professors Barr and Stroud entitled "Some New Telemeters and Range Finders;" in which the authors gave particulars of the results of researches they had made in this field. It would be impossible to give an adequate description of the beautiful philosophical instruments devised by Professors Barr and Stroud without the aid of drawings, and for the present we will content ourselves with a brief abstract of this interesting paper, hoping to deal with the subject more fully at a future date.

The instruments described apply to that class of range finder in which the range is found by two observers with two angular instruments, connected by a base line of known length and each provided with a conspicuous mark. Each angular instrument is similar in operation to an ordinary optical square, though very different in construction. One observer (the assistant) adjusts his position so that the mark upon that of the other (or chief observer) shall appear in coincidence with the distant object. The chief observer then measures the range by determining the angle between the distant object and the mark on the instrument of the assistant observer. The novel points consist (1) in the provision of an optical square incapable of derangement, and (2) in the provision of means for measuring the above angle. With reference to the first point, the optical square consists of a quadrilateral prism of glass, having two contiguous silvered reflecting faces inclined at 45 deg. or thereabouts, and two contiguous transmitting faces inclined to one another at 90 deg., and symmetrically situated with reference to the reflecting faces. This arrangement has the great advantage over the Weldon prism in that the field of view can be made as large as is desired. With reference to the second point, viz., the provision of means for measuring the angle referred to, several plans have

MODERN FRENCH ARTILLERY. (*See Page* 297.)

(See Page 297.)

TABLE XLII.—BALLISTICAL PARTICULARS OF 15-CENT. (5.90 IN.) CANET QUICK-FIRING GUNS (MODEL 1889).

Length of Gun	yds.	m.	30 Calibres.		40 Calibres.		50 Calibres.	
			in.	mm.	in.	mm.	in.	mm.
Calibre			590	150	590	150	590	150
Total length of gun			177.2	4500	236.2	6000	295.3	7500
Length of bore			168.3	4275	227.4	5775	286.4	7275
			tons	kilos.	tons	kilos.	tons	kilos.
Weight of gun			3.69	3750	4.89	4970	6.051	6150
			lb.		lb.		lb.	
,, armour-piercing shell			88.18	40	88.18	40	88.18	40
,, charge			9.70	4.40	19.84	9.00	30.86	14 00
			ft.	metres	ft.	metres	ft.	metres
Muzzle velocity			1640	500	2165	660	2559	780
			foot-tons	metre tons	foot-tons	metre tons	foot-tons	metre tons
,, energy			1645.6	509.68	2738.2	888.07	4005.0	1240 36
	yds.	m.	ft.	metres	ft.	metres.	ft.	metres
Remanent velocity at ..	547	500	1512	461	1991	607	2352	717
	1094	1000	1394	425	1834	550	2168	661
	1641	1500	1287	392	1689	515	1994	608
	2188	2000	1197	365	1555	474	1837	560
	2735	2500	1125	343	1430	436	1689	515
			foot-tons	metre tons	foot-tons	metre tons	foot-tons	metre tons
Total energy at	547	500	1399.0	433 27	2425.4	751.17	3384.5	1048.09
	1094	1000	1189.0	368 24	2057.0	637 06	2876.1	890.76
	1641	1500	1012.0	313.38	1746.0	540 72	2466.0	763.64
	2188	2000	877.1	271.61	1479.0	458 05	2064 3	639.34
	2735	2500	774.4	239.85	125.12	387 55	1746.0	540.72
Energy per inch and per cent. of circumference of shell	At muzzle		89.88	10.96	156.61	19.10	218.7	26.67
	547	500	76.42	9 32	132.42	16.15	184.83	22.54
	1094	1000	64.95	7 92	112.35	13.70	157.01	19.15
	1641	1500	55.19	6.73	95.36	11 63	132.91	16 21
	2188	2000	47.89	5.84	80.77	9 85	107.76	13 75
	2735	2500	42.31	5.16	68.31	8.33	95.36	11.63
			in.	cm.	in.	cm.	in.	cm.
Penetration in wrought-iron	At muzzle		7.87	20.0	11.69	29.7	14.88	37.8
	547	500	7.00	17.8	10.39	26 4	13.19	33.5
	1094	1000	6.25	15.9	9.25	23.5	11.73	29.8
	1641	1500	5.54	14.1	8.22	20.9	10.39	26.4
	2188	2000	5.03	12.8	7.28	18 5	9.25	23.5
	2735	2500	4.60	11.7	6.45	16.4	8.22	20 9
	deg.		yards	metres	yards	metres	yards	metres
Range at different angles ..	3		2,198	2,010	3,242	2,965	3,964	3,625
	5		3,363	3,075	4,779	4,370	5,692	5,205
	7		4,391	4,015	6,075	5,555	7,125	6,515
	10		5,741	5,250	7,732	7,070	8,908	8,145
	15		7,622	6,970	9,941	9,090	11,243	10,285
	20		9,132	8,350	11,659	10,660	13,040	11,925
	25		10,313	9,430	12,992	11,880	14,425	13,190
	30		11,220	10,260	13,982	12,795	15,452	14,139
	35		11,854	10,840	14,688	13,430	16,164	14,780

been adopted, none of them depending, however, upon micrometric arrangements, which are so liable to derangement with rough usage. In one instrument a refracting prism of small angle is attached to the chief observer's instrument, and so placed that the rays of light from the distant object pass through it normally, or nearly so, before reaching the observer. By rotating this prism in its own plane the distant object appears to move in a circle whose angular magnitude at the eye depends upon the angle of deviation of the refracting prism, which in no case exceeds a few degrees. The rotation of this prism furnishes the means of bringing the assistant observer's mark into coincidence with the distant object, when a reading of the position of a graduated circle attached to the prism, with reference to a fixed index, gives the range.

Another method adopted is even simpler. The assistant observer carries attached to his instrument a scale of ranges graduated for the particular base employed. After the assistant observer has adjusted his position with reference to the distant object and the chief observer, the latter sees the distant object in juxtaposition with the scale of ranges by means of his optical square. With a base of 25 yards and no telescopic attachment, the accuracy obtainable is about 1 per cent. at 1000 yards, 2 per cent. at 2000, and so on. The time occupied in taking a range need not exceed half a minute.

Mr. Rapier was the first speaker in the discussion. He said he was in a position to bear witness to the value of the system described in the paper. Some years ago a friend of his had had occasion to make a survey of some land, but had been threatened with violence by those opposed to his operations. For this reason he had been unable to measure the ground in the usual way with the chain, but he had arrived at a sufficiently close approximation by using his theodolite and adopting much the same principle as that carried out by the authors in designing the instruments they had described.

Sir William Thomson also bore testimony to the value of the instruments described in the paper. He had tried their effect in actual use, being assisted by a gentleman who was not accustomed to work of the kind, and, in fact, was not engaged in scientific pursuits at all. Sir William himself too was not practised in the use of instruments of that nature. In a quarter of a minute they had, however, determined the distance of an object 82 ft. distant within one-fifth per cent. of accuracy. The simplicity and ease of working were points of especial value in these inventions, and he considered the instruments were well adapted both for military purposes and ordinary surveying.

Professor Robert Smith also spoke of the simplicity and ingenuity of the instruments. The authors, however, had not given figures as to the degree of accuracy which could be obtained. They had claimed that their instruments were less likely to get out of order than the ordinary optical square. This might be so as far as the non-liability to derangement of surfaces through accident, &c., where the latter were composed of different pieces, but the chief cause of error in the ordinary optical square was from expansion and contraction through variations in temperature, and he questioned whether the solid prism used by the authors would not be subject to the same disturbing element. The speaker also pointed out that in the ordinary optical square there was a double reflection, that from the front surface and that from the back. This gave a somewhat blurred reflection, whilst the reflection from the surface of a prism was always remarkably sharp. The speaker also pointed out that stretching of the cord forming the base line might lead to error.

Captain Noble pointed out that the errors or imperfections in observation might be cumulative, and in that case, he asked, would not the effect be serious?

In replying to the discussion, Professor Barr said, with regard to what had been stated by Mr. Rapier, that observations of the nature referred to when made with a theodolite were very difficult and always open to question. It was well known to be easier to set the theodolite on an object than to read it off, and in this respect he claimed an advantage for his instrument. Professor Smith had asked a question as to the percentage of accuracy. That depended both on the observer and the object. If the latter were stationary and ample time were allowed they could depend on readings to be true within 1 per cent. at 1000 yards. They, the authors, had arrived at this result by some practice, but still they could not be said to be practised operators, in the sense that trained observers, like soldiers, accustomed to the work and told off for such duties, would be trained observers. Too much stress might be laid on the point of speed of observation so far as practical work in the field was concerned. For instance, four observations per minute had been laid down as a standard by the military authorities, but for artillery purposes it would be impossible to relay and fire a gun four times in a minute. As to the accuracy of the base, also referred to by Professor Smith, if the instruments were required to be used for surveying purposes they would adopt some more stable line than the string used, but he might state that a stretching of 9 in. in the 25 ft. of cord would only give an error of 1 per cent.

A vote of thanks to the authors closed the proceedings for the day.

On the evening of Thursday the annual soirée of the Institution was held in the Municipal Buildings, and was attended by a large number of members and associates and their friends, together with many of the inhabitants of Leeds and the neighbourhood.

At the second day's sitting, Friday, the 5th inst., seven papers and two reports of committees were read.

ESTUARIES COMMITTEE.

The first business was the presentation of the report of the Estuaries Committee by Professor Osborne Reynolds. This is a continuation of the work of research that was inaugurated by the work described at the Manchester meeting, when it will be remembered that Professor Reynolds, who was then President of Section G, described the model estuary by means of which he had investigated certain phenomena in connection with the Mersey Estuary. The work of the Committee had been much delayed by the postponement of certain works on the Seine upon which they had depended as a basis from which they might follow up a given course of inquiry. The labours of the Committee will be more profitably dealt with when they are completed and some harmonious conclusion has been worked out.

GRAPHIC METHODS.

A further report of the Graphic Methods Committee was next read. This also will be of greater value when the labours of the Committee are brought to a more definite point.

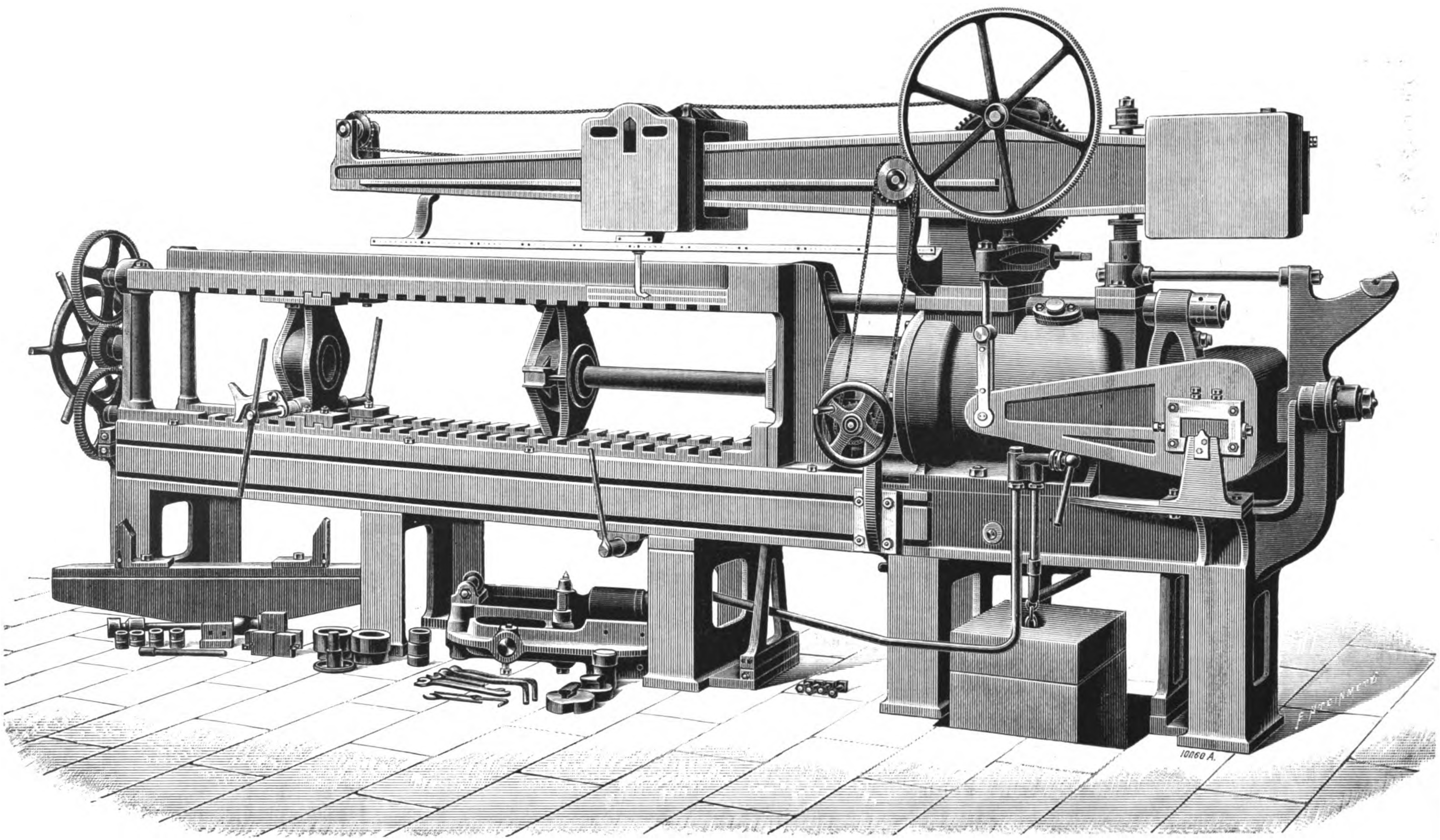
SHEET-METAL NETTING.

A paper by Mr. J. F. Golding "On the Manufacture of Netting from Sheet Metal," was next taken. We have so recently described this manufacture (see page 100 *ante*), that it will be unnecessary for us to reopen the subject here. A discussion followed in the course of which several speakers expressed

TESTING MACHINE AT PROFESSOR KENNEDY'S LABORATORY.

CONSTRUCTED BY MESSRS. JOSHUA BUCKTON AND CO., LIMITED, ENGINEERS, LEEDS.

(*For Description, see Page* 310.)



the opinion that the new netting is well suited for many purposes to which wire netting would not be applicable; one great virtue in the sheet metal variety being its rigidity, which enables it to be, to a great extent, self-supporting.

Cable Tramways.

Mr. W. N. Colam next read a paper "On Cable Tramways." The paper commenced by stating that nearly 14 millions sterling have been expended in providing tramway locomotion through streets in this country, and that 477,596,268 passengers were carried last year in the United Kingdom. Cable tramways were first introduced in Clay-street, in the city of San Francisco, and San Francisco has now a complete system all over the city. Chicago followed suit and has now 52 miles of cable road working at speeds of 12 and 8 miles an hour. The cost of running per car-mile has been reduced from 23½ cents by horses to 9½ cents by cable, and big dividends are being paid. Other cities in America also have cable systems. The Brooklyn Bridge line is mentioned. Over this line 35,698,874 passengers were carried last year, and in one day as many as 159,259 were conveyed. The most brilliant success followed the cable system in Australia. In the streets of Melbourne last year 45,000,364 passengers were carried over 43½ miles of cable road, and the dividend earned was 75 per cent. The first line laid in England was the Highgate Hill line, which the author considered an unfortunate example. Edinburgh and Birmingham followed. The returns issued by the Birmingham Company show that the working expenses per car-mile with different modes of propulsion, were as follows:

	Per Cent. of Gross Receipts.
Horses	85.5
Steam engine...	64.5
Cable	46.5

The following the author lays down as some of the chief points to be observed if cable roads are to meet with approval.

1. The slot in the road should be narrow and not such as to interfere with vehicular traffic.

2. The amount of metal presented in the sur-

15-CENT. (5.90-IN.) GUNS AND NAVAL CARRIAGES: CANET SYSTEM.

CONSTRUCTED BY THE FORGES ET CHANTIERS DE LA MEDITERRANÉE, HAVRE.

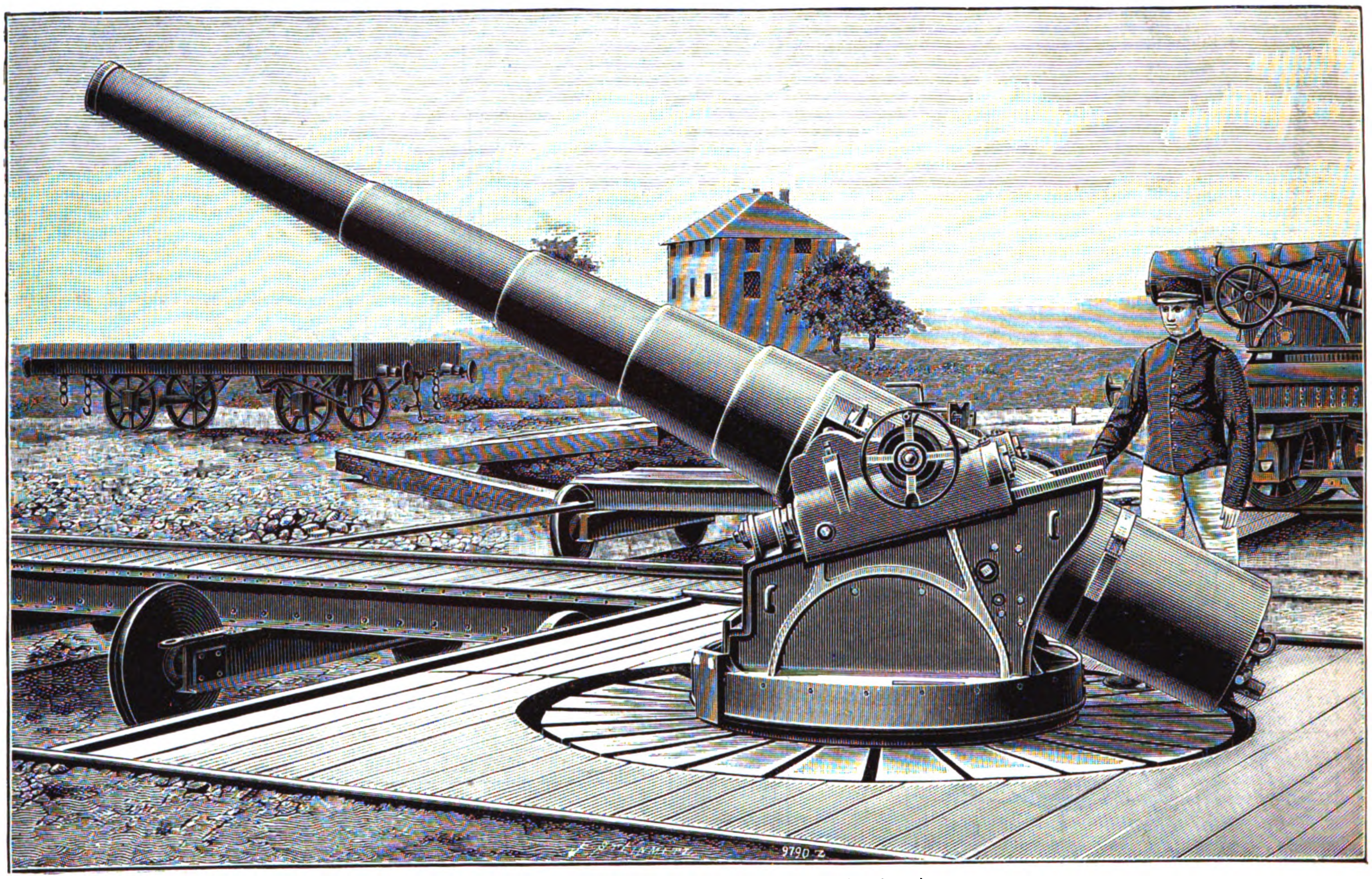


Fig. 412. Central pivotted mounting for 15-cent. (5.90-in.) Canet gun.

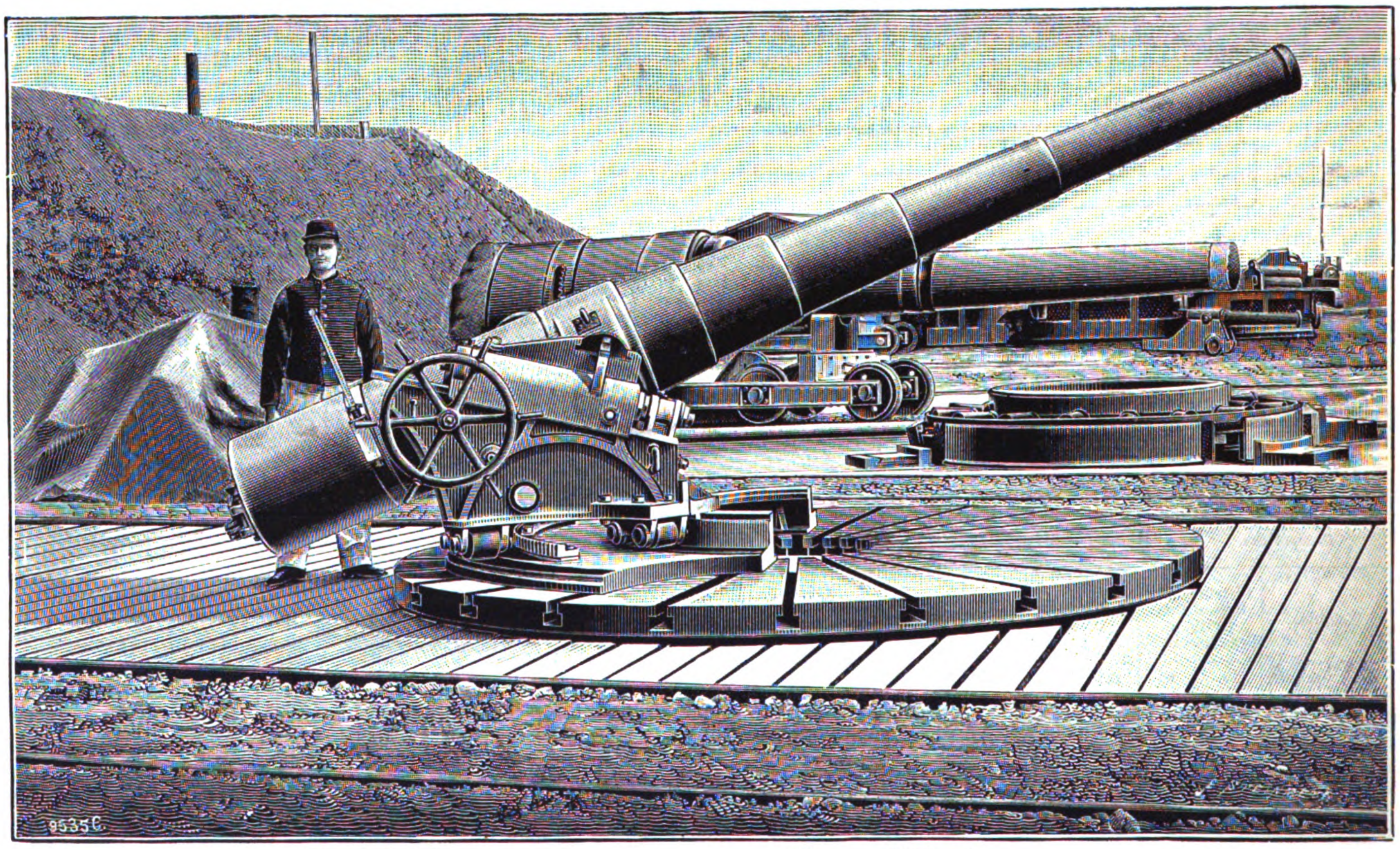


Fig. 413. Forward pivotted mountings for 15-cent. (5.90-in.) Canet gun.

of the same calibre and length. 3. Central pivotted carriages with hydraulic brakes for guns 27-centimetre bore and 36 calibres in length. 4. Turret carriage with hydraulic brake for 27-centimetre guns, 30 calibres in length.

The mounting for the central-pivotted carriages with hydraulic brake for 15-centimetre guns consists of four principal parts as follows: *a*, the carriage properly so called; *b*, the underframe; *c*, thebaseplate; *d*, the shield (Figs. 409 to 412, pages 415 and 416).

The carriage is constructed of two hydraulic brake cylinders, the lower sides of which are formed with slides which bear upon, and are clipped to, the corresponding slides of the underframe. At the upper side of these cylinders are two projections

FORWARD PIVOTTED MOUNTING FOR 15-CENT. (5.90-IN.) CANET GUN.

CONSTRUCTED BY THE FORGES ET CHANTIERS DE LA MEDITERRANÉE, HAVRE.

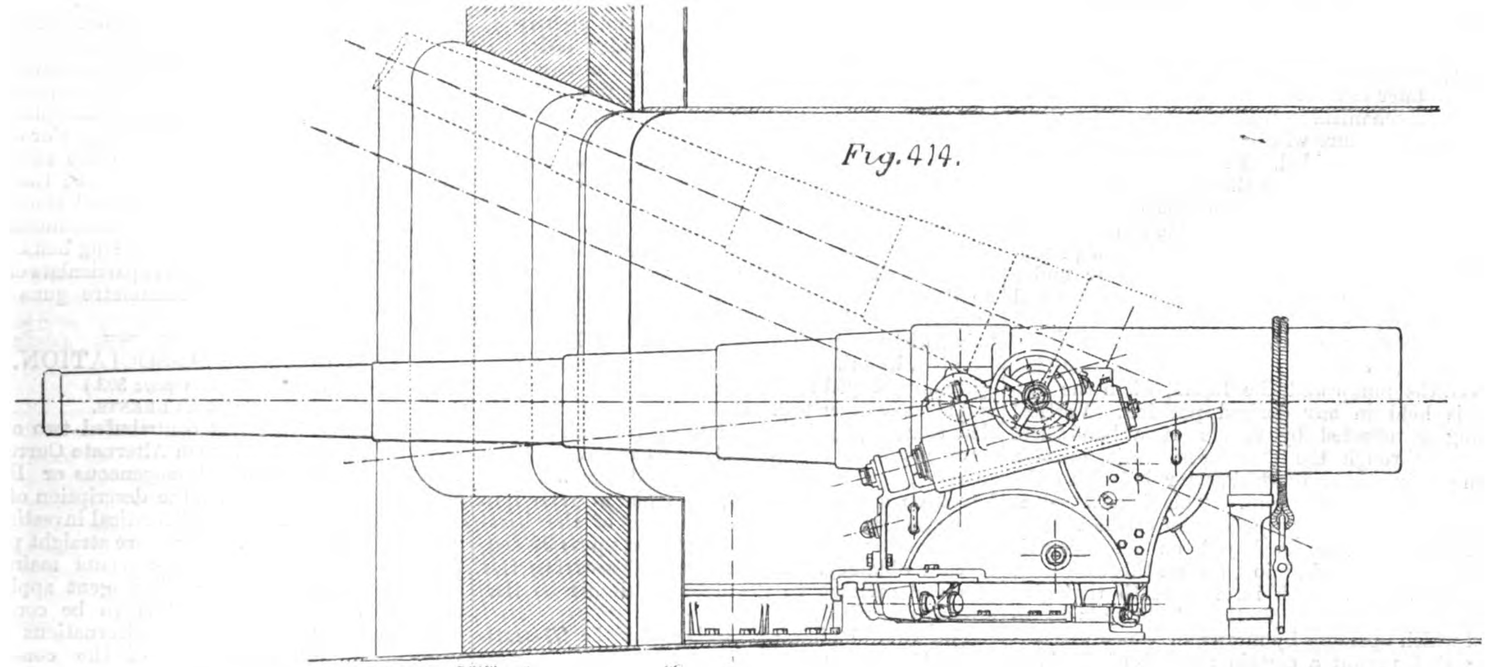


Fig. 414.

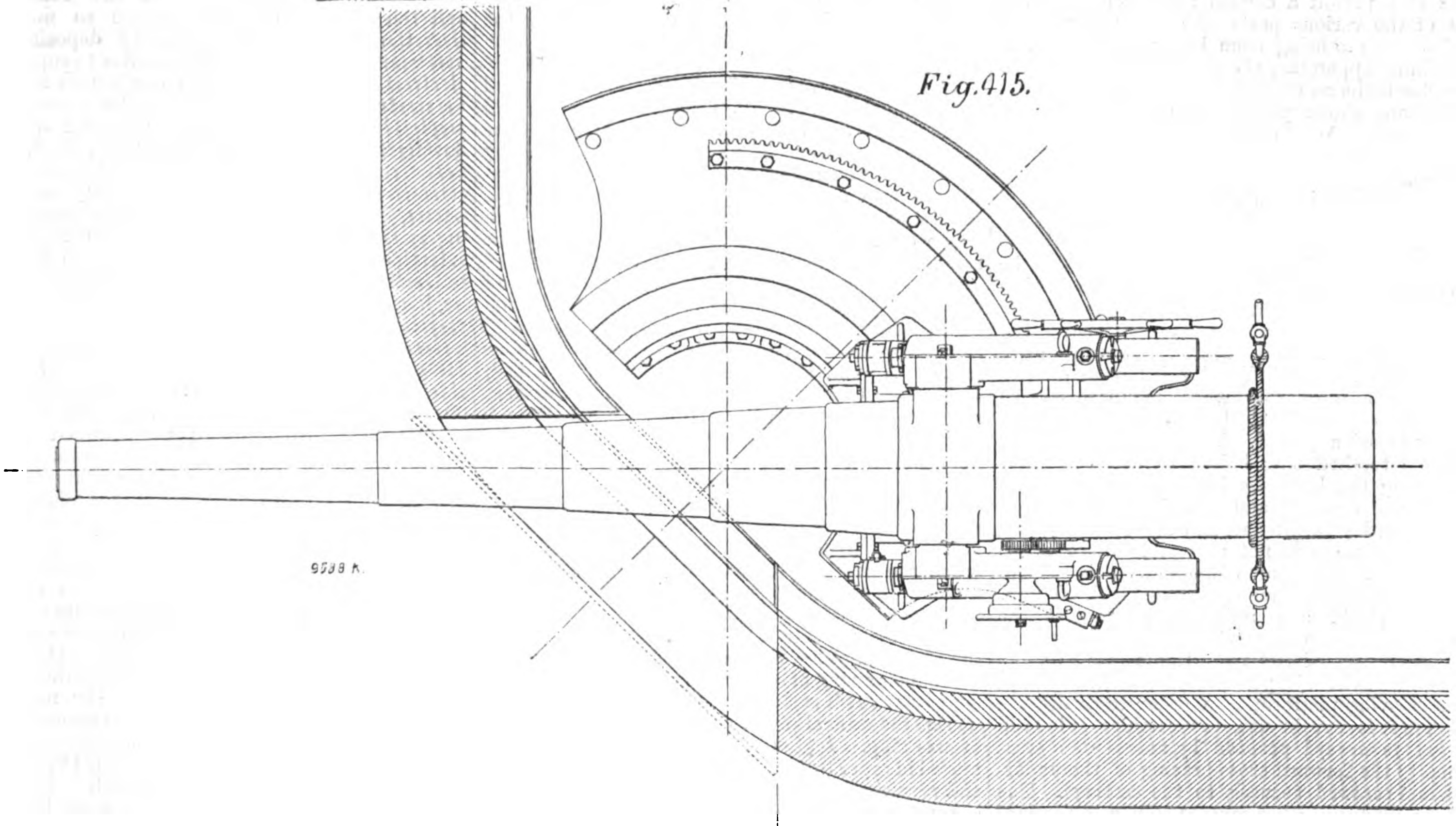


Fig. 415.

that receive the trunnions of the gun. The two cylinders are connected by cross-pieces of cast steel, and which are hollowed in the centre for allowing the gun to be trained to extreme angles of elevation and depression. On the left-hand side of this carriage are placed the various parts which compose the apparatus for elevating the gun. The underframe consists of two vertical side frames and a platform; all of these being strongly braced together. The upper sides of the frame are formed into slides on which bear the under parts of the upper carriage, as above described; in front of the under carriage are projections to which are attached the ends of the piston rod which work in the hydraulic brake cylinders. On the right-hand side of this under carriage is secured the mechanism for horizontal training; on the left-hand side is fixed a hand pump and small tank for bringing the gun back out of firing position; this is worked by a lever. In the centre of the platform is a socket to receive the pivot which projects from the middle of the baseplate. Two steel clips are fixed to the front part of the platform and resist the overturning effort made by the gun when it is fired. The baseplate which is bolted to the deck of the ship supports the underframe by means of a roller ring, the wheels of which are kept in their proper positions by inner and outer rings that are recessed at equal distances to receive the axes of the rollers. This roller ring facilitates the rotating movement of the frame around the pivot, which takes its bearing in the socket of the platform. The object of this pivot is to guide, with perfect accuracy, the moving part of the carriage while the gun is being trained for direction, and to prevent any horizontal displacement during fire. On the outside of the baseplate is a projecting ring, under which the steel clips fastened to the platform take their bearing. A special arrangement is provided to enable the roller ring and its various parts to be easily inspected and repaired. The hydraulic brake is on the Canet system with a central counter-rod. It is formed of two cylinders cast with the upper carriage, the pistons in which are attached to the rods, the ends of the latter being bolted to the projections at the top of the underframe already mentioned. The piston-rods are hollow, and in the spaces thus provided the counter-rods can enter; the ends of the latter are bolted to the bottom of the hydraulic cylinders. During recoil the movement of the gun is transmitted to the carriage, and the water or other liquid is compressed between the front face of the pistons and the forward end of the cylinders; then it passes to the rear of the pistons through the annular space left clear between the central rod and the slight openings made in the middle of the piston. The liquid, in order to pass through these openings, lifts the valve, which is held down in place by a spring, and which falls back again, closing the orifice as soon as the recoil is terminated.

This valve serves to regulate the return of the gun to firing position and to prevent this movement from being too rapid. At the end of the recoil, when the valve has been forced back upon its seat, the liquid cannot pass from the rear to the front of the piston except by flowing through some very narrow passages, and, as a consequence, the gun rises back into firing position at a slow and easily controlled rate. The orifices for the passage of the fluid during recoil are regulated by the central counter-rod, the diameter of which varies at each instant with the travel of the piston, in order that it may follow step by step the variations in the effort of recoil, and maintain a constant pressure within the brake cylinders. It is in this simple manner that an absolutely regular action of the brake mechanism is maintained, and any irregularities of pressure which would be injurious to the carriage, are avoided. Bringing the gun down out of firing position when the agency of the recoil is not available, is effected by means of the hand-pump mounted on the left-hand side of the frame; this pump forces the liquid into the hollow piston-rod of the brake cylinder. The water under pressure acts on the bottom of the cylinder and forces the carriage to shift into the desired place on the underframe; all that is then necessary is to close the valve, which shuts off communication between the pump and the liquid, when the carriage is held in any desired position. Vertical training is effected by means of a handwheel working—through the Canet differential gear—a pinion gearing into a toothed sector bolted to the left-hand side of the gun. This handwheel is mounted on a spindle perpendicular to the side of the underframe; it is keyed on an eccentric sleeve, and a toothed pinion, fast on this eccentric, gears into a sleeve with internal teeth that give motion to the working spindle. A clutch is introduced which operates by means of cones and flat plates that permit a certain amount of displacement of the various parts. In order to prevent the shock due to firing from being transmitted to the training apparatus, the pinion that gears into the sector turns on the spindle and is free to slide, so that any shock produces no damage to the various parts. With each revolution of the handwheel the working shaft turns through an angle corresponding to the difference between the number of teeth in the inner and outer geared wheels; this arrangement reduces the effort required for raising or lowering the gun, and also increases the speed at which the operation can be performed. The whole of the training mechanism is inclosed within a bronze casing that completely covers it and protects it from dirt, &c. The lateral training is also effected by means of a handwheel, on the spindle of which is an endless screw, gearing into a wormwheel mounted on the upper end of a vertical shaft, to the bottom of which is keyed a pinion. This pinion gears into the large toothed ring bolted to the baseplate. On turning the handwheel the desired displacement of the carriage and gun is produced, the whole mounting turning around the central pivot. As this apparatus is not reversible there is no danger of any lateral displacement in rough weather. A shield made of chrome steel, 40 mm. (1.55 in.) thick, and intended to protect the mounting and the men serving the gun, is fixed to the forward part of the underframe (see Fig. 409 to 411), and is held in place by two struts that rest on the moving platform. In order to secure the gun when it is not in use, the carriage is held in its extreme inward position by means of a strut secured to the forward cross-bracing of the underframe and screwed securely to the carriage. The gun is lowered into a horizontal position, a block of hard wood is placed at the rear of the carriage under the gun, and a cable is passed around the breech near the block and is held down to the deck by means of ring bolts.

The forward pivotted carriage (Figs. 413 to 415, pages 416 and 417) for the 15-centimetre gun of 36 calibres, consists of the three following principal parts: *a*, the carriage properly so called; *b*, the underframe; and *c*, the baseplate. The first named is absolutely similar to that of the central pivotted mounting we have just described, and it is furnished with the same mechanism for vertical training. The underframe consists of two sides connected in the front and at the rear by cross-pieces, the whole being of cast steel in one piece; double clips are introduced to connect this with the bedplate, and to resist any lifting tendency when the gun is fired, or during a heavy sea; they also serve as guides when the gun is being trained horizontally. This underframe rests upon eight coned rollers mounted in groups of two—four in the front and four at the rear; the bottom of the underframe is so formed as to receive the axis on which these rollers are mounted. On the left side of the underframe is attached a small hand-pump, as in the carriage just described, and serving the same purpose. The underframe bolted to the deck is made in a single piece of cast steel. As the maximum angle of horizontal training is 90 deg., it follows that this part of the mounting may be considered as one-fourth of a circular bedplate, the centre of which is fixed in such a way as to reduce its dimensions as much as possible. On the forward part of this bedplate is cast a circular guiding flange over which pass the two clips bolted to the underframe as described above. On the face of the bedplate are also formed two concentric and inclined paths on which travel the groups of rollers that form the forward and rear supports of the mounting; as these paths are cast on the bedplate, which is made in a single piece, there is no danger (from settlement of the deck or other cause) of the level to which the mounting is set being disturbed. The mechanism for horizontal training, like that for elevation, is analogous to the system employed for the central pivotted mounting and already described. It consists of a handwheel that controls, by intermediate gearing, an endless screw mounted perpendicularly to the rear of the carriage, and a wormwheel that drives a pinion keyed on a vertical shaft; this pinion gears into a toothed arc bolted to the rear of the baseplate, and a range of angular motion up to 90 deg. is thus obtained. The method of securing this gun and carriage to the deck is similar to that already described.

The central pivotted carriage for the 27-centimetre Canet gun of 36 calibres is very similar to those already described, and consists of: *a*, the carriage; *b*, the underframe cast in one piece with the platform; *c*, the baseplate; and *d*, the shield.

The carriage proper is similar, in its general arrangement and in its mechanism for vertical training, to the turret mounting which will be hereafter described. The length of recoil is slightly increased. The underframe, with its platform, consists of two side frames braced together in the front and rear, and at the upper portion of each frame on the slides, grooves are cut to receive the rollers, which are mounted in the bottom of the carriage proper, to facilitate the movement of recoil. The projections to which the piston-rod of the brake are attached, are placed at the rear of the carriage at the end of the slides of the underframe. A pump similar to that already described, is attached to the left-hand side of the mounting, and is worked in the same manner. A small handwheel for controlling the valve for bringing the gun back into firing position, is also mounted on the left-hand side of the underframe. Two hand cranks for operating the lateral training mechanism are placed at the rear of the carriage at a suitable height for convenient working. The forward cross-bracing is arranged to receive the shield, which is further secured by struts; on this cross-plate are also mounted the buffers to absorb the shock from the gun when it runs forward. The platform carries the socket that receives the central pivot, and it rests upon a ring of coned rollers. The cast steel bedplate, which is bolted to the deck of the ship, carries the central pivot, which is furnished with a bronze ring. A part of this bedplate can be removed in order to facilitate the inspection, cleaning, and repairing of the coned rollers. This bedplate, of course, carries the whole weight of the mounting and of the shield.

The lateral training is effected either by hand or by a steam motor, no device for throwing out of gear being introduced, so that the hand and power applications could be made simultaneously; by this arrangement an additional or differential movement can be obtained according to the direction in which the power is applied. The lateral hand training device is operated by means of two levers mounted on the underframe, the movement being transmitted by means of intermediate wheels to a common shaft, perpendicular to the sides of the under carriage and traversing it. This shaft carries an endless screw operating a wormwheel keyed on a vertical shaft attached to the vertical portion. On this shaft is keyed a pinion gearing with the outer teeth of a ring that is also provided with internal teeth. This ring is exactly centred on the axis of the carriage, and it is keyed fast and serves as an abutment. The pinion in moving around this toothed ring carries with it the underframe, the turning platform, the carriage, and the gun. The carriage is mounted on an iron platform, on which is placed a steam engine that drives an endless screw controlling a wormwheel keyed on a vertical shaft; this shaft is placed in the axis of the pivot and rests in the socket, above which is placed the mechanism by which the hand and power devices can be operated independently. The engine is started by two levers placed within the reach of the men serving the gun; these levers are connected by rods to two other levers, and are moved by the carriage for automatically stopping the engine. Two projections on the baseplate also limit the range of horizontal training. For anchoring the gun to the deck, a bolt on the right-hand clip is passed into a socket in the deck; the gun is lowered into a horizontal position, and the breech, resting on a block of wood, is surrounded by a steel cable secured to the deck by ring bolts.

Table XLIII., page 415, gives particulars of firing trials made with the 15-centimetre guns above referred to.

THE BRITISH ASSOCIATION.

(*Continued from page 393.*)

Alternate Currents.

Sir William Thomson contributed two cognate papers. The first one, "On Alternate Currents in Parallel Conductors of Homogeneous or Heterogeneous Substance," gives the description of some of the results of a full mathematical investigation. Sir William assumes two or more straight parallel conductors having alternate currents maintained in them by a dynamo or other agent applied to the one end, the other ends to be connected in some way; the period of alternations to be very great, and the length of the conductors and the effective ohmic resistance so moderate that the quantities of electricity deposited on and removed from their boundaries to supply the electrostatic forces along the conductors required for producing the alternations of the currents, are negligible in comparison with the total quantity flowing in either direction in the half period. This latter condition excludes the applicability of these conclusions to problems of telegraphy and telephony, but includes the problem of electric lighting by alternate currents transmitted through considerable distances, as, for instance, from Deptford to London. The cross-sections should everywhere be homogeneous, but the parts of the conductors may consist of different metals. We can only quote a few of the examples stated by Sir William; the full paper will appear in the *Philosophical Magazine*. In a flat bar of 4 centimetres thickness and 30 to 40 centimetres breadth, a current of 80 periods per second would be confined to two strata extending to small distances inwards from its two sides, the time maximum at the surface being 7.4 times what it is at a distance of 1.43 centimetres from the surface. Snow Harris is justified for advising tubes or broad plates for lightning conductors, and those who condemned him out of Ohm's law are proved to be wrong; but Snow Harris was not right in lowering the conductors down in the interior of a ship (even through a powder magazine) instead of across the deck, down its sides, or from the mast along the rigging and down the sides to the water. The non-independence of the total quantity of current in the material, whether iron or non-magnetic metals, further seems quite in accordance with Dr. Lodge's doctrines regarding "alternate path" lightning conductors. This implies also that more heat was developed by the same alternate current, in iron than in copper, as advanced by Lodge. Professor Rowland mentioned that he had studied these phenomena for perfect conductors, where the distribution of the current was the same as if the conductors were charged with electricity at rest. As regards ordinary imperfect conductors, he did not know of any solution. Sir William's second paper, "On Anti-effective Copper in Parallel or Coiled Conductors for Alternate Currents," has considerable practical importance, and opens a pleasant prospect of economy in copper, inasmuch as it teaches that too thick conductors are not only wasteful, but may actually be injurious. As a rule we simply think that by making conductors too thick, we do not get the full advantage of the copper for alternate currents. But it might be expected that we should get an augmentation of the effective ohmic resistance, because we know that the presence of copper generates heat in the conductor, and the calculations fully bear this out. If we increase the thickness we reduce the ohmic resistance, but only until a certain thickness is reached. Any further addition of copper then produces an actual loss, struct, maintain, and to operate to mill the grains extensively.

"In illustration I present an approximate estimate for a 500 horse-power steam plant to work 24 hours per day and 309 days per year, as is the usual practice in flouring and paper mills

	dols.	dols.
Condensing engine, boilers, houses, and stack, at 60.00 dols. per H.P. ...		30,000.00
Present worth of renewals in ten years, in ten annual payments		22,080.00
Annual cost of fuel...	at 50.00 per H.P.	
" " supplies	" 1.85 " "	
" " attendance	" 10.25 " "	
" " repairs	" 3.00 " "	
" " of insurance, taxation ...	" 1.20 " "	
Annual cost of heating and incidentals ...	" .75 " "	
	67.05 " "	
500 H.P. at 67.05 dols., 33,525.00 dols. annual expense, capitalised at 6 per cent.		558,750.00
Capitalised cost per H.P. 1221.74 ...		610,870.00

"Sixty dollars per horse-power for original cost of plant and 67 dols. annual expense for 24-hour runs are moderate estimates. Col. Samuel Webers estimated the average cost of large steam plants for cotton mills at 100.00 dols. per horse-power, original cost, and in 1876 he found the actual annual cost of steam power used ten hours per day at six large cotton mills in Fall River and Newburyport in Massachusetts, to range from 45.27 dols. to 55.12 dols. per horse-power, with an average of 50.04 dols. for cost of fuel, supplies, and attendance only.

"In 24-hour runs, the above annual expenses per horse-power would be at least doubled, and the annual expenses of repairs and depreciation more than doubled.

"Steam power is convenient and invaluable if power is required in locations where water power cannot be obtained, and for light mechanical works in which cost of power is a small part of the expense, and the number of hands employed is large, for each horse-power used, but in cotton and woollen manufactures requiring one and one-half horse-powers per hand, paper manufacture requiring five horse-powers per hand, and in flour manufacture, requiring thirteen horse-powers for each hand employed, water power still holds its supremacy."

MODERN FRENCH ARTILLERY. No. XXXIX.

Naval Gun Carriages—*concluded.*

The turret mounting on the new Greek ironclads for the 27-cent. (10.63 in.) Canet gun, 30 calibres in length, consists of the following parts: (1) The upper carriage; (2) the under carriage; (3) the platform; (4) the baseplate; (5) the central tube; (6) the ammunition hoist; (7) the shield.

1. The carriage properly so called (Figs. 416 to 420, pages 476 and 477) includes two brake cylinders arranged similarly to those for the 15-cent. gun mountings, connected by a cross-piece cast in one with them; this cross-piece is curved to give space for the movements of the gun when it is being trained, and in it are also placed two auxiliary cylinders and spring buffers to deaden the shock as the gun comes back into firing position; these buffers take their bearing against the transverse portion of the underframe. On the upper part of the brake cylinders are cast the brackets that receive the trunnions of the gun; on the underside, and extending along the whole length, are the slides, which are made with flanges and clips. On the right-hand side of the carriage is placed the mechanism for vertical training; plugs for emptying and filling the brake apparatus, closing holes formed in the cylinders. Under the curved cross-piece and following the longitudinal axis, is mounted a valve box, the purpose of which will be described further on in connection with the brake.

2. The underframe consists of two side plates connected by transverse pieces; on the upper face of each side plate are the slides in which are grooves guiding the rollers that carry the upper carriage and assist in bringing the gun back into firing position. At the rear of the slides are cast the heads to which the piston-rods of the hydraulic brake are attached. To the rear of the side plate, at a suitable height for convenient working, are placed on each side the cranks that operate the hand mechanism for lateral training. On the left side plate is fixed a hand pump, by which the liquid used in the brake apparatus can be forced into the main and auxiliary cylinders for the purpose of bringing the gun back into battery; this pump is worked by a lever. The upper carriage travels forward bringing the gun into firing position, simply by opening a small valve. The communication between the pump and the brake is cut off during fire by a small valve that is closed by hand, and which is placed on the left-hand block, to which the corresponding piston-rod of the brake is attached. The forward transverse piece carries two blocks for the buffers on the upper carriage to strike against, and two projections to which are attached the plungers of the auxiliary cylinders. The underframe rests upon the platform, which is of large area, carefully faced, under the two side frames and under the forward transverse frame; two projections prevent any shifting of the underframe on the platform, and clips in the front of the carriage check any tendency to lifting. The underframe is securely bolted to the platform by bolts and nuts.

3. The upper face of the platform is carefully dressed and levelled to correspond with the underside of the frame that is bolted to it; it rests upon a ring of live rollers on which it travels in a circular direction when the gun is being trained horizontally. In the middle of this platform is the pivot, which serves as a guide for the under carriage, and also in the centre is the guide for the large tube through which the ammunition is hoisted to the firing platform; a connection is made between the platform and the baseplate by means of heavy steel clips that prevent any tendency to throw the mounting over when the gun is fired. The platform can be locked by means of a bolt which passes into a socket fixed to the deck; this holds the whole of the mounting stationary in any desired position when the ship is in a seaway, and the gun is fastened down to the deck. On the left side of the platform are placed a steam engine, and the mechanism for horizontal training, which can be done either by hand or by power, or by both combined.

4. The baseplate is fixed to the deck by means of bolts, and on its upper surface is a circular roller path on which the live ring with its coned rollers rests; it is through this ring that the whole of the weight of the carriage and gun is supported and transmitted to the deck; the ring also carries the weight of the central ammunition tube and the hoist. The rollers are kept at a fixed distance apart by recesses in the outer and inner rings within which the ends of the roller axes take their bearings.

5. The central ammunition tube is formed of steel plate; it is attached to the platform and extends below as far as the magazines. To the interior of this tube are attached the guides for the hoists, and on the outside, below the level of the armour deck, is a steam winch; above, it is protected by a special armoured casing which extends as far as the upper deck.

6. The ammunition hoist is of the so-called revolver type, and consists of a three-tiered cage; the top compartment is intended to receive the projectile, and the others the two half-cartridges which compose the charge. The cage is free to turn round a central axis, carried at each end by bearings mounted in a frame which carry rollers on each side that serve to direct the cage during its ascent. The complete rotation of the hoist is effected by means of a hand crank. A safety apparatus is introduced to control the position of the cage at every point, either in rising or falling. When the cage is at the bottom of the tube, after having been loaded and placed in a suitable position for lifting, it is hoisted by means of a steam winch, which actuates two chains that, after having been led over a series of transmission pulleys placed at the top of the tube, descend the tube and are attached to the cage. The latter is lifted vertically at first, until it reaches the upper part of the tube, when it assumes an oblique direction so as to rise clear of the carriage and the gun, which by that time has been trained. This movement is continued until the cage has risen above the breech by some inches. The oblique movement is then transformed a second time into a vertical one and the cage is stopped, when the upper tier containing the projectile is opposite the chamber of the gun; this arrest is effected automatically by a stop, which holds it in the desired position and keeps it fast while the gun is being loaded. The hoist being in place, the men serving the gun who are on the firing platform, and who have already opened the breech, force the projectile into place, and turn the cage by means of the lever which they have placed on the square end of the vertical shaft; this brings the two half-cartridges one after the other opposite the chamber of the gun, and when in this position they can be introduced and the operation of loading completed. After this has been finished, the cage is released and descends by its own weight, the winch having nothing to do during the descent. The hoist is guided during all these different movements by rollers that are kept working in grooves. It should be remarked that

TABLE XLIV.—BALLISTICAL DATA OF 27-CENT., 30.5-CENT., AND 32-CENT. NAVAL CANET GUNS CONSTRUCTED BY THE FORGES ET CHANTIERS DE LA MEDITERRANÉE.

Nature of Gun.	Bore.	Length of Gun. Calibres.	Total Length.		Length of Bore.		Diameter of Chamber.		Length of Rifling.		Number of Grooves.	Terminal Angle.	Weight of Gun.		Weight of Projectile.		Weight of Charge.		Initial Velocity.		Total Energy.		Thickness of Iron Plate Penetrated at Muzzle.		Maximum Range.	
	in.		in.	mm	in.	mm.	in.	mm	in.	mm.			lb.	kilos.	lb.	kilos.	lb.	kils.	ft.	m.	ft. tons	m. tns.	in.	cm.	yards	m.
27 cm. gun	10.63	25	265.7	6,750	247.2	6,280	11.34	288	196.7	4,995	82	Uniform rifling at 6 deg.	44,750	20,300	529.1	240	180.8	82	1770	540	11,516	3567.	20.7	52.5	15,272	13,695
Ditto	10.63	30	318.9	8,100	298.7	7,586	11.64	296	245.5	6,235	82		60,842	27,600	529.1	240	227.1	103	2000	610	14,697	4551.7	24.6	62.5	17,633	16,125
Ditto	10.63	36	382.6	9,720	362.5	9,206	11.97	304	298.3	7,575	82		72,086	32,700	529.1	240	278.0	127	2230	680	18,295	5666.3	28.7	73.	19,348	17,690
Ditto	10.63	43	457.1	11,610	435.2	11,054	12.28	312	370.5	9,410	82		97,660	44,300	529.1	240	330.7	150	2424	740	21,626	6698.5	32.4	82.4	20,631	18,865
Ditto	10.63	50	531.0	13,500	511.6	12,944	12.60	320	435.0	11,050	82		110,010	49,900	529.1	240	374.8	170	2625	800	25,218	7810.7	36.3	92.1	21,758	19,895
30.5 cm. gun	12.01	25	299.0	7,525	279.3	7,094	12.68	322	222.1	5,640	92		64,371	29,200	771.6	350	264.4	120	1770	540	16,794	5201.85	24.9	63.2	16,284	14,890
Ditto	12.01	30	360.3	9,150	337.4	8,570	13.07	332	277.4	7,045	92		72,304	32,800	771.6	350	330.7	150	2000	610	21,430	5637.89	29.6	75.2	18,760	17,155
Ditto	12.01	36	430.0	10,920	409.5	10,400	13.46	342	336.8	8,585	92		103,830	47,100	771.6	350	410.1	186	2230	680	26,659	8256.3	34.6	87.8	20,713	18,940
Ditto	12.01	43	516.4	13,115	491.6	12,486	13.86	352	418.5	10,630	92		140,880	63,900	771.6	350	485.0	220	2424	740	31,538	9768.64	39.0	99.0	22,190	20,290
Ditto	12.01	50	600.5	15,250	575.7	14,622	14.25	362	489.4	12,430	92		158,300	71,800	771.6	350	551.1	250	2625	800	36,862	11416.96	43.4	110.4	23,497	21,485
32 cm. gun	12.60	25	315.0	8,000	293.0	7,442	13.31	338	233.1	5,920	96		74,288	33,700	881.8	400	299.8	136	1770	540	19,194	5944.94	26.4	67.1	15,835	14,480
Ditto	12.60	30	378.0	9,600	354.1	8,992	13.70	348	291.0	7,390	96		101,410	46,000	881.8	400	379.2	172	2000	610	24,494	7586.11	31.5	79.9	19,032	17,405
Ditto	12.60	36	453.6	11,520	429.7	10,912	14.09	358	353.4	8,975	96		119,920	54,400	881.8	400	467.4	212	2230	680	30,436	9427.1	36.7	93.3	21,051	19,250
Ditto	12.60	43	541.8	13,760	515.8	13,100	14.49	368	439.0	11,150	96		162,700	73,800	881.8	400	551.1	250	2424	740	36,043	11164.08	41.4	105.2	22,573	20,640
Ditto	12.60	60	630.0	16,000	604.0	15,340	15.28	378	515.9	13,100	96		182,990	83,000	881.8	400	626.1	284	2625	800	42,125	13047.9	45.6	116.4	23,927	21,880

27-CENT. (10.63-IN.) GUN AND TURRET MOUNTING; CANET SYSTEM.

CONSTRUCTED BY THE FORGES ET CHANTIERS DE LA MEDITERRANÉE, HAVRE.

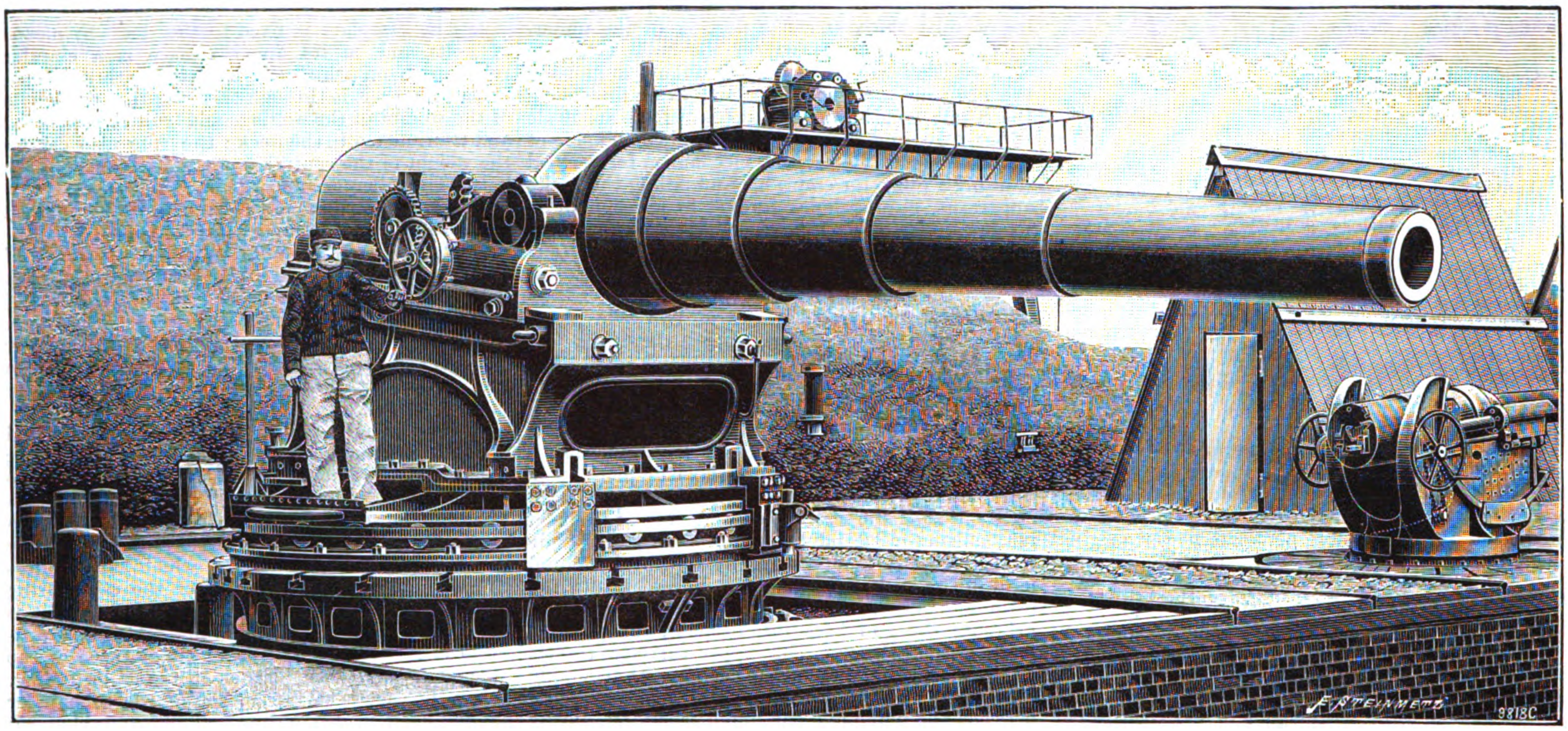


Fig. 416.

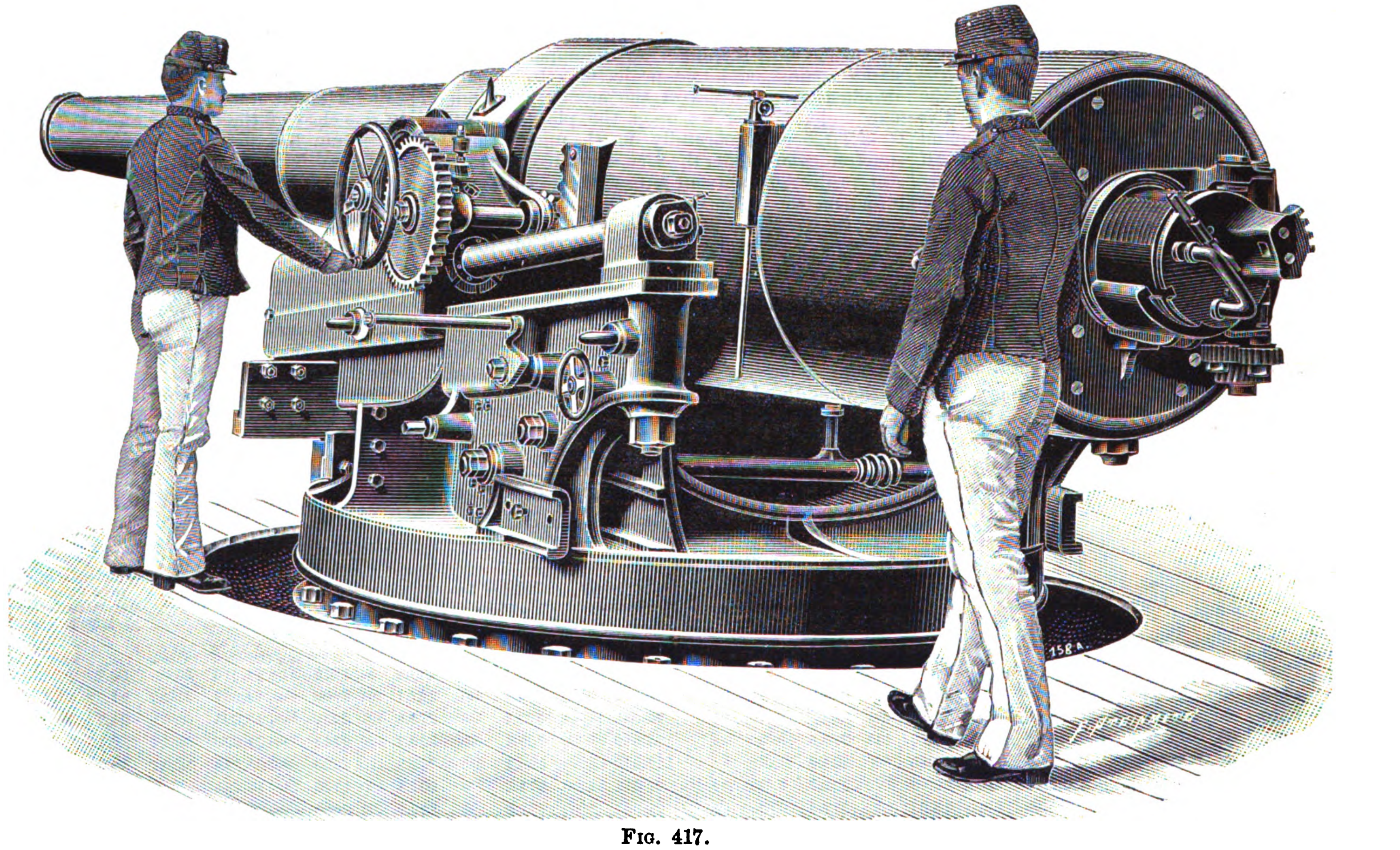


Fig. 417.

the tube turning with the mounting, and shifting the hoist in its movement, the operation of loading can be performed in every position of the turret. This arrangement was applied for the first time by M. Canet. The winch is fixed on the outside of the tube beneath the armour deck; it is provided with a drum, round which the chains are rolled, and it is fitted with a brake.

The hydraulic brake consists of two cylinders cast in one piece with the upper carriage and two pistons, the rods of which are attached to the projections at the rear of the underframe. The brake is of the Canet central rod type. Two counter-rods are fixed in the forward ends of the cylinders and regulate the area of orifice through which the liquid is discharged, in the same way as has been described for the mountings of the 15-cent. guns, excepting that the valve placed in each piston to regulate the return of the gun to firing position, is unnecessary on account of the auxiliary cylinders and the communicating valve. In these latter cylinders, which are cast with the cross-piece of the upper carriage, are two bronze plungers fixed in front and of the same diameter as the brake piston-rods. These cylinders are connected with the main cylinders by pipes which connect the forward end of the one with the rear end of the other, and in the centre is placed the valve-box. During the recoil of the carriage the liquid is compressed between the front face of the piston and the front end of the cylinder; it passes through the central discharge orifice and forms a brake, but as at the rear of the piston the volume is diminished by that of the piston-rods, a corresponding quantity of liquid passes through the pipes into the auxiliary cylinder, where, on account of the outward movement of the plungers, there is left a free space equal to that it occupied in the brake cylinders. Before arriving at the auxiliary cylinders, the liquid has to flow through the central box and to lift a valve which is loaded in such a way as to close automatically as soon as the recoil is completed, thus preventing any return of the liquid from the auxiliary into the brake cylinders; the gun is thus held back. In order to bring the

TURRET MOUNTING, CANET SYSTEM, FOR 27-CENT. (10.63-IN.) GUNS.

CONSTRUCTED BY THE FORGES ET CHANTIERS DE LA MEDITERRANÉE, HAVRE.

Fig. 418.

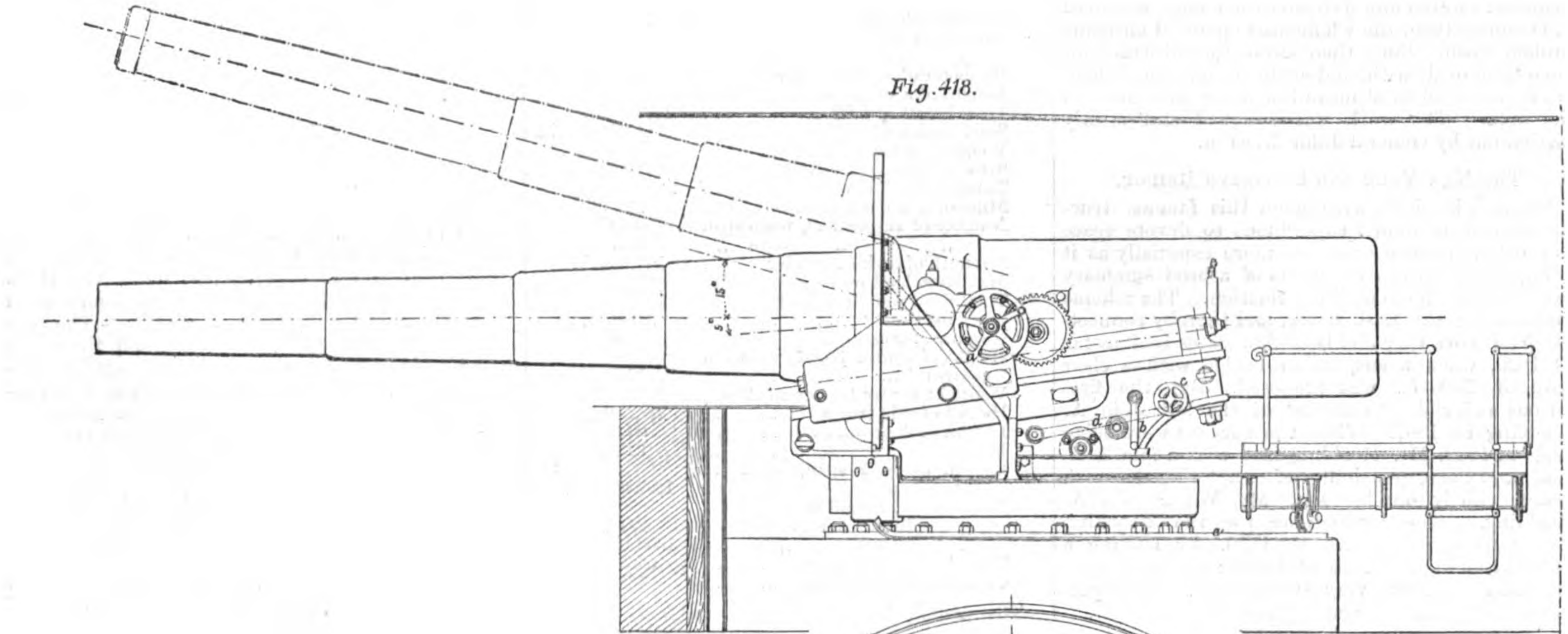


Fig. 420.

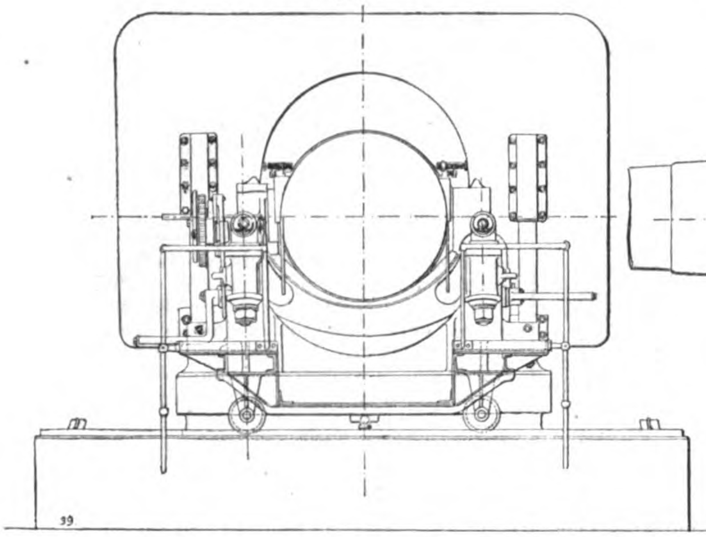
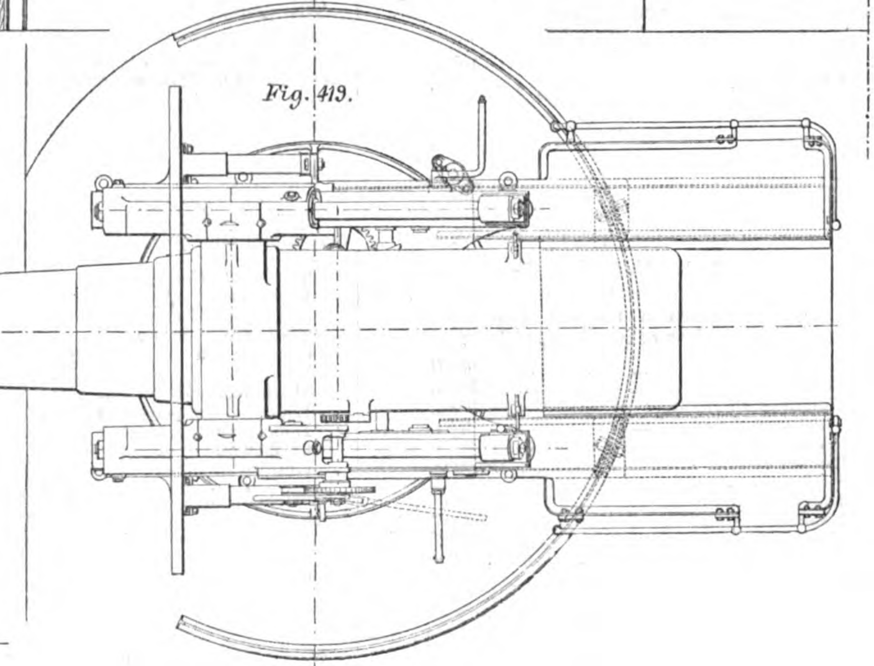


Fig. 419.



latter into firing position, one of the men turns a small handwheel placed on the left side of the underframe, and which by transmitting gear opens or closes a valve made in the valve-box, and the function of which is to put the auxiliary cylinders into communication with the brake cylinders. When the valve is open, the upper carriage tends to run down the slides of the underframe. It forces the liquid which flows out of the auxiliary cylinder back into the brake cylinder, and in this way the gun is run out at a speed which is entirely controlled by the amount of opening which is given to the valve. In order to make this movement automatic it is sufficient to leave the valve open when the gun is fired. The valve is arranged in such a way as to prevent the cylinders from communicating and consequently to prevent the upper carriage from sliding down the underframe in heavy seas.

Training the gun vertically is effected by mechanism similar to that used for the 15-cent. guns and already described. The lateral training is done either by hand or by means of a steam engine. In the former case two levers placed on the side of the under carriage are used; they actuate, through intermediary gearing, a shaft mounted perpendicularly to the sides of the underframe and which traverses it. This shaft acts on the training mechanism and is supported by a special bearing on the turning-plate. The detailed description of this gear will be given further on when we notice another installation of this method of mounting.

The protecting shield, which moves with the carriage, consists of an armour plate in front, cylindrical in form and with vertical sides, the thickness being 50 mill. (1.97 in.); of vertical front shields and of a covering 30 mill. (1.18 in.) thick; the whole of this is made of special steel. The height of the protection above the deck is fixed by the amount of clearance above the firing platform which is necessary for the men serving the gun, to perform the different manœuvres easily. It falls about 25 cent. (10 in.) below the level of the thicker armour-plate, and is continued by ordinary plating as far as the series of U-shaped bars that rest on the moving platform and which carries the shield. The various parts of this protection are connected by T-irons so as to give the amount of stiffness required. To secure the gun it is lowered into a horizontal position, and the bolt that is placed on the left-hand clip is shot into the socket prepared for it on deck.

Table XLIV. gives ballistical data of the 27-cent. gun, the mounting of which we have described, as well as various other calibres of Canet heavy naval guns.

THE IRON AND STEEL INSTITUTE IN AMERICA.

New York, October 3, 1890.

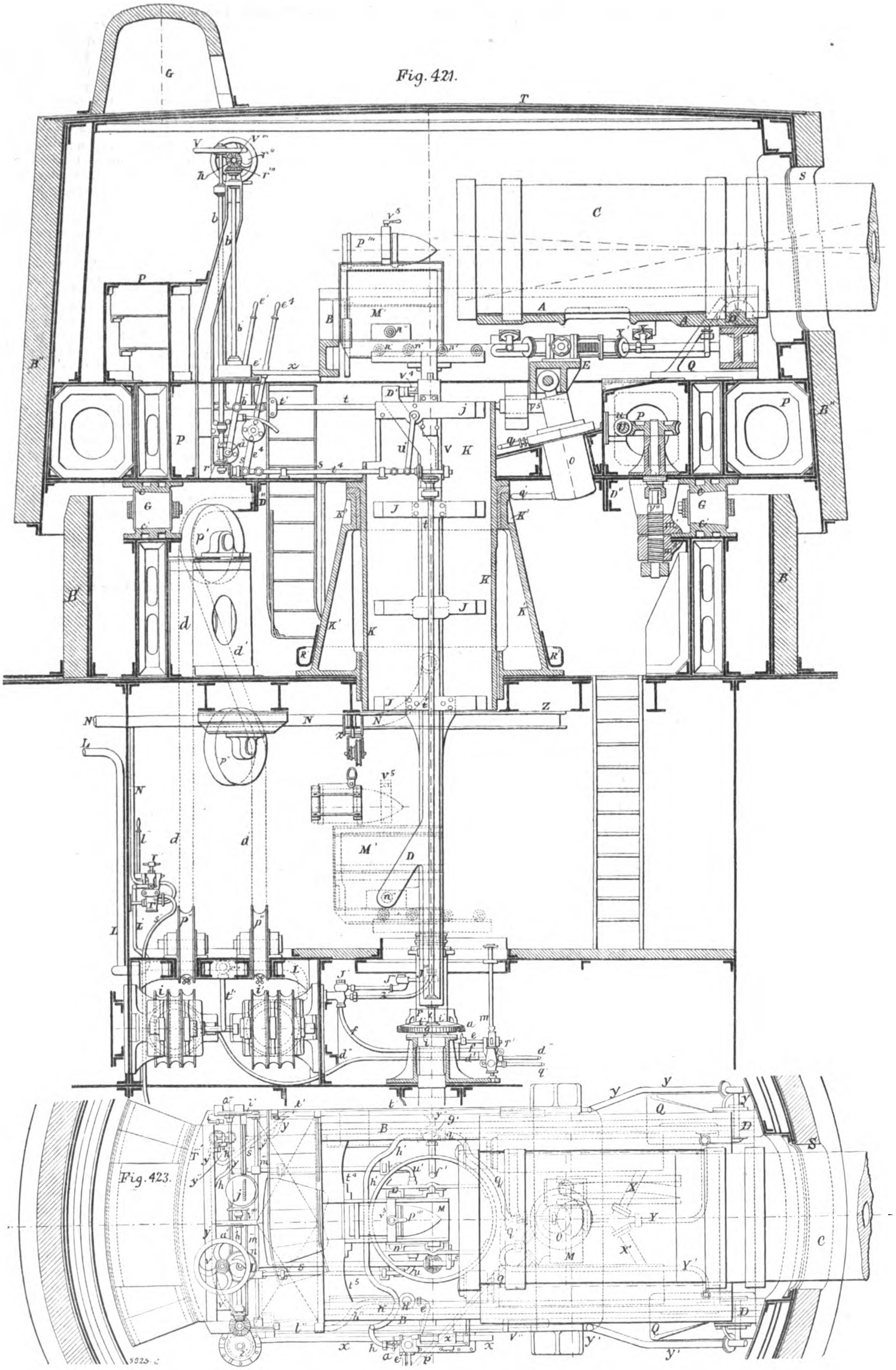
(Continued from page 466.)

Hell Gate.

Excursionists up the East River had an opportunity of passing through the channel where the arm of the sea known as the East River, the Harlem River, and the waters of Long Island Sound meet, and which were formerly known appropriately as Hell Gate. Little but the name now remains, nearly all the rocks once so dangerous to navigation, having been removed. This work of freeing the channel was a very long and arduous one, involving many years of labour and great engineering skill. The place where the obstructions existed is an enlargement of the channel into which the East River flows southward in two branches formed by Blackwell's Island, and by the Harlem River flowing south; to the north-east these combined streams flow off to Long Island Sound. Before work was commenced this enlargement was set thickly with sunken rocks and reefs, among which the currents and tides set fiercely and with disastrous effects to navigation. Work was commenced in 1869 at Hallet's Point, a projection from the main land of Astoria. From the bottom of a shaft sunk 325 ft. from the shore, a number of radiating galleries were driven and 47,500 cubic feet of rock were removed. Into the sides and roofs of these galleries 3700 holes were drilled, 2 in. or 3 in. in diameter, and about 9 ft. deep. No less than 47,680 lb. of dynamite were charged into these holes, and were simultaneously exploded in September, 1874, removing instantaneously the danger to navigation at that particular spot. A large obstruction in the channel known as Flood Rock, was next attacked, the same system being followed. A central shaft was sunk to a depth of 64 ft. below tide and radial and connecting galleries

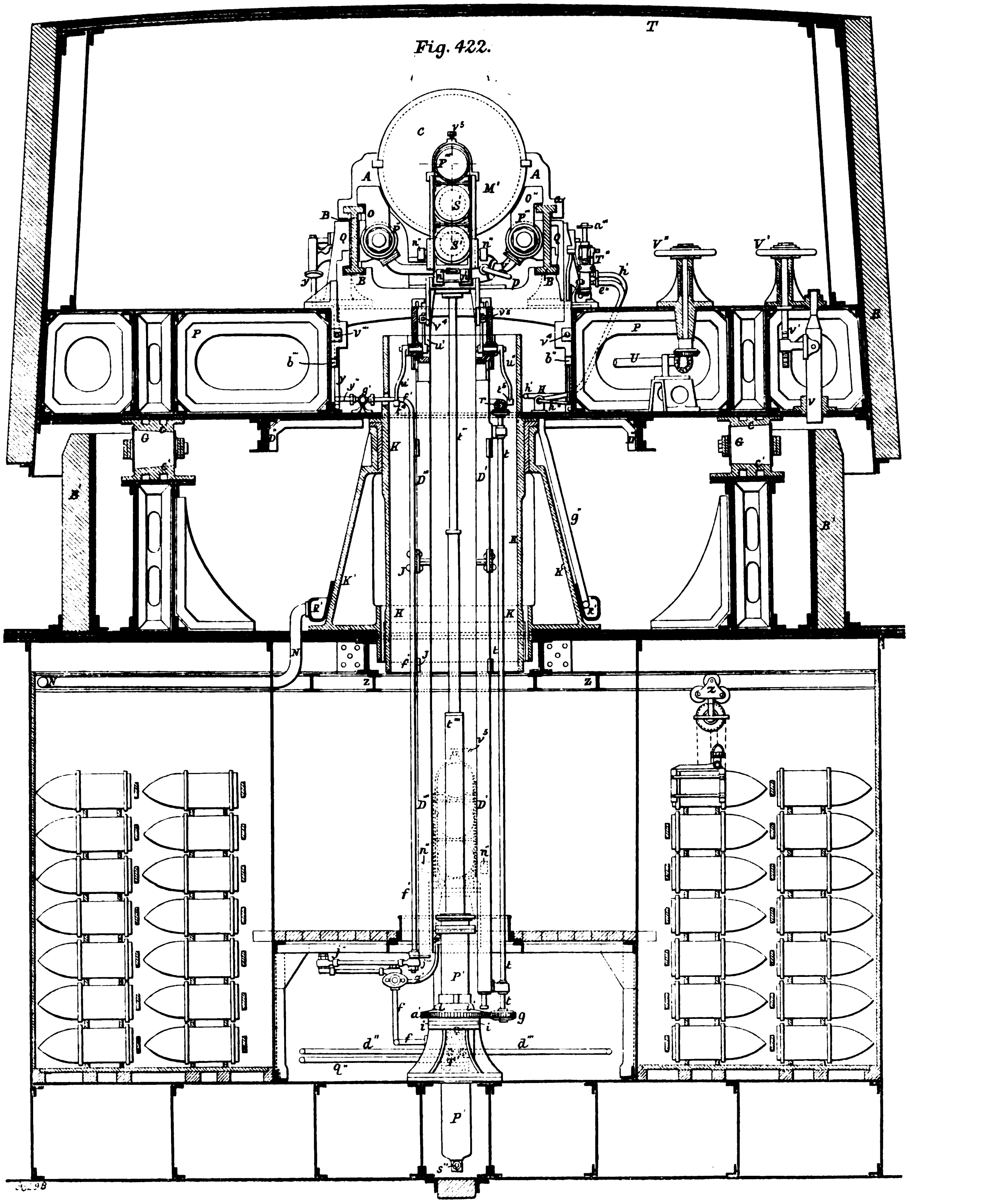
GUN MOUNTING AND TRAINING MACHINERY; FRENCH TURRET SHIP "ACHÉRON."

(*For Description, see Page* 511.)



GUN MOUNTING AND TRAINING MACHINERY; FRENCH TURRET SHIP "ACHÉRON."

(*For Description, see Page* 511.)



	ft.
Height of Auditorium Tower	270
„ Board of Trade Tower balcony	227
„ Grand Central Passenger Station Tower	200
Height of Owings Buildings (fourteen stories)	158
Height of Chamber of Commerce building	200
„ Tacoma building	164
„ Rookery building	159
„ Pullman building	140

Messrs. Adler and Sullivan are the engineers and architects of the building. To the latter is due all the beautiful and daring decoration, and to the former the bold engineering details and the admirable hydraulic and other mechanical arrangements of the theatre.

The New Sanitary Scheme for Chicago.

Very important works for improving the sanitary condition of Chicago are now in progress, and will be explained to the visitors. These works are rendered advisable, not on account of immediate necessities, but in view of the constant growth of the city. They include, moreover, a project of great magnitude for giving Chicago a waterway to the Gulf of Mexico. Under a law passed by the last Legislature of Illinois, the territory included in and about Chicago has been organised into a corporation called the Sanitary District of Chicago, with power to issue some fifteen millions in bonds and to make an annual tax levy of something over one million dollars for the purpose of disposing of the sewage of the city and its environs, and incidentally to create a waterway from Lake Michigan for some 43 miles ; this waterway is to be part of the through route to the Mississippi, such as it is assumed that the State and the nation will assist in completing.

Chicago is situated on a very low site, but a few feet above the level of the lake. When the city began to grow, and as early as 1856, Mr. E. S. Chesbrough was employed to provide a system of

COAST DEFENCE CARRIAGES, CANET SYSTEM, FOR 27-CENT. GUN OF 30 CALIBRES.

CONSTRUCTED BY THE FORGES ET CHANTIERS DE LA MEDITERRANÉE, HAVRE.

(*For Description, see Page* 566.)

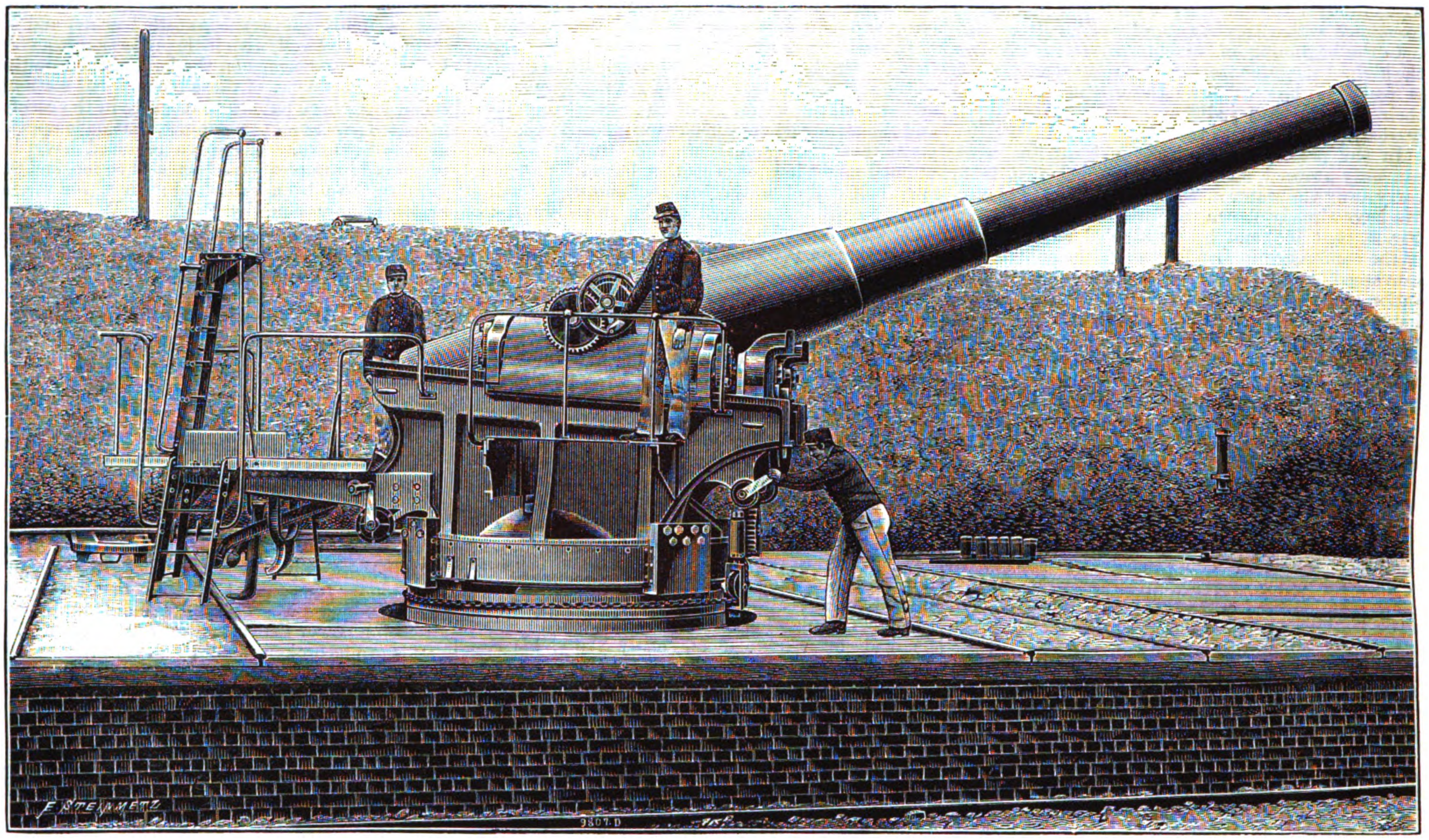
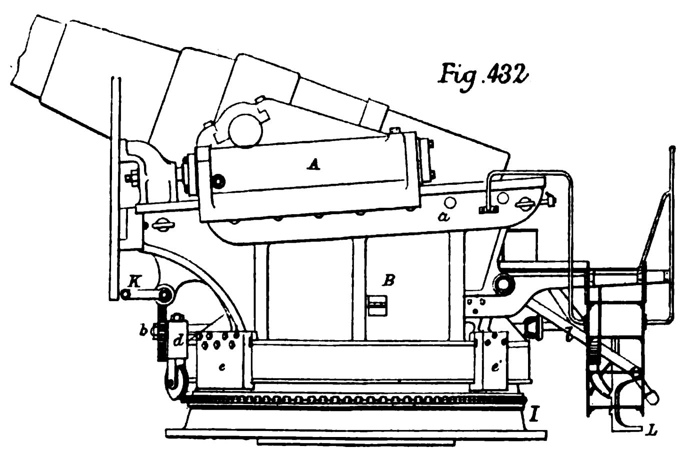
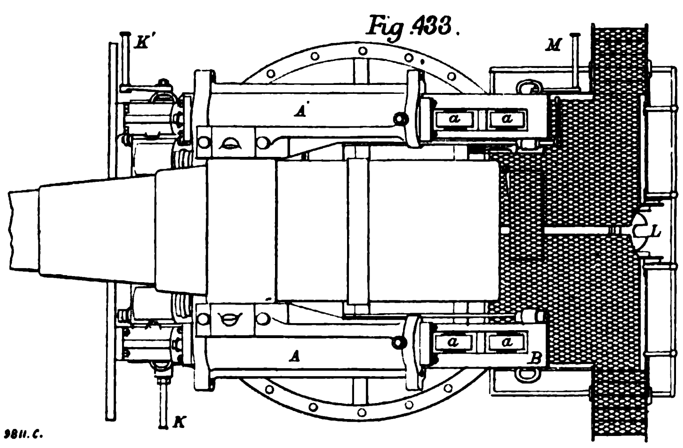
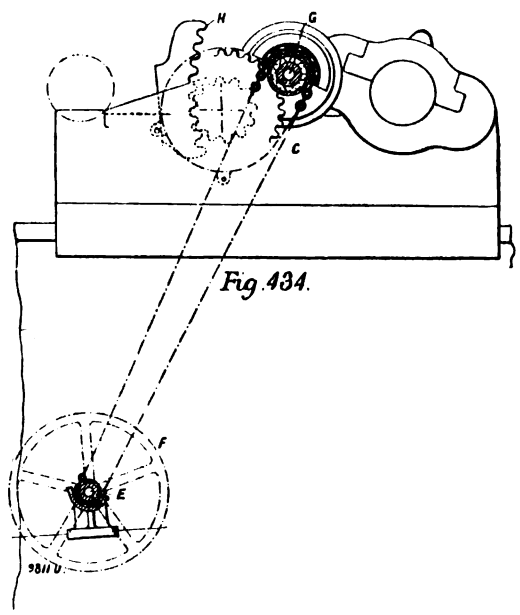


Fig. 430.







cuts of the borings already published in Engineering, it will be seen that below 40 ft. water was found at only one place in the several borings. It is the great solidity and freedom from fissures that is evident in the exposed rocks along the lower river that has been corroborated by the borings. The second danger, moisture in sides passing into cracks and causing falls, suggests the remark that no one can tell in advance just what will be found in the process of driving the tunnel. The strata lie like the leaves of a book in this place, sloping slightly towards the south, but so little as to be practically level. The wells sunk above, and the borings recently made at the face of the cliff and at the 6700 ft. point, also on the Quay lot near the present Hydraulic Canal, agree in the main features. There are layers of limestone interspersed with some thin seams of the so-called shale, but this mineral is persistently named 'slate' in the report of the chief engineer at Niagara.

"The tunnel, as designed, will not lie wholly in this stone, but will in all probability pass through the strata and for some distance only be wholly in this argillaceous limestone, which I consider a more correct designation than the word 'shale.' True shales are said to be made up of the finest rounded particles and contain very few flattened particles such as occur in slate, and define the lines of cleavage. All sedimentary rocks differ in their physical qualities and durability when exposed to air, moisture, and frost.

"The pages of the book of the rocks in this locality

COAST DEFENCE CARRIAGES, CANET SYSTEM, FOR 27-CENT. AND 30-CENT. GUNS.

CONSTRUCTED BY THE FORGES ET CHANTIERS DE LA MEDITERRANÉE, HAVRE.

(*For Description, see Page* 566.)

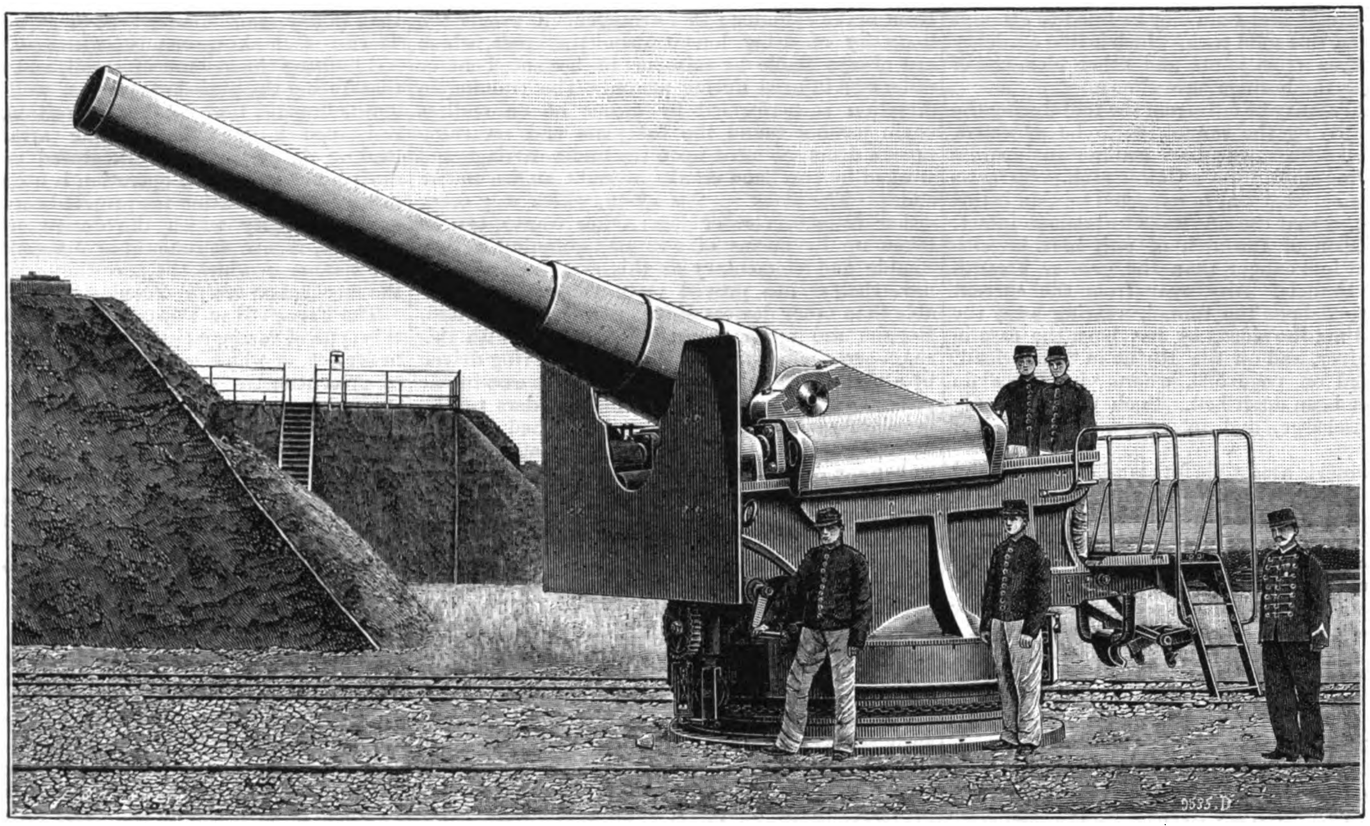


Fig. 428.

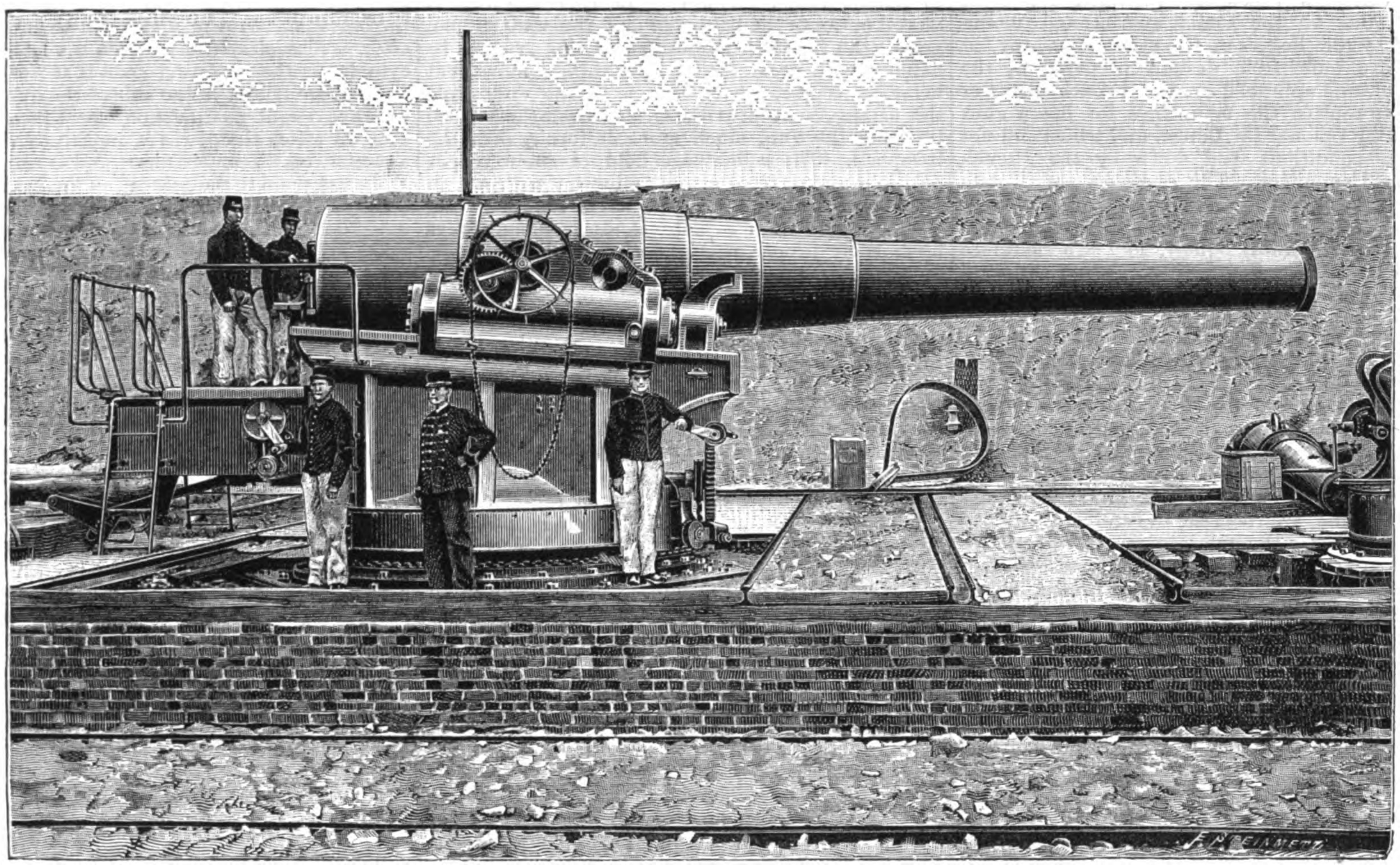


Fig. 429.

have not been dog-eared or crumpled up, as they have been in other places, by great convulsions of nature, and in this book the name shale occurs in the chapters devoted to the triassic, carboniferous, devonian, and down as low as the silurian, where the Niagara shale lies over the sandstone and under the limestone that are below the Onandaga salt group.

"Among the primary rocks the shales, as a recent writer has said, have been cooked, while in the secondary rocks at Niagara, the slates and shales have been compacted by long pressure, and not burned. If all known shales were as solid and compact as the so-called Niagara shale—this argillaceous limestone under consideration—they would not be dreaded by engineers, who know to their cost that some very solid shales are met with that give them trouble in tunnel driving. It was with knowledge of this fact that I did most unhesitatingly assert, and still maintain, that this rock, as placed by nature at Niagara, is better unlined for tunnel purposes, than any artificial lining man can build; and if steel plates were rivetted to form a lining, who can tell how long they would last when exposed to air and moisture and the chemical action of minerals surrounding the metal lining? I have known wrought-iron pipes laid underground and kept full of water, to rust out in ten years, and have no faith in rolled steel that cannot be protected by paint from time to time, being continuously durable.

"The perpendicular walls that bound the Lower Niagara River bear evidence of how well this natural masonry stands as compared to any work of human hands, and I am not inclined to attempt improving on this solid rock, which is like a mighty monolith, free from joints and other elements of weakness, as the borings have shown.

"That there may be falls from the roof during the process of driving the tunnel, is to be expected, but the rocks lie in the best manner to insure a speedy keying-up to form a Gothic arch. So far as one can foresee, what may be expected to occur in this rock tunnel, is that the side walls will remain intact. The small span of the arch of only 18 ft. breadth will present less danger than the greater breadth of railway tunnels. Any wear from the current will tend to deepen the tunnel, wearing away the bottom and not the sides, as has been the case in the lower river, and on the Rhône in Switzerland, as mentioned on page 535, where 'La Perte du Rhône' has been described. Such wear will only facilitate discharge, and introduce no element of danger.

"The tunnel is accessible for its whole length, and can be controlled so as to insure its running full of water if such is found desirable. Frost is excluded *in toto*, and no current of cold air can enter. If springs are met with, they will be allowed room for free discharge. Possibility of access to the tunnel was what governed the location of the mouth; but for this reason the tunnel might have been driven at a lower level to insure its being always full of water. At times, the lower river is known to rise from 10 ft. to even 20 ft. above mean water level, when for short periods of time it will be immersed for a greater length."

MODERN FRENCH ARTILLERY.
No. XLII.

Coast Gun Carriages with Hydraulic Brakes.

The carriages especially intended for coast defence guns on the Canet system and manufactured by the Forges et Chantiers Company, at Havre, are built from designs prepared at the request of, and approved by, the French Minister of War, to replace the mountings for heavy guns proposed by Colonel De Bange, and which did not fulfil the conditions laid down by the French Ordnance Committee. The carriages are of two classes, those of cast iron, which are much cheaper and heavier, and those of steel, which are more costly but considerably lighter, and are therefore transported with greater facility. These carriages consist of three distinct parts; the carriage properly so called, to which the gun is connected by its trunnions, and which carries the hydraulic brake cylinders, as well as the mechanism for training the gun for elevation; this part of the mounting is free to move to and fro upon the slides of the underframe. The bottom of the underframe has approximately a spherical form; the base is cylindrical and rests upon a roller ring; the two slides which are cast in one piece with the vertical sides above the dome, are recessed to receive a series of rollers upon which the carriage moves to and fro, and they are tied together by strong cross-bracing. Both in the front and in the rear of the underframe, suitable transverse plates are introduced to give the mounting ample stability. The baseplate carries the central pivot around which the underframe revolves, as well as the path for the rollers that support it. The hydraulic brakes are constructed on the Canet system with the central counter-rod in each cylinder, so that during recoil the variations of the energy imparted to the gun after it has been fired, are allowed for. By this arrangement the brake exerts a constant resisting force during the whole period of recoil, and thus reduces the strain thrown upon the mounting. As soon as the recoil is complete the gun returns to firing position by its own gravity, running down the slides of the underframe on the rollers upon the carriage; a special arrangement of the brake mechanism permits the latter to operate during the return of the gun to firing position as well as during recoil; by this means the gun can be traversed forward upon its slides as slowly as may be desired, or as rapidly as is consistent with the avoidance of shock to the mounting. Training for elevation is effected by means of toothed gearing and a sector attached to the gun; but on account of the heavy weights to be dealt with, a special apparatus is provided with eccentric rollers in place of endless screws; by this device the effort required for raising the gun is considerably reduced, and the rapidity of handling is increased. The controlling handwheel is mounted on the left-hand brake cylinder; this arrangement avoids the necessity of using long transmitting rods, which are always liable to seize or to become bent or otherwise injured during action. The training in direction is performed by means of an endless chain passing round the baseplate and returning upon a drum mounted upon the under-carriage and worked by two hand cranks at right angles to the slides. The slack in this chain, which may occur either from service or from other causes, can be taken up by means of a screw-tightening device. Simple and elementary as this arrangement is, it nevertheless has proved more efficient and reliable than other devices which are more complicated. Repairs are much more easily effected with this chain arrangement than with a toothed ring driven by a pinion, especially when this ring is cast in one piece with the underframe, which renders repairs in place almost impossible. A toothed ring is, moreover, almost certain to rust up, or at all events to become choked with sand and dirt during action, which causes considerable trouble and hardness in working for lateral training. The operation of loading is effected by means of a tray hung to an arm supported by a horizontal shaft perpendicular to the slides, and by a cam around which a chain is passed acting upon a spring device. In order to make the work upon the handle operating this mechanism uniform, the apparatus is arranged in such a way that the springs are compressed when the tray is lowered empty, while when it is raised loaded with the projectile and cartridge, the same springs give out the energy that was stored up in them, and so reduce the work to the man handling the projectiles. The latter are brought to the gun in a barrow of a special form from which they can be delivered direct upon the tray or holder without the men serving the gun having the trouble to handle them. The ring of rollers, which is placed between the baseplate and the underframe, permit the heaviest mountings of this type to be handled with great facility, the rolling movement being, of course, easier than a sliding one, while this arrangement distributes the strains produced by firing the gun, much more uniformly over the baseplate. The rollers are held in their proper positions and at fixed distances by the two rings in which they are mounted, and a rib raised around the edge of the baseplate confines them always upon their proper path, so that the underframe always rests upon them with an equally distributed weight; the rollers are covered in with a guard that can be easily removed for the purpose of inspection and cleaning. Moreover, the rollers themselves can be taken out and examined one by one; a division is formed at one part of the circular baseplate, leaving a gap, which is filled up by a removable packing piece, the upper face of which forms a continuation of the baseplate. When it is desired to inspect the rollers, this packing piece is taken out, and the carriage is moved round until a roller passes over the gap into which it falls, and from which it can be easily removed for examination or exchange.

The man training the gun, as well as the other numbers, occupy the platform on the frame at the rear of the gun; in some cases where considerable depression is required, the training number mounts to the small platform approached by a ladder at the back of the main platform.

The advantages claimed for this type of carriage by the Forges et Chantiers are as follows: 1. The adoption of a heavy baseplate in a single piece upon which the whole weight of the gun and mounting are supported; by means of this self-contained arrangement the gun can be always operated easily, even if the foundation on which the base rests should settle. 2. An underframe formed of two parallel sides in one piece with the spherical casting, resting upon the roller ring, over which all weights and pressures are uniformly distributed. 3. The use of a ring of rollers, which reduces the labour of rotating the carriage and distributes the weights uniformly over the baseplate. 4. The use of an endless chain for training the gun horizontally; this very simple device is easily repaired, and, taken in connection with the roller ring, forms a means of rapid and very useful manœuvring. 5. The carriage on which the gun rests is very low, and the brake cylinders mounted upon it are so arranged that the effort of recoil exerts a minimum strain tending to upset the gun. It is stated that the arm of the lever of this reversing couple, which is measured by the distance from the axis of the brake cylinders to that of the trunnions, is smaller than in any other similar type of gun carriage. 6. The use of a brake mechanism with a central counter-rod limiting the amount of recoil, and so arranged that during the period of recoil, as well as when the gun is brought back into firing position, a constant resistance is offered. 7. The arrangement of loading, by which the work stored up in springs during one part of the operation is utilised to assist subsequently in lifting the projectile and cartridges. 8. The facility which the design offers for inspection, repair, or renewal of different parts, and the manner in which the most important details of the mechanism are protected.

The French War Department is so satisfied with this type of carriage that it has about 100 of them in service, of which more than 70 are for coast guns of 27 centimetres (10.63 in.). Before committing itself so far to this type of mounting, the French Government subjected a trial carriage to very exhaustive experiments; these having proved satisfactory, a second type was made and tested, and it was upon the result of these trials that large and permanent orders had been given. Before acceptance, every carriage has to be tested by fifty rounds at battering charges fired from a gun corresponding in calibre to the type of carriage, and elevated at extreme angles. The various illustrations, Figs. 428 to 434, pages 564, 565, and 568, illustrate clearly this type of mounting. Fig. 431 is a perspective view of a 32-centimetre gun and coast carriage, and Figs. 428, 429, and 430 are similar views of mountings for 27-centimetre guns. Figs. 432 and 433 show clearly the principal details. Beneath the platform at the end is the projectile crane worked by the man at the left-hand side, who turns the crank that raises or lowers the crane. The latter operation compresses the springs as explained above. At the rear of the platform is an elevated station for the look-out to direct the number training the gun, and the breech mechanism, which will be described hereafter, is also clearly seen. On the left-hand brake cylinder is the elevating gear that works into the toothed arc bolted to the side of the gun. Fig. 434 shows a slight modification introduced into this gear, in which the power is applied to a handwheel mounted on the underframe, and is transmitted by a pitched chain to the gearing on the brake cylinder. In Figs. 432 and 433, A A are the brake cylinders, *a a* the rollers on which the upper carriage takes its bearings; M is the handle for working the projectile crane, and K and K^1 are those for horizontal training; *e* and e^1 are the clips for holding down the underframe to the baseplate, and L is the bracket on which the projectile is placed. Fig. 432 also shows the mode of turning the gun and carriage on its central pivot.

A good example of this mode of mounting heavy guns for coast defence was shown in the Pavilion of the Minister of War last year at the Paris Exhibition; it could be manœuvred with one hand. Several of the same type have resisted 200 rounds at full charges without sustaining any injury. The Japanese Government has adopted this type as their standard for coast defence purposes, partly on account of the facilities it offers for relatively large angles of depression; the elevated coast line of Japan rendering this mode of firing necessary. All of these mountings are protected by steel shields, not shown in the illustrations. Tables XLVII., XLVIII., and XLIX. contain particulars of the ballistic characteristics of Canet naval guns of various calibres.

SUBMARINE MINES.

Critique on Major G. S. Clarke's Paper on "Submarine Mines in relation to War."

By Lieut.-Colonel J. T. Bucknill, late Major R.E.

Not long ago Major G. S. Clarke, C.M.G., R.E., delivered two lectures on the above subject at the Royal Artillery Institution, Woolwich. He states that the aim of the lectures was to raise discussion on the various points; and, inasmuch as these form the most severe attack ever yet delivered against the utility of submarine mines, it is peculiar that so appreciative an audience should have been selected, and that those most interested should have found it almost impossible to obtain a

TABLE XLVII.—FORGES ET CHANTIERS DE LA MEDITERRANÉE. PRINCIPAL PARTICULARS OF CANET NAVAL GUNS.

Nature of Gun.	Calibres.	Total Length.		Length of Bore.		Diameter of Chamber.		Length of Rifling.		Number of Grooves.	Angle of Rifling.	Weight of Gun.		Weight of Shell.		Weight of Charge.		Muzzle Velocity.		Striking Energy.		Penetration in Wrought Iron.		Maximum Range.	
		mm	in.	mm	in.	mm.	in.	mm	in.			kls.	lb.	kilos.	lb.	kilos.	lb.	m.	ft.	m. tons	ft.-tons	cm.	in.	metres	yards
9 cm. gun ..	25	2250	**88.58**	2068	**81.42**	98	**3.86**	1665	**65.55**	28	Uniform rifling at 6 deg.	750	**1650**	9	**19.8**	3.1	**6.82**	540	**1772**	133.76	**431**	11.0	**4.32**	9,280	**10,150**
Ditto	30	2700	**106.30**	2503	**98.55**	102	**4.01**	2080	**81.89**	28		1030	**2266**	9	**19.8**	3.9	**8.58**	610	**2001**	170.69	**551.2**	13.1	**5.15**	10,370	**11,340**
Ditto	36	3240	**127.56**	3043	**119.76**	106	**4.17**	2525	**99.41**	28		1180	**2596**	9	**19.8**	4.8	**10.56**	680	**2231**	212.11	**685**	15.3	**6.02**	10,880	**11,898**
Ditto	43	3870	**152.37**	3658	**144.01**	110	**4.33**	3135	**123.42**	28		1520	**3314**	9	**19.8**	5.6	**12.32**	740	**2428**	251.19	**811.5**	17.3	**6.80**	11,435	**12,505**
Ditto	50	4500	ft. in. **14 9**	4288	ft. in. **14 0.8**	114	**4.43**	3685	**145.08**	28		1800	**3960**	9	**19.8**	6.4	**14.08**	800	**2625**	293.58	**948.5**	19.3	**7.59**	11,725	**12,821**
10 cm. gun..	25	2500	in. **98.43**	2303	in. **90.67**	108	**4.25**	1850	**72.84**	30		1030	**2266**	12.5	**27.5**	4.300	**9.46**	540	**1772**	185.78	**583.0**	13.2	**5.19**	10,765	**11,772**
Ditto	30	3000	**118.11**	2788	**99.77**	112	**4.40**	2310	**90.94**	30		1420	**3124**	12.5	**27.5**	5.400	**11.88**	610	**2001**	237.07	**765.3**	15.7	**6.17**	12,140	**13,277**
Ditto	36	3600	**141.73**	3388	**133 39**	116	**4.56**	2805	**110.44**	30		1620	**3564**	12.5	**27.5**	6.600	**14.52**	680	**2231**	294.59	**590.8**	18.3	**7.20**	13,010	**14,228**
Ditto	43	4300	ft. in. **14 13**	4072	ft. in. **13 4.34**	120	**4.72**	3485	ft. in. **13 7.21**	30		2080	**4576**	12.5	**27.5**	7.800	**17.16**	740	**2428**	348.88	**665.0**	20.6	**8.11**	13,635	**14,911**
Ditto	50	5000	**16 48**	4772	**15 7.87**	124	**4.87**	4095	**13 5.22**	30		2460	**5412**	12.5	**27.5**	9.000	**19.8**	800	**2625**	407.75	**1316.4**	23.1	**9.09**	16,165	**17,679**
12 cm. gun..	25	3000	in. **118.11**	2772	in. **109.13**	128	**5.03**	2220	in. **87.40**	36		1780	**3916**	21	**46.2**	7.200	**15.84**	540	**1772**	312.00	**1007.3**	16.5	**6.49**	11,085	**12,121**
Ditto	30	3600	**141.70**	3350	**131.89**	134	**5.27**	2770	**109.06**	36		2450	**5390**	21	**46.2**	9.000	**19.8**	610	**2001**	398.15	**1285.5**	19.7	**7.75**	12,540	**13,713**
Ditto	36	4320	ft. in. **14 2**	4070	ft. in. **13 4.24**	140	**5.51**	3365	ft. in. **132 43**	36		2800	**6160**	21	**46.2**	11.000	**24.2**	680	**2231**	494.77	**1597.4**	23.0	**9.05**	13,465	**14,724**
Ditto	43	5160	**16 11**	4895	**16 0.72**	146	**5.74**	4180	**13 8.56**	36		3600	**7920**	21	**46.2**	13.000	**28.6**	740	**2428**	585.93	**1891.6**	25.9	**10.19**	14,130	**15,451**
Ditto	50	6000	**19 8.2**	5735	**18 9.79**	152	**5.98**	4910	**16 1.30**	36		4250	**9350**	21	**46.2**	15,000	**33.0**	800	**2625**	684.80	**2211.0**	28.9	**11.37**	14,705	**16,080**

TABLE XLVIII.—FORGES ET CHANTIERS DE LA MEDITERRANÉE. PRINCIPAL PARTICULARS OF CANET NAVAL GUNS.

Nature of Gun.	Calibres.	Total Length.		Length of Bore.		Diameter of Chamber.		Length of Rifling.		Number of Grooves.	Angle of Rifling.	Weight of Gun.		Weight of Shell.		Weight of Charge.		Muzzle Velocity.		Striking Energy.		Penetration in Wrought Iron.		Maximum Range.	
		in.	mm.	in.	mm.	in.	mm.	in.	mm.			lb.	kilos.	lb.	kils.	lb.	kils.	ft.	m.	ft.-tons	m. tons	in.	cm.	yards	metres
19 cm. gun	25	**179.9**	4,750	**173.4**	4,404	**8.03**	204	**138.4**	3515	58	Uniform rifling at 6 deg.	**15,542**	7,050	**185.2**	84	**63.93**	29	**1771**	540	**4031**	1248.43	**12.6**	32	**13,376**	12,230
Ditto	30	**224.5**	5,700	**209.7**	5,326	**8.34**	212	**172.8**	4390	58		**21,230**	9,630	**185.2**	84	**79.37**	36	**2001**	610	**5143.9**	1593.07	**15.0**	38.1	**15,279**	13,970
Ditto	36	**269.3**	6,840	**254.6**	6,466	**8.66**	220	**209.9**	5330	58		**25,310**	11,480	**185.2**	84	**99.21**	45	**2231**	680	**6391.8**	1979.7	**17.48**	44.4	**16,551**	15,135
Ditto	43	**321.7**	8,170	**306.2**	7,778	**8.97**	228	**260.6**	6620	58		**34,060**	15,450	**185.2**	84	**114.6**	52	**2428**	740	**7569.6**	2344.44	**19.69**	50.0	**17,477**	15,980
Ditto	50	**374.0**	9,500	**358.6**	9,108	**9.29**	236	**306.3**	7780	58		**38,294**	17,370	**185.2**	84	**132.3**	60	**2625**	800	**8846.5**	2740.03	**22.09**	56.1	**18,275**	16,710
22 cm. gun	25	**216.6**	5,500	**201.1**	5,108	**9.29**	236	**160.3**	4070	66		**24,140**	10,950	**286.6**	130	**97.0**	44	**1771**	540	**6238.1**	1932.1	**15.47**	39.3	**14,328**	13,100
Ditto	30	**259.8**	6,600	**243.0**	6,172	**9.60**	244	**200.0**	5080	66		**33,069**	15,000	**286.6**	130	**123.4**	56	**2001**	610	**7960.0**	2465.5	**18.43**	46.8	**16,431**	15,025
Ditto	36	**311.8**	7,920	**295.0**	7,492	**9.92**	252	**242.9**	6170	66		**39,242**	17,800	**286.6**	130	**152.2**	69	**2231**	680	**9,891**	3063.8	**21.50**	54.6	**17,658**	16,145
Ditto	43	**372.4**	9,460	**354.3**	9,000	**10.23**	260	**301.8**	7635	66		**52,910**	24,000	**286.6**	130	**176.4**	80	**2428**	740	**11,715**	3628.3	**24.25**	61.6	**18,988**	17,370
Ditto	50	**433.0**	11,000	**415.0**	10,540	**10.55**	268	**354.8**	9010	66		**59,523**	27,000	**286.6**	130	**202.8**	92	**2625**	800	**13,812**	4280.6	**27.12**	68.9	**19,927**	18,220
24 cm. gun	25	**236.2**	6,000	**219.4**	5,572	**10.03**	256	**174.8**	4440	72		**31,302**	14,200	**374.8**	170	**127.9**	58	**1771**	540	**8,157**	2526.6	**17.60**	44.7	**14,637**	13,385
Ditto	30	**283.5**	7,200	**265.4**	6,740	**10.39**	264	**218.1**	5540	72		**42,769**	19,400	**374.8**	170	**160.9**	73	**2001**	610	**10,410**	3224.1	**20.95**	53.2	**16,897**	15,450
Ditto	36	**340.2**	8,640	**322.1**	8,180	**10.71**	272	**265.0**	6730	72		**50,706**	23,000	**374.8**	170	**198.4**	90	**2231**	680	**12,935**	4006.5	**24.45**	62.1	**18,460**	16,880
Ditto	43	**406.4**	10,320	**386.6**	9,820	**11.02**	280	**329.2**	8360	72		**68,560**	31,100	**374.8**	170	**231.5**	105	**2428**	740	**15,390**	4744.8	**27.28**	69.3	**19,625**	17,945
Ditto	50	**472.0**	12,000	**452.8**	11,500	**11.34**	288	**386.7**	9820	72		**77,160**	35,000	**374.8**	170	**266.7**	121	**2625**	800	**17,903**	5545.3	**30.43**	77.3	**20,641**	18,875

TABLE XLIX.—FORGES ET CHANTIERS DE LA MEDITERRANÉE. PRINCIPAL PARTICULARS OF CANET NAVAL GUNS.

Nature of Gun.	Calibres.	Length in Calibres.	Total Length.		Length of Bore		Diameter of Chamber.		Length of Rifling.		Number of Grooves.	Angle of Rifling.	Weight of Gun.		Weight of Shell.		Weight of Charge.		Muzzle Velocity.		Muzzle Energy.		Penetration in Wrought Iron.		Maximum Range.	
	in.		in.	mm	in.	mm	in.	mm	in.	mm			lb.	kilos.	lb.	kilos.	lb.	kilos.	ft.	m.	ft.-tons	m. tons	in.	cm.	yards	m.
14-cm. gun ..	**5.51**	25	**137.8**	3500	**127.4**	3235	**5.90**	150	**101.9**	2590	42	Uniform rifling at 6 deg.	**6,217**	2,820	**74.95**	34	**25.57**	11.6	**1771**	540	**1631.5**	505.31	**8.19**	20.8	**12,659**	11,575
Ditto ..	**5.51**	30	**165.4**	4200	**154.1**	3915	**6.14**	156	**127.4**	3235	42		**8,576**	3,890	**74.95**	34	**33.06**	15	**2001**	610	**2081.9**	644.81	**9.76**	24.8	**14,409**	13,175
Ditto ..	**5.51**	36	**198.1**	5040	**187.2**	4755	**6.47**	162	**154.5**	3925	42		**9,810**	4,450	**74.95**	34	**39.68**	18	**2231**	680	**2587.1**	801.29	**11.41**	29.0	**15,495**	14,170
Ditto ..	**5.51**	43	**237.0**	6020	**225.1**	5716	**6.61**	168	**192.2**	4880	42		**12,566**	5,700	**74.95**	34	**46.29**	21	**2428**	740	**3063.8**	948.94	**12.87**	32.7	**16,344**	14,945
Ditto ..	**5.51**	50	**275.6**	7000	**263.6**	6696	**6.84**	174	**225.6**	5730	42		**14,881**	6,750	**74.95**	34	**52.91**	24	**2625**	800	**3580.9**	1109.06	**14.41**	36.6	**16,968**	15,515
15-cm. gun ..	**5.90**	25	**147.6**	3750	**144.4**	3665	**6.37**	162	**109.2**	2775	46		**7,650**	3,470	**92.59**	42	**31.53**	14.3	**1771**	540	**2015.3**	624.22	**9.09**	23.1	**12,780**	11,685
Ditto ..	**5.90**	30	**177.2**	4500	**165.2**	4196	**6.61**	168	**136.4**	3465	46		**10,472**	4,750	**92.59**	42	**39.68**	18	**2001**	610	**2371.6**	796.5	**10.82**	27.5	**14,562**	13,315
Ditto ..	**5.90**	36	**212.7**	5400	**200.6**	5096	**6.84**	174	**165.6**	4205	46		**12,566**	5,700	**92.59**	42	**48.50**	22	**2231**	680	**3195.9**	989.85	**12.64**	32.1	**15,873**	14,515
Ditto ..	**5.90**	43	**253.9**	6450	**241.1**	6125	**7.08**	180	**205.7**	5225	46		**16,755**	7,600	**92.59**	42	**57.32**	26	**2428**	740	**3785.0**	1172.3	**14.29**	36.3	**16,541**	15,125
Ditto ..	**5.90**	50	**295.3**	7500	**282.5**	7175	**7.32**	186	**241.7**	6140	46		**18,849**	8,550	**92.59**	42	**66.14**	30	**2625**	800	**4423.6**	1370	**15.55**	39.5	**17,269**	15,790
16-cm. gun ..	**6.29**	25	**157.5**	4000	**145.5**	3696	**6.84**	174	**116.4**	2960	48		**9,259**	4,200	**110.23**	50	**37.48**	17	**1771**	540	**2398.8**	742.99	**9.80**	24.9	**12,570**	11,495
Ditto ..	**6.29**	30	**189.0**	4800	**176.2**	4475	**7.08**	180	**145.5**	3695	48		**12,675**	5,750	**110.23**	50	**48.50**	22	**2001**	610	**3061.1**	948.11	**11.69**	29.7	**14,276**	13,055
Ditto ..	**6.29**	36	**226.8**	5760	**214.0**	5435	**7.32**	186	**176.6**	4435	48		**15,101**	6,850	**110.23**	50	**59.52**	27	**2231**	680	**3801.0**	1178.3	**13.66**	34.7	**15,371**	14,055
Ditto ..	**6.29**	43	**270.9**	6880	**257.3**	6534	**7.55**	192	**219.5**	5575	48		**20,282**	9,200	**110.23**	50	**68.34**	31	**2428**	740	**4504.8**	1395.28	**15.39**	39.1	**16,176**	14,790
Ditto ..	**6.29**	50	**315.0**	8000	**301.4**	7654	**7.79**	198	**257.9**	6550	48		**22,883**	10,380	**110.23**	50	**79.36**	36	**2625**	800	**5264.9**	1630.72	**17.21**	43.7	**16,858**	15,415

printed copy of the lectures afterwards. When obtained no record is discovered of the proceedings; and the discussion, said to be invited, is conspicuous by its absence. Had Major Clarke read his papers either at the Royal United Institution or at Chatham, he might have relied on plenty of criticism from many of his brother officers, his own corps being principally connected with the subject he examines. He commences with some frivolity about an Emperor's clothes which, according to a tale by Hans Anderson, were non-existent. He likens these clothes to submarine mines, yet the rest of his attack is a laboured attempt to prove that the mines are too existent. If there be any bottom to the analogy, then the "faithful old ministers," who reported mendaciously in order to conceal their own ignorance, must be intended to apply to those distinguished officers who have successively directed our expenditure on coast defences for the past twenty years. If Major Clarke be right, they were all wrong; as also all similar authorities in other nations where submarine mines and the *personnel* for laying them have been provided at great cost and trouble. True it is that a distinction is drawn between our case and that of nations not possessing an equal naval predominance, but this is the same argument which has recently been launched against harbour defences in general by a few enthusiastic sailors who grudge public expenditure on anything else than the Navy.

When, therefore, Major Clarke would permit the use of sea mines at some of our distant harbours, but fails to see the advantage of their employment as provided for our home stations, he practically places himself in rank with Admiral Colomb, and asserts that the British Empire is car-

COAST DEFENCE CARRIAGE, CANET SYSTEM, FOR 32-CENT. GUN OF 30 CALIBRES.

CONSTRUCTED BY THE FORGES ET CHANTIERS DE LA MEDITERRANÉE, HAVRE.

(*For Description, see Page* 566.)

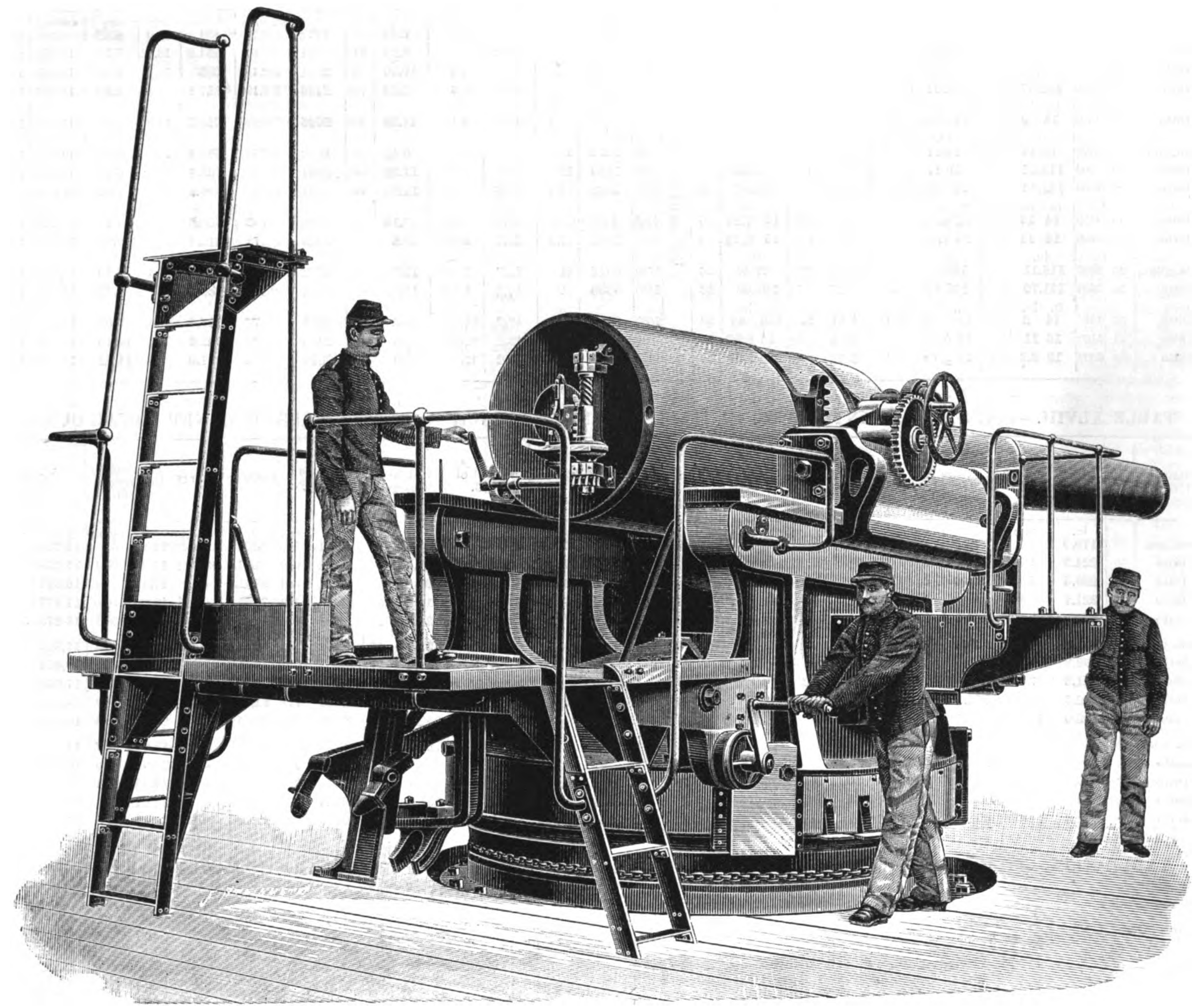


Fig. 431.

ried on her ironclads. And there is much truth in it, but far from the whole truth. Surely every sensible man must see that a good defence should be capable of bringing every available force into array, and should possess several lines, mutually supporting; the whole forming one scheme so harmonious and well organised that a foe in heart may never become one in fact, but give up any idea of attack in despair of final success.

The Navy is our first, foremost, and main line of defence. The strategic harbours are fortified in order to relieve it of responsibility, to increase its mobility, and protect its stores and reserves. The commercial harbours are also fortified to relieve the fleet of much responsibility, by keeping raiding vessels at bay. Such fortifications can scarcely be said to form a second line, for they really form part of the first line—the naval defence—and they also give a power of naval attack at a distance from the base, which might not be possible and would certainly be more hazardous without them.

The land forces, with their magazines in strong places, should form our inner defence.

With regard to harbour defence, the highest authorities have held the opinion for quite twenty years that sea mines are a most useful adjunct to artillery.

This opinion was probably in the first instance based on the results obtained from their use in the American War of Secession, but Major Clarke asserts that the conditions are so unlike those which would obtain if England were engaged in a war, that deductions from it may mislead us, and he considers that "we know exceedingly little of the real value of submarine mining defence, applied to varying conditions. We must take it all on trust." The same remark applies to the 100-ton guns, and to his favourite rapid-firing small calibre guns; also to the Whitehead torpedoes and their boats; and to all those modern inventions which, fortunately for mankind, have been rarely if ever tried in actual warfare on an extended scale.

The value of a weapon for war is usually at present based on the knowledge of two kinds of experts. The one examines the weapon in detail, tries it experimentally, and endeavours to perfect it. The other decides, let us hope logically and sensibly, as to its application. Major Clarke does not attack submarine mines in their detail, but denies the opinions held generally as to their usefulness. He commences by saying that "submarine mining defence may not impossibly assume such inconvenient proportions as will one day cause it to be ruthlessly lopped." As, however, by implication these proportions have not yet been attained, our submarine miners have apparently been reasonable in their demands.* Certainly the more costly portion of our service—the *personnel*—is insufficient to handle and work the mines already provided as expeditiously as other nations consider the work should be done, and our authorities have therefore been economical rather than prodigal in meeting the requirements of the miners and mines. This economy is, perhaps, justifiable in our case, so long as we keep powerful squadrons of armed ships permanently afloat. Major Clarke considers that "all the really important questions connected with submarine mines require expert naval knowledge at every stage of their solution," and he points out that the sea mine systems of France, Germany, Italy, and Austria are now in the hands of their navies. Apparently he advocates this arrangement, although it must be clear to all that the speedy mobilisation of her Navy on the outbreak of hostilities would be of paramount importance to England, and it is openly stated that she possesses or will soon possess more warships than

* General Abbot, U. S. Engineers, says that the "claim of cheapness can certainly be stoutly maintained," and instances that "the U. S. Board of Fortifications or other Defences, recommended a liberal use of this obstruction" (submarine mines) "for their 27 chief ports, and the cost, including the mines, casemates, electric lights, &c., was only 3½ per cent. of the whole outlay required."

missioners are simply an administrative body. Their efforts to manage to the best advantage the property placed under their administration, or even, in an extreme case, to protect this property from commercial failure, may at any time be neutralised, if not made entirely futile, by the workings of the political body. It is alleged that when the Act was drawn appointing the Commissioners it was with the view that the railway estate should be independent of political agitation, or the action of self-interested legislators; in so far as the Commissioners' administration of the system under their control, the foregoing idea has been carried out, saving only the natural pressure, referred to previously, which the community bring to bear. The work of the Commission has up to the present borne good fruit; whether the exigencies of political parties will allow this to continue remains to be seen. For it is ordered thus: When new railways are to be built, it is the Government of the day by their majority—often servile and interested—who decide where they shall go, what districts shall have them, and to what extent the railway estate shall be burdened with properties which may eat up the surplus receipts of necessary and remunerative lines. Justification for such a view lies in the reading of the Act and its practical application.

There are two clauses which refer to the building of new lines; an excerpt from Clause No. 61, dealing with this part of the subject, is as follows:

> The Commissioners shall also construct all lines of railway and works which such Commissioners may be authorised hereafter by any Act or Acts of Parliament so to do.

Clause 79 states:

> Before the second reading in the Legislative Assembly of any Bill authorising the construction of new lines of railway, the Commissioners shall transmit to the minister a statement under their seal, showing their estimate of the cost of constructing each proposed new line, and of the traffic, and other returns likely to be derived therefrom; and the minister shall before such second reading, lay the same upon the table of the Assembly.

The foregoing gives the Commissioners no voice in the matter—they are simply asked for estimates; were they to report favourably or adversely upon the proposal to construct any new line, they would clearly step into a domain which the legislator has reserved entirely for himself.

(*To be continued.*)

MODERN FRENCH ARTILLERY.
No. XLIV.
Cast-Iron Guns; Canet System.

The guns recently made by the Forges et Chantiers de la Mediterranée for the Japanese Government for the purposes of coast defence may be considered as examples of the best modern French practice in the manufacture of cast-iron ordnance reinforced by steel tubes and hoops. This type of heavy gun is used to a considerable extent by the French War Department in the armament of land defences, and its use in the service can be justified by very strong argument. With all the improvements in material and mode of manufacture, guns of this class are very different in efficiency from those made ten or twelve years ago, and are far superior to the converted cannon which are still used in some services. Of course they must remain inferior to the best natures of steel ordnance, but their cheapness and the rapidity with which they can be produced, render them well adapted for coast defence, and it will be seen from the particulars presently to be given, that cast-iron reinforced ordnance constitutes a most effective weapon of offence and defence in places where it can be easily replaced in the event of failure. It is evident also that the two advantages of cheapness and ease of manufacture, enable a country to protect more points along its coast line than if the costly and more slowly produced built-up steel guns be only used. The two types which we illustrate differ in some respects from the French regulation pattern, but the differences are insignificant, and certainly the latter are no less efficient than those which are known as belonging to the Canet system.

The two types, Figs. 440 and 441 (see page 630), are the 24-centimetre (9.45-in.) gun of 28 calibres in length, and the 27-centimetre (10.63-in.) and 30 calibres in length. The former of these is constructed of a long cast-iron tube, which constitutes the body of the gun; in this mode of construction there is no steel lining tube. The rear portion is re-inforced by a strong steel tube, which is shrunk over the cast-iron body and bears on the trunnion ring, thus insuring a better distribution of strength longitudinally; this system of reinforcement is common to the Canet principle. Over this jacket is shrunk a row of steel tubes extending beyond the trunnion ring. The breech-closing mechanism is similar to that already described for guns of this calibre, the interrupted screw, the De Bange obturator modified, and the usual safety devices being employed. The larger and longer gun shown in Fig. 441 is of different construction; the former piece is intended to be fired with black quick-burning powder; in the latter, brown prismatic powder, burning much more slowly, is used. It was therefore necessary to provide for a higher degree of resistance along the whole length of the bore in the latter weapon. For this purpose the cast-iron body is lined with a steel tube extending from end to end, and at the breech the screwed seating for the block is provided for; this tube is screwed into the cast-iron body, the proportions of which are clearly shown upon the section. Over the cast iron is shrunk a row of steel hoops which are stopped near the trunnion ring and are then extended beyond the body of the gun; the breech-closing mechanism is the same as for the 24-centimetre gun. It should be pointed out that the efficiency of these two types, as regards weight of projectile and initial velocity, is very considerable; there is but little difference in the weight of the guns themselves, the heavier type being only about 1800 lb. more than the lighter. The latter may indeed be considered as a preferable form of construction, and the weight of steel, which in one case is disposed outside the body, is in the other more usefully employed in the steel lining tube. The weight of projectile fired by the 27-centimetre gun is 475 lb. The shorter type of this calibre imparts a velocity of 1620 ft. to this projectile, the weight of the powder charge being 114 lb. of black powder. The longer type fires a charge of 167 lb. of brown prismatic powder P B 2 S, and gives the initial velocity of 1870 ft. In November and December, 1889, guns of this construction, made for Japan, were subjected to very exhaustive trials at Havre, in which they fully sustained the reputation of their designer. The guns supplied to the Japanese Government are mounted on carriages of the Canet system, and of the same pattern as has been largely adopted by the French Government; the men serving them are protected by iron shields. An unusual detail had to be provided for in the construction of these carriages; the batteries in which they are to be mounted are situated in very elevated portions of the coast, and it became necessary to provide for firing at angles below the horizontal. Tables L. and LI. give the results of the firing trials referred to above, LII., LIII., LIV., and LV., on pages 627, 630, and 631, contain full particulars of the ballistical and other qualities of this class of ordnance.

Table L.—*Test of* 27-*Centimetre* (10.63-*In.*) *Guns at Havre, November and December*, 1889.

Weight of Projectile.	Nature of Powder.	Weight of Charge.	Initial Velocity.	Pressure in Gun.
lb.		lb.	ft.	lb. per sq. in.
554	P B 2 S lot 29	280	2090	31,290
553	" "	280	2090	28,450
550	P B 1 S 1st lot 88	275	2128	34,140
556	" "	280	2151	35,000
550	" "	277	2187	34,140
552	P B 2 S 1st lot 89	275	2290	39,825
440	" "	220	2128	28,000
440	P B 1 S 1st lot 89	277	2345	33,430

Table LI.—*Tests of* 15-*Centimetre* (5.90-*In.*) *Gun made at Havre*, 1889 *and* 1890.

Weight of Projectile.	Nature of Powder.	Weight of Charge.	Initial Velocity.	Pressure in Gun.
lb.		lb.	ft.	lb. per sq. in.
94.6	P B 2 S 1st lot	46.2	1879	24,890
94.6	P B 3 S 4th lot	46.2	2040	29,870
94.6	P B 2 S 1st lot	55	2076	21,340
94.6	" "	59.4	2158	37,700
94.6	P B 2 S 7th lot	59.4	2184	35,300
92.4	P B 3 S 1st lot	50	2138	35,560
92.4	" "	55	2294	37,000
92.4	P B 3 S 3rd lot	59.4	2269	44,000
92.4	P B 2 S 2nd lot	59.4	2273	42,670
92.4	" "	59.4	2289	44,000
92.4	P B 2 S 5th lot	59.4	2322	35,560
92.4	P B 3 S 1st lot 89	59.4	2328	47,000

Guns of this class above the calibre of 24 centimetres (9.45 in.) are fitted with the breech mechanism of the design already described, and by which, turning a handle constantly in one direction gives the three movements of rotation, extraction of the block, and pivotting on the bracket which supports it around its axis. Such guns are naturally adapted for smaller powder charges than are used in those made of steel, as they withstand less severe strains, but as we have said above they can be made to render very important services for coast defence armament. In positions of secondary importance, or where the defence is comparatively easy, such guns can be relied upon as amply sufficient because they possess comparatively high power. Especially in those countries which have a very extended coast line where it would be too costly to arm all the forts required for defence with steel guns, it is generally preferred to make use of cast iron. By this means with a moderate expenditure it is possible to have a very complete system of defence and an uninterrupted line of forts and batteries fully equipped. It may be added that cast iron, that is to say of the qualities used for gunmaking, is a very homogeneous metal, which may be relied upon up to the limits of its strength, and it is for this reason that it was so largely used for heavy calibres until a comparatively recent date before the manufacture of steel had been so much improved as to make it entirely reliable. The experiences gained during the American war fully confirmed the claims of cast iron as a material for gunmaking, but it involved the necessity of employing very heavy masses, and of course it is not comparable with the higher classes of gun steel, by the use of which alone weapons of comparative lightness and a maximum power of resistance can be manufactured. When the bore of a cast-iron gun has been eroded by service, it is easy, without great expense, to enlarge it and line it with a steel tube. This practice has been followed to a very large extent in this country, and some Canet cast-iron guns have also been lined in a similar manner with perfect success.

In addition to these cast-iron guns, the Forges et Chantiers Company manufacture a large number of types on the Canet system of steel, from the small 9-centimetre up to the 37-centimetre and even the 42-centimetre bore; such guns are intended for coast defence, are identical in form with the steel naval guns of corresponding calibres; they have similar powers of resistance both transversely and horizontally, and they are reinforced in the same manner with a greater or less number of rings. Each calibre comprises, as in the naval guns, a certain number of types varying in length and power. The lengths of the Canet coast defence gun of the latest pattern are 20, 25, 30, 36, 43, and 50 calibres. The initial velocities attained from projectiles fired from these guns are respectively 460, 540, 610, 680, 740, and 800 metres (1510 ft., 1770 ft., 2000 ft., 2230 ft., 2428 ft., and 2624 ft.) It will thus be seen that this system provides a complete series of guns for coast defence, either of the same or of varying calibres corresponding to all the different requirements of service. It is generally preferable when guns of high power are required, to restrict the calibre within moderate limits and to increase the length so as to impart a higher initial velocity to a smaller mass of projectile. This has the advantage of greatly simplifying the equipment of the battery, since two guns of widely differing energy can fire the same class of projectile, so that no confusion can arise from this cause, while if one of the guns become disabled the ammunition provided can be fired from the other one. Similar mountings can also frequently be used for guns of very different power. It may be mentioned that M. Canet has worked out a very complete system of defence both on sea and land; this system comprises the use of three guns of the same calibre, but of different lengths; such guns could be used indifferently on board ship and for coast defence, while all complication arising from a variety of stores and ammunition would be avoided. If, for example, a ship should be blockaded in a port, or has received such damage as to prevent it from going to sea, its armament might be used to reinforce the coast batteries in the vicinity. Such

MODERN FRENCH ARTILLERY; PARTICULARS OF CAST-IRON GUNS, CANET SYSTEM.

TABLE LII.—22-Cent. and 24-Cent. (8.66-In. and 9.45.-In.) Cast-Iron Guns for Coast Defence.

—	yds.	m.	22-Cent. Short Gun.		22-Cent. Long Gun.		24-Cent. Short Gun.		24-Cent. Long Gun.	
			in.	mm.	in.	mm.	in.	mm.	in.	mm.
Calibre			8.66	220	8.66	220	9.45	240	9.45	240
Total length of gun			242.5	6160	259.8	6600	264.5	6720	283.5	7200
			tons	kilos.	tons	kilos.	tons	kilos.	tons	kilos.
Weight of gun			12.6	12,800	12.7	12,900	16.34	16,600	16.49	16,750
			lb.		lb.		lb.		lb.	
,, shell			242.5	110	242.5	110	306.6	140	306.6	140
,, powder charge ..			61.7	28	83.8	38	77.16	35	106.0	49
			ft.	metres	ft.	metres	ft.	metres	ft.	metres
Initial velocity			1607	490	1869	570	1607	490	1869	570
			foot-tons	m. tons	foot-tons	m. tons	foot-tons	m. tons	foot-tons	m. tons
Striking energy			4345.4	1346.4	5880.2	1821.9	5530.9	1713.6	7484.0	2318.8
			ft.	metres	ft.	metres	ft.	metres	ft.	metres
Remanent velocities at	547	500	1505	459	1751	534	1512	461	1758	536
	1094	1000	1410	430	1637	499	1427	435	1656	505
	1641	1500	1325	404	1538	469	1341	409	1558	475
	2188	2000	1246	390	1443	440	1266	386	1466	447
	2735	2500	1181	360	1351	412	1206	366	1381	421
			foot-tons	m. tons	foot-tons	m. tons	foot-tons	m. tons	foot-tons	m. tons
Striking energy at	547	500	3813	1181.4	5161.1	1599.1	4895.6	1516.8	6617.8	2050.5
	1094	1000	3354	1039.2	4506.2	1396.3	4358.7	1350.5	5874.7	1820.1
	1641	1500	2954	915.26	3981.0	1233.5	3853.4	1193.9	5197.1	1610.3
	2188	2000	2613.4	809.74	3503.9	1085.7	3436.8	1064.9	4603.2	1426.1
	2735	2500	2345.8	726.80	3072.3	951.87	3085.9	956.04	4083.0	1265.0
Striking energy in foot and metric tons per inch and per cent. of circumference of projectile ..	At muzzle		161.45	19.69	218.51	26.05	188.35	22.97	254.91	31.09
	547	500	141.7	17.28	191.79	23.39	166.69	20.33	225.40	27.49
	1094	1000	124.39	15.17	167.52	20.43	148.50	18.11	200.07	24.40
	1641	1500	109.79	13.39	147.92	18.04	131.19	16.00	177.02	21.59
	2188	2000	97.08	11.84	130.20	15.88	117.09	14.28	156.78	19.12
	2735	2500	87.15	10.63	114.12	13.92	105.02	12.81	139.06	16.96
			in.	cm.	in.	cm.	in.	cm.	in.	cm.
Thickness of wrought-iron plate penetrated (Gâvre formula)	At muzzle		11.97	30.4	14.84	37.7	13.35	33.9	16.58	42.1
	547	500	10.90	27.7	13.54	34.4	12.24	31.1	15.20	38.6
	1094	1000	9.92	25.2	12.28	31.2	11.26	28.6	13.94	35.4
	1641	1500	9.09	23.1	11.22	28.5	10.31	26.2	12.75	32.5
	2188	2000	8.30	21.1	10.27	26.1	9.52	24.2	11.73	29.8
	2735	2500	7.71	19.6	9.33	23.7	8.81	22.4	10.74	27.3
	deg.		yards	metres	yards	metres	yards	metres	yards	metres
Range at different angles	3		2,176	1,990	2,728	2,495	2,198	2,010	2,761	2,525
	5		3,335	3,050	4,456	4,070	3,379	3,090	4,533	4,145
	7		4,407	4,030	5,336	4,880	4,456	4,075	5,429	4,965
	10		5,779	5,285	6,922	6,330	5,872	5,370	7,114	6,505
	15		7,644	6,990	9,093	8,315	7,862	7,190	9,268	8,475
	20		9,109	8,330	10,814	9,890	9,486	8,675	11,039	10,095
	25		10,350	9,465	12,155	11,115	10,761	9,840	12,450	11,385
	30		11,470	10,490	13,176	12,050	11,733	10,730	13,520	12,365
	35		12,220	11,175	13,888	12,700	12,422	11,360	14,265	13,045

TABLE LIII.—27-Cent. and 30.5-Cent. (10.63-In. and 12.01-In.) Cast-Iron Guns for Coast Defence.

—	yds.	m.	27-Cent. Short Gun.		27-Cent. Long Gun.		30.5-Cent. Short Gun.		30.5-Cent. Long Gun.	
			in.	mm.	in.	mm.	in.	mm.	in.	mm.
Calibre			10.63	270	10.63	270	12.01	305	12.01	305
Total length of gun			297.7	7560	3189	8100	336.3	8540	360.2	9150
			tons	kilos.	tons	kilos.	tons	kilos.	tons	kilos.
Weight of gun			23.23	23,600	23.49	23,850	33.52	34,050	33.86	34,400
			lb.		lb.		lb.		lb.	
,, shell			440.9	200	440.9	200	639.3	290	639.3	290
,, powder charge.. ..			110.2	50	154.3	70	158.7	72	220.4	100
			ft.	metres	ft.	metres	ft.	metres	ft.	metres
Initial velocity			1607	490	1870	570	1607	490	1870	570
			foot-tons	m. tons	foot-tons	m. tons	foot-tons	metre tons	foot-tons	m. tons
Striking energy			7901.4	2448.1	10690.5	3312.6	11,455	3549.5	15,502	4803.3
			ft.	metres	ft.	metres	ft.	metres	ft.	metres
Remanent velocities at	547	500	1522	464	1772	540	1532	467	1781	543
	1094	1000	1443	440	1676	511	1463	446	1699	518
	1641	1500	1368	417	1588	484	1394	425	1621	494
	2188	2000	1306	398	1506	459	1332	406	1545	471
	2735	2500	1234	376	1427	435	1273	388	1476	450
			foot-tons	m. tons	foot-tons	m. tons	foot-tons	metre tons	foot-tons	m. tons
Striking energy at	547	500	7084	2195.1	9596	2973.1	10,496	3224.2	14,070	4359
	1094	1000	6371	1973.9	8592	2662.4	9,491	2940.7	12,803	3906.9
	1641	1500	5722	1773.0	7696	2388.5	8,619	2670.3	11,644	3607.8
	2188	2000	5212	1615.1	6933	2148.1	7,865	2436.9	10,586	3279.7
	2735	2500	4652	1441.4	6227	1929.3	7,181	2225.6	9,662	2993.8
Striking energy in foot and metric tons per inch and per cent. of circumference of projectile ..	At muzzle		239.3	29.18	315.6	38.49	302.3	36.87	410.1	50.01
	547	500	214.6	26.17	290.6	35.44	275.3	33.57	372.1	45.38
	1094	1000	192.9	23.53	260.2	31.74	251.1	30.62	338.7	41.30
	1641	1500	173.3	21.13	233.4	28.47	227.9	27.80	308.9	37.67
	2188	2000	157.8	19.25	210.0	25.61	208.0	25.37	279.9	34.14
	2735	2500	140.9	17.18	188.6	23.0	190.0	23.17	255.6	31.17
			in.	cm.	in.	cm.	in.	c.m	in.	cm.
Penetration in wrought-iron (Gâvre formula)	At muzzle		15.87	40.3	19.29	49.0	18.74	47.6	23.31	59.2
	547	500	14.68	37.3	18.19	46.2	17.52	44.5	21.82	55.4
	1094	1000	13.58	34.5	16.81	42.7	16.42	41.7	20.32	51.6
	1641	1500	12.60	32.0	15.59	39.6	15.31	38.9	19.02	48.3
	2188	2000	11.77	29.9	14.45	36.7	14.33	36.4	17.72	45.0
	2735	2500	10.86	27.6	..	34.0	13.42	34.1	16.62	42.2
	deg.		yards	metres	yards	metres	yards	metres	yards	metres
Range at different angles	3		2,236	2,045	2,821	2,580	2,291	2,095	2,909	2,660
	5		3,456	3,160	4,681	4,280	3,560	3,255	4,833	4,420
	7		4,577	4,185	5,621	5,140	4,724	4,320	5,829	5,330
	10		6,059	5,540	7,360	6,780	6,294	5,755	7,798	7,130
	15		8,153	7,455	9,728	8,895	8,525	7,795	10,242	9,365
	20		9,842	9,010	11,620	10,625	10,330	9,445	12,248	11,200
	25		11,199	10,240	13,106	11,985	11,768	10,760	13,849	12,665
	30		12,248	11,195	14,250	13,030	12,875	11,775	15,070	13,780
	35		12,980	11,870	15,052	13,765	13,670	12,500	15,921	14,560

a combination appears very ingenions and very practical, not probably for great maritime nations, but for those which possess only a second-class navy and imperfect means of defending their shores.

HEAVY PLATE EDGE AND BUTT PLANING MACHINE AT ELSWICK.

An engraving on page 625 represents a machine made for Messrs. Sir W. G. Armstrong, Mitchell, and Co., Limited, Elswick-on-Tyne, for planing the edges and butts of plates. This machine has been designed and constructed by Messrs. Hugh Smith and Co., Possil Engine Works, Glasgow, for planing the edges of the heaviest ship-plates, and for armour plates up to 18 in. thick, the gearing being made sufficiently powerful to take a heavy cut off the edge of a steel plate 2 in. thick. It is specially adapted for planing the armour plates when being fitted into their place, the butt planer being arranged to plane the butt edge either at right angles or at an obtuse or acute angle to the other edge of plate, the saddles being fitted with all the necessary motions for this work. The tool-holders can be angled in order to plane the edges of plates to a bevel. The plates are held in position by means of hydraulic rams which admit of the plate being very quickly fixed and released. The machine has an arrangement of levers for preventing the saddles from coming in contact.

HORIZONTAL COLD STEEL SAWING MACHINE.

The illustration given on page 624, represents a cold saw ing machine designed and patented by Messrs. Isaac Hill and Son, Derby, and used principally for the sawing of runners or gates of steel castings. Two machines of this type are in use at the works of the Steel Company of Scotland for this purpose. It will be seen that the saw is caused to revolve in a horizontal plane, and in the case of the machine illustrated, it may be raised to 3 ft. 6 in. The machine carries a 28-in. diameter saw, having a longitudinal travel of 16 in., and will cut solids up to 8 in. thick. The saw is secured to the spindle by a flush side arrangement, while the driving is by a type of gearing dispensing with the usual worm and wormwheel. Both of these, shown in the engraving, are patented by the firm. The feed is self-acting, of three speeds and suitable for sawing solids, for quick return motion, and for disengaging motion, there being an automatic gearing for disengaging the gear clutch at any point in the forward or return traverse. The slide bed upon which the saw-carrying saddle moves, has a traverse slide which fits the standard. The raising or lowering is done by hand through a worm and wormwheel, by a wire rope carried on suitable carrying pulleys on a drum; while the exact lowering or raising adjustment of the saw is done by means of a telescopically arranged spindle. The driving is from the main shaft on to pulleys on an overhead shaft carried in bearings across the top of the machine. Upon this latter shaft is a bevel pinion which gears with a bevel wheel supported on a bearing as shown, this bevel wheel communicating motion by a feather key to the vertical shaft which can slide through it. On the lower part of this shaft is secured a bevel pinion which gears with a bevel wheel on to the principal shaft of the sawing portion of the machine. The machine is self-contained, and the massive framed standard has a secure foundation plate.

THE ENGINES AND BOILERS OF THE "BARHAM" AND "BELLONA."

We give this week a two-page engraving, together with other views on the present and opposite pages, illustrating the machinery of H.M.S. Barham and Bellona. These are sister vessels, and have been designed by Mr. W. H. White, the Director of Naval Construction. The Barham has been built at Portsmouth, and the Bellona at the Hebburn yard of Messrs. R. and W. Hawthorn, Leslie, and Co., by which firm the engines of both vessels have also been constructed. They are classed as twin-screw protected cruisers, and measure 293 ft. in length by 35 ft. in breadth. Their armament largely consists of 4.7 in. quick-firing guns, in addition to machine guns and torpedoes. The propelling machinery consists of two sets of triple-expansion engines having cylinders 27 in., 40½ in., and 60 in. in diameter, with a stroke of 27 in. We reserve a fuller description of the machinery till the appearance of further engravings, which we shall give in an early issue; meanwhile we will only say that the engines include many interesting features and that their performance on trial has been most creditable to their makers.

The natural draught trial of the Bellona took place in the North Sea off the mouth of the Tyne on Saturday, the 15th inst., on the long course between St. George's Church, Cullercoats, and Newbiggin Church, a certified distance of 9.6 knots, and the speed attained was as follows:

	Knots	
First run north	19.1	Mean speed 19.46 knots.
Second run south	19.86	
Third run north	18.58	
Fourth run south	20.32	

The time on the trial was 6 hours. The contract required 8 hours, and all arrangements were made for the running the full contract time, but a fog coming down at about the 6½ hours, the makers were compelled suddenly to stop the trial and 6 hours was accepted. The mean indicated horse-power was 3557 for the whole of the 6 hours, a maximum of 4200 horses was maintained for some time, but as 3500 was the contract natural draught power, it was deemed unnecessary by the officers in charge to exceed that power by more than a sufficient margin.

Mention has been made of weaknesses in the structure of these vessels, the Barham and Bellona. It is only necessary to say that during this trial, with a mean speed of 19½ knots and part of the time 20½ knots, there was a marked absence of any vibration whatever, either in the hull of the vessel or the engine seatings, where local vibration is not an uncommon circumstance. It will be seen from the engravings that more than usual care has been exercised in the design and construction of the seatings for the engines by means of strong transverse girders, to which the steel bedplates of the machinery are firmly bolted by continuous flanges and small bolts placed closely together, so making engines and ship one structure. These transverse girders are again supported and strengthened by long longitudinal kelsons running the full length of the engine space.

AUTOMATIC TORPEDOES.

*Automobile Torpedoes, the Whitehead and Howell, with a Detailed Description of each.**

By Ensign John M. Ellicott, U.S. Navy.

(*Continued from page* 574.)

The Machinery Chamber.—Next abaft the reservoir comes the rear cone (Fig. 3),† containing two compartments, the machinery chamber and the buoyancy chamber. Between them is a bulkhead K bolted to a flange *g*. The flange is rivetted and soldered to the envelope, and the joint between it and the bulkhead is made water-tight by a rubber gasket. To this bulkhead the propelling machinery is secured. This consists of a Brotherhood or Whitehead engine, a starting valve, and a pressure governor. Previous to 1880 the motor used was the Brotherhood engine, but in the models of that year, and later ones, the motor is a modification of the Brotherhood known as the Whitehead engine.*

The Whitehead engine consists of three cylinders, A A A (Fig. 11, page 632), fixed radially about the propeller shaft, with their axes 120 deg. apart. Within the circular inclosure at the junction of the cylinders the main crank is free to revolve and receives its impulse from the piston of each cylinder in succession. The compressed air is admitted behind the pistons and evacuated in proper order by means of three slide valves, each working in a separate chest S on the forward face of each cylinder, but all regulated by a single cam Q keyed to the main shaft.

The valves consist of a cylindrical disc T of bronze, cast in one piece with a stock *t* carrying four guide blades *l l l*, and it slides in a bronze sleeve C perforated with radial ports *o o* which open upon an annular aperture E in the valve chest, communicating with the cylinder space behind the pistons. The valve stem is in two parts, screwing one into the other to allow adjustment. One part simply sockets in the valve stock, as shown in the drawing, while the other is split and carries a small roller X in contact with the cam Q. The compressed air is admitted into the space *u* behind the valve disc T, and maintains the contact between the valve, the stem, and the cam in all positions. By removing the screw caps *v* from outside the torpedo the valves may be readily removed and overhauled, or the valve stems set.

In Fig. 10, page 632, the position shown is when the piston is about to commence its return stroke and the air is exhausting from behind it, shown by the arrows. When the piston has completed its return stroke the cam Q will have rotated until the valve T, moving toward the main shaft, opens communication through the ports *o* with the annular aperture E, and admits the compressed air into the cylinder behind the piston. The cam Q regulates the valve motion to cut off at about half-stroke. In the Model 1885 torpedo and later ones it is about four-tenths stroke. Thus as the air is acting at full pressure in one cylinder it is acting expansively in the next, and exhausting from the third.

When the torpedo is launched from a submerged frame or skeleton tube the working of the pistons and valves is much impeded by the water which backs up into the cylinders through the exhaust pipe. A little reservoir D is therefore provided for each cylinder. The water, when backed up through the channel *e*, lifts the metal ball *d*, and, entering the reservoir D, is retained there by the ball falling back again over the orifice.

To remedy the evil in the latest models the slide valves T are made in two parts, as shown in Fig. 12, page 632. When there is water in the cylinders it can escape upon compression through the holes *u*, separate T' and T'', as shown in the second view, and pass off as indicated by the arrows. At other times T' and T'' are kept together, as shown in the first view, by the air pressure behind T'. The slide valve is also a cylinder relief valve.

The piston-rods are fitted in the pistons with a ball-and-socket joint, as shown in both Figs. 13 and 14, and attached to the crank by means of blocks K, with feathers at each end fitting in annular grooves *q q* cut into the inner face of the crank webs. The crank has a counterbalance *g* forged in one piece with it. The crank and propeller shaft are of steel, the latter being hollow. The air exhausting through it acts as an additional propelling force. The piston-rods are also of steel, and the pistons, cylinders, and blocks K of bronze or brass.

The compressed air is turned on the machine by opening a valve (T, Fig. 15) which will be described further on, but before reaching the cylinders, it passes through a pressure governor (Figs. 13 and 14). The air-pipe T' passes from the starting value T to the governor through the machinery bulkhead, and serves to secure the governor to the bulkhead as shown. The governor consists of a hollow cylindrical slide valve P, of bronze, closed at its upper end but perforated radially with three rows of square ports *e*, 1.4 in. across, opening upon three annular air ports *e'*, 1 in. across, which communicate with the air-pipe T' (Fig. 14) through the channel *a*. At rest the valve ports should be squarely over the air ports, lapping them $\frac{1}{16}$ in. on either side. This can be adjusted by leather washers *w* under the cap *o* (Fig. 13), upon which the foot of the valve rests. Above the valve

* From the Annual of the U.S. Office of Naval Intelligence.

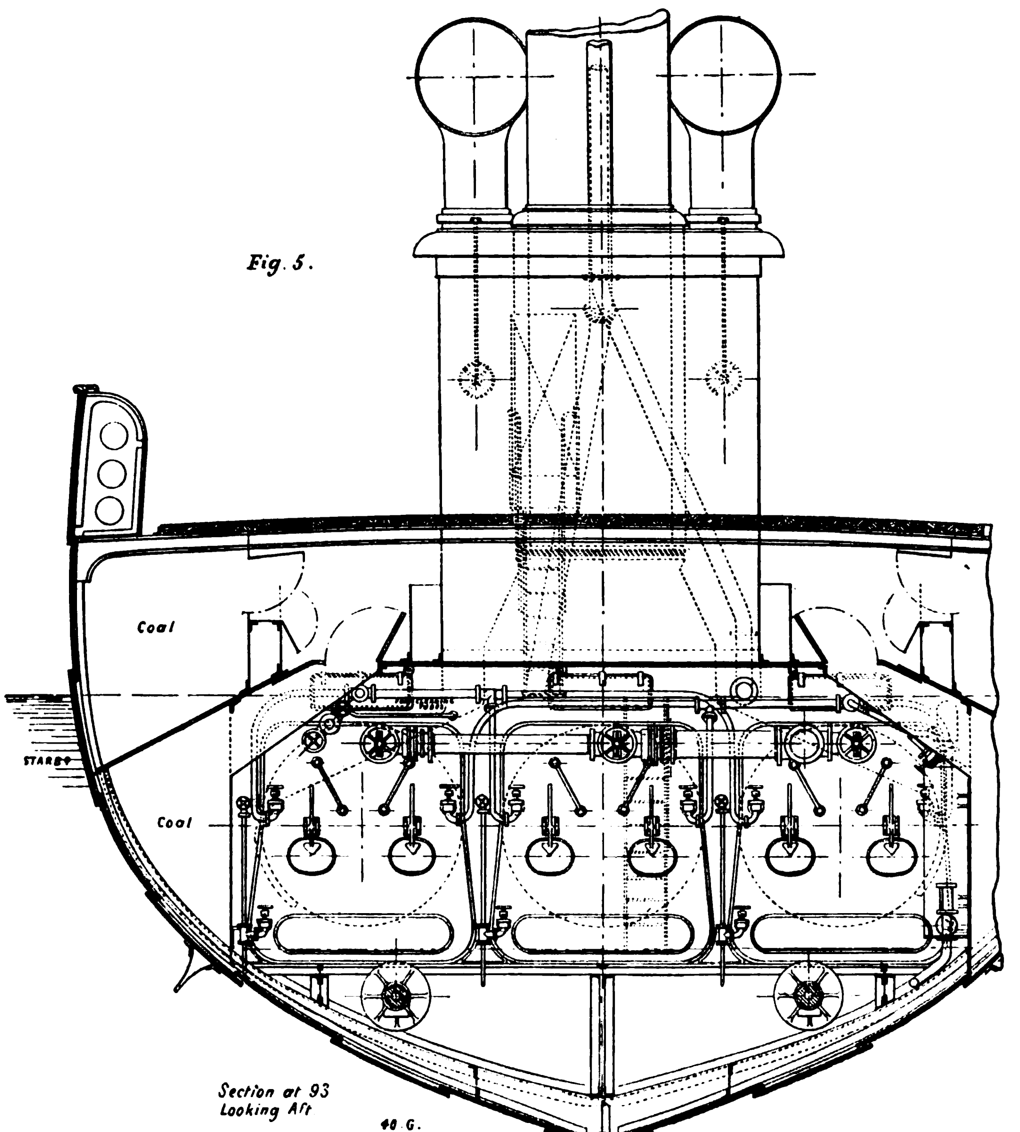
† See page 573 *ante*.

* These we shall illustrate later. Brotherhood improves his engines continually, and they are very probably still used in torpedoes not manufactured at Fiume. Schwartzkopf also uses a patented type of three-cylinder engine.

BOILERS OF H.M.S. "BARHAM."

CONSTRUCTED BY MESSRS. R. AND W. HAWTHORN, LESLIE, AND CO., LIMITED.

Fig. 5.



CAST-IRON GUNS (CANET SYSTEM) FOR COAST DEFENCE.

(*For Description, see Page* 626)

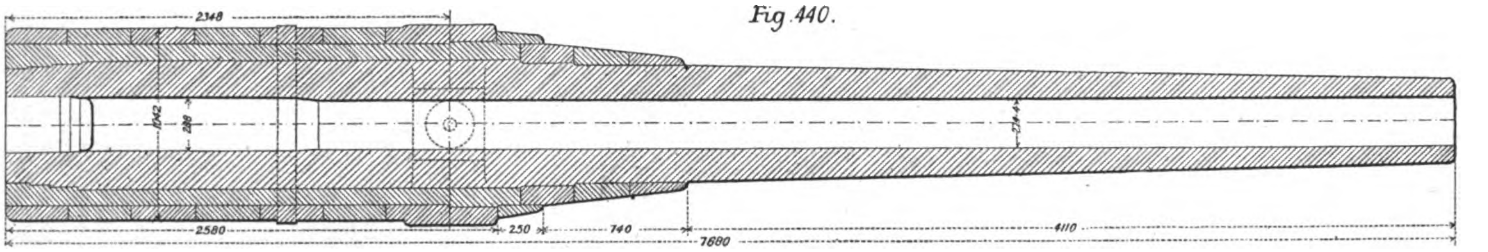


Fig. 440.

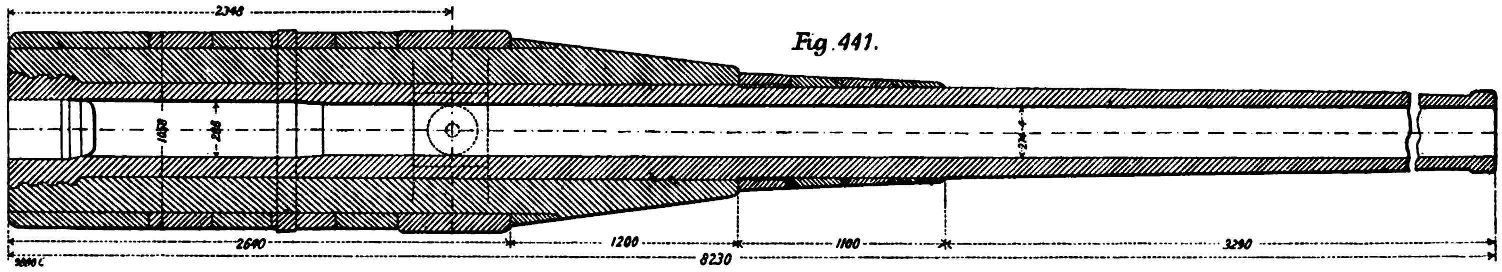


Fig. 441.

TABLE LIV.—BALLISTICAL DATA OF CAST-IRON GUNS FOR COAST DEFENCE (CANET SYSTEM); CONSTRUCTED BY THE FORGES ET CHANTIERS DE LA MEDITERRANÉE.

Nature of Gun.	Calibre.		Total Length.		Length of Bore.		Diameter of Chamber.		Length of Rifling.		Number of Grooves.	Terminal Angle.
	in.	mm	in.	mm	in.	mm	in.	mm.	in.	mm		
Coast, 15 cm. short	5.90	150	165.4	4200	155.3	3945	6.10	155	129.9	3300	24	Uniform rifling at 7 deg.
,, 15 ,, long	5.90	150	177.2	4500	167.1	4245	6.10	155	138.2	3510	46	
,, 19 ,, short	7.47	190	209.5	5320	196.8	4998	7.67	195	164.6	4180	30	
,, 19 ,, long	7.47	190	224.5	5700	211.8	5380	7.67	195	175.2	4450	58	
,, 22 ,, short	8.66	220	212.5	6160	227.8	5786	8.89	226	190.6	4840	34	
,, 22 ,, long	8.66	220	259.8	6300	245.3	6230	8.89	226	203.2	5160	66	
,, 24 ,, short	9.45	240	264.5	6720	248.5	6312	9.72	247	207.9	5280	38	
,, 24 ,, long	9.45	240	283.5	7200	267.3	6790	9.72	247	221.7	5630	72	
,, 27 ,, short	10.63	270	297.7	7560	279.6	7100	10.94	278	233.9	5940	42	
,, 27 ,, long	10.63	270	318.9	8100	300.8	7640	10.94	278	249.2	6330	82	
,, 30.5 ,, short	12.01	305	336.3	8540	313.0	7950	12.36	314	263.8	6700	46	
,, 30.5 ,, long	12.01	305	360.2	9150	337.0	8560	12.36	314	277.6	7050	92	
,, 32 ,, short	12.60	320	352.8	8960	331.5	8420	12.99	330	277.2	7040	50	
,, 32 ,, long	12.60	320	377.9	9600	356.7	9060	12.99	330	294.9	7490	96	

Nature of Gun.	Weight of Gun.		Weight of Projectile.		Weight of Charge.		Initial Velocity.		Total Energy.		Thickness of Iron Plate Penetrated at Muzzle.		Maximum Range.	
	lb.	kilos.	lb.	kls.	lb.	kls.	ft.	m.	ft-tons	m. tns	in.	cm.	yards	m.
Coast, 15 cm. short	8928.6	4,050	77.161	35	19.84	9	1607	490	1383.0	428.4	6.92	17.6	10,940	10,005
,, 15 ,, long	9038.9	4,100	77.16	35	26.45	12	1870	570	1871.4	579.7	8.62	21.9	12,341	11,285
,, 19 ,, short	18188.0	8,250	154.3	70	39.68	18	1607	490	2762.8	865.8	9.60	24.4	11,421	10,445
,, 19 ,, long	18298.0	8,300	154.3	70	55.11	25	1870	570	3742.8	1159.4	11.93	30.3	12 965	11,850
,, 22 ,, short	28,219	12,800	242.5	110	61.73	28	1607	490	4346.2	1346.4	11.97	30.4	12,221	11,175
,, 22 ,, long	28,439	12,900	242.5	110	83.77	38	1870	570	5881.9	1821.9	14.84	37.7	13,888	12,700
,, 24 ,, short	36,596	16,600	308.6	140	77.16	35	1607	490	5332.1	1713.6	13.35	33.9	12,397	11,360
,, 24 ,, long	36,928	16,750	308.6	140	108.02	49	1870	570	7487.8	2318.8	16.58	42.1	14,264	13,045
,, 27 ,, short	52,029	23,600	449.9	200	110.23	50	1607	490	7903.7	2448.1	15.87	40 3	12,980	11,870
,, 27 ,, long	52,581	23,850	449.9	200	154.32	70	1870	570	10695.0	3312.6	19.29	49.0	15,052	13,765
,, 30.5 ,, short	75,068	34,050	639.3	290	154.32	72	1607	490	11459.0	3549.6	18.74	47.6	13,670	12,500
,, 30.5 ,, long	75,833	34,400	639.3	290	220.4	100	1870	570	15508.0	4803.3	23.31	59.2	15,921	14,560
,, 32 ,, short	86,641	39,300	749.6	340	187.39	85	1607	490	13436.0	4161.6	20.52	52.1	14,013	12,815
,, 32 ,, long	87,523	39,700	749.6	340	264.55	120	1870	570	18180.0	5631.4	25.47	64.7	16,386	14,985

at right angles to the main shaft, screwed into the walls of the chamber and enlarged at its centre to allow a hole through it for the shaft A. The rods passing through the buoyancy chamber also pass through the bevel gear chamber. The propellers, besides being keyed, are secured to their respective shafts by washers *w w'*, screwed over them.

The Tail.—The tail of the torpedo consists of two parts, the rudder support and the rudders. The former consists of a conical stock K screwed on the bevel gear chamber, which carries four fins, two vertical, F F, and two horizontal (not shown). These fins are either cast in one piece with the stock or rivetted to flanges upon it. From the vertical fins shoes S S' extend aft, and to these the vertical vanes V V are secured. The upper shoe has a lug *u'* which fits in a longitudinal groove in the top of the launching tube and keeps the torpedo upright in launching. The lower shoe opens to form a frame *f f*, in which is pivotted the lever *l* of the horizontal rudders.

The after part of the tail consists of a stock K' with vertical vanes V V, which act as the vertical rudder, and with two horizontal rectangular frames R R in which are set the horizontal rudders H. To the outer extremities of these frames rods are attached which extend forward and fit in sockets on the outer edges of the horizontal fins of the forward part. By properly adjusting the set screws which secure the rods in their sockets, sufficient inclination can be given to the vertical vanes V V to counteract any tendency of the torpedo to lateral deviation. Experiments are always made to determine this correction.

There is an unnatural strain brought upon the shoes S S' by this method of inclining the vertical vanes, and sometimes, too, the free action of the horizontal rudder rods is impeded. A new arrangement introduced by Schwartzkopf has therefore been adopted since 1880, and is shown in Fig. 23. On the horizontal fins of the tail stock little vertical rudders *a a*, above and below the fins in the same vertical plane, are pivotted at *b b*, and are set to the required angle by set screws *c* passing through slots *d d*. It will be seen, too, in the figure that the framing is no longer carried around the horizontal rudders.

In the tail of the Model 1880 torpedo and earlier models is the mechanism for stopping after a certain run, and also that for suspending the action of the horizontal rudders. The first consists of the following arrangement: On the shaft of the forward propeller is an endless screw *v* engaging a toothed wheel W on whose face is a stud *s*. At each rotation of W the stud *s* engages the escapement wheel W' and moves it one tooth. The wheel W' is restrained by the spring *p'*, and has on its face a stud *s*. After a certain number of escapements of W' the stud *s'* comes in contact with the trigger *t*, and turning it about the axis *x*, causes the notch *u* to release the box X surrounding the shaft and containing the spring *p* under compression. This spring, acting between the after flange of the box and a collar on the shaft, causes the former to jump backwards, dragging with it, by means of a lug *u''*, the rod *d*. This, by means of the connecting-rod *e* (Fig. 17), the bell-crank *i k*, and the link *m*, pulls forward the lever L and closes the starting valve.

To recock the apparatus a hook is inserted in a slot in the tail stock, and the lug *u''* dragged forward until the notch *n* drops over the rear edge of the box X.

The slot *j* (Fig. 17) in the rod *c* allows the lever L to be thrown back as the torpedo leaves the launching tube without hindrance from the stopping mechanism, but if the latter is not set as described it can readily be seen that the lever L will not be thrown back and the torpedo would simply lie where it fell upon the water.

The escapement wheel W' is graduated on its face as shown in order that it may be set to stop the torpedo after a run of any desired distance. How to set this wheel, should no table be available, may be obtained as follows: Multiply the mean pitch of the propellers, minus the percentage of slip, by the number of teeth in the wheel W; divide the distance the torpedo is to run by this product, and the quotient will be the number of teeth in the wheel W' which must be traversed by the stud *s'* and the trigger *t*. Of course the mean pitch of the propellers must be expressed in the same denomination as the distance to be run by the torpedo.

The mechanism for restraining the action of the horizontal rudders is to protect them from the initial vagaries of the pendulum due to inertia and shocks upon launching. To this end an arm M free to turn about the axis *x* independent of the trigger *t*, has attached to it a claw C pressed downwards by a spring *p''*. Also attached to the arm M is a system of rods *y z*, which, in the machinery chamber, are connected to one end of an athwartship lever *l'*, Fig. 18, on a vertical axis *x'*; the other end of the lever having a flat edge *k'*, and fitting into a pair of jaws *j'*, Fig. 19, on the vertical rod I. This rod, therefore, cannot move until the stud *s*, Fig. 16, on the wheel W, engages the claw C and drags back the arm M and the rods *y z*. The latter, acting upon the athwartship lever, withdraws its further end from the jaws of the rod I and allow the immersion regulators to act upon the horizontal rudders. Once back, the claw C is inoperative, simply rising and falling each time the stud *s* passes it. This stud is adjusted by turning the wheel W (through the medium of the propellers) by hand. Its proper position varies with the mode of launching and in different models.

The jaw *j'* is adjustable along the rod I, so that the horizontal rudders can be rendered inactive at any inclination with the plane of their frames. Thus, not only can the duration of their inactivity be controlled, but their position during inactivity. Such adjustment has been found by experiment to be beneficial in guiding the torpedo more quickly to its plane of immersion, and an empirical table or curve of inclinations for different models and modes of launching is furnished.

In actual warfare it is desirable that a torpedo which has missed its target shall neither fall into the hands of the enemy nor float about as a danger. To this end a sinking arrangement is devised. It consists of a bronze valve Z (Fig. 17), kept seated in the machinery bulkhead by a spring P, and having a rectangular grip Z', into which drops the hooked end of a rod *y* attached to the lever *k*. The rod *y* passes through the slot of a bent lever U fixed upon the axis of the cam lever L of the starting valve. The upper arm of the lever U, being a spring of lateral tendency, catches in one of the two notches on the edge of the slot *o* in the envelope of the torpedo. When in the forward notch, as shown in Fig. 17, the rod Y is lifted from Z' and the arrangement remains inactive, but when in the after one the action is as follows: Before launching, when the starting valve is closed, the lip *h''* of the hook *h'* (Fig. 17) rests upon Z'. When the lever L is thrown backward, as the torpedo launches from the tube, the rod Y being drawn aft, allows the hook *h'* to fall into the grip Z' of the valve. Thus it remains until the end of the run, when the stopping arrangement, by closing the starting valve, as shown in dotted lines, opens the valve Z and floods the buoyancy chamber, causing the torpedo to sink. It is safer when practising with a torpedo to remove the rod Y entirely; otherwise a mistake in setting it might cause the loss of the torpedo.

In the Model 1885 and later ones the stopping arrangement and that for suspending the action of the horizontal rudders has been transferred to the machinery chamber. The new stopping arrangement (Figs. 20, 21, and 22) consists as follows: A ratchet wheel A, Fig. 20, is fixed on a shaft B and turned by a ratchet L worked by

MODERN FRENCH ARTILLERY. (*See Page* 626.)

(*See Page* 626.)

TABLE LV.—32-Cent. (12.6-In.) Cast-Iron Guns for Coast Defence (Canet System).

—			32-Centimetre Short Gun.		32-Centimetre Long Gun.	
			in.	mm.	in.	mm.
Calibre			**12.6**	320	**12.6**	320
Total length of gun			**352.8**	8030	**377.9**	9600
			tons.	kilos.	tons	kilos.
Weight of gun			**33.68**	39,300	**39.08**	39.700
			lb.		lb.	
" shell			**749.5**	340	**749.5**	340
" powder charge			**187.39**	85	**264.5**	120
			ft.	metres	ft.	metres
Initial velocity			**1607**	490	**1870**	570
			foot-tons	metre tons	foot-tons	metre tons
Striking energy			**13,432**	4161.6	**18,175**	5631.4
	yds.	metres	ft.	metres	ft.	metres
Remanent velocities at	**547**	500	**1539**	469	**1788**	545
	1094	1000	**1467**	447	**1709**	521
	1641	1500	**1407**	429	**1637**	499
	2188	2000	**1343**	411	**1565**	477
	2735	2500	**1293**	394	**1499**	457
			foot-tons	metre tons	foot-tons	metre tons
Striking energy at	**547**	500	**12,305**	3812.5	**16 679**	5167.4
	1094	1000	**11,180**	3463.3	**15,128**	4686.8
	1641	1500	**10,295**	3189.9	**13,931**	4315.9
	2188	2000	**9,450**	2927.9	**12,730**	3943.7
	2735	2500	**8,684**	2690.6	**11,684**	3619.9
Striking energy in foot and metric tons per inch and per cent. of circumference of shell	At muzzle		**343.3**	41.87	**464.5**	56.65
	547	500	**314.5**	38.36	**426.3**	51.99
	1094	1000	**285.7**	34 84	**386.6**	47.15
	1641	1500	**263.1**	32.09	**356.0**	43.42
	2188	2000	**241.5**	29.45	**325.4**	39.68
	2735	2500	**222.0**	27.07	**298 6**	36.42
			in.	cm.	in.	cm.
Penetration in wrought iron	At muzzle		**20.52**	52.1	**25.47**	64.7
	547	500	**19.25**	48.9	**23.94**	60.8
	1094	1000	**17.99**	45.7	**22.33**	56.7
	1641	1500	**16.97**	43.1	**21.11**	53.6
	2188	2000	**15.95**	40.5	**19.73**	50.1
	2735	2500	**15.04**	38.2	**18.98**	47.2
	deg.		yards	metres	yards	metres
Range at different angles	**3**		**2,307**	2,110	**2,942**	2,690
	5		**3,598**	3,290	**5,036**	4,605
	7		**4,790**	4,380	**5,938**	5,430
	10		**6,402**	5,855	**7,972**	7,290
	15		**8,688**	7,945	**10,466**	9,570
	20		**10,548**	9,645	**12,543**	11,470
	25		**12,033**	11,005	**14,217**	13,000
	30		**13,180**	12,055	**15,496**	14,170
	35		**14,012**	12,815	**16,386**	14,985

an eccentric on the main shaft A′. On the opposite side of the wheel is a detent L′, and both ratchet and detent are held against the wheel by the spring *p*. On the shaft B and abaft A is a screw thread, and also, at its rear end, a cam G, Figs. 21 and 22. Parallel to B is another shaft D, having keyed upon it, but free to slide along its length, a sector E with a screw-threaded periphery which engages the threads on B. On the rear face of the sector is a stud H, and on its upper edge is a latch P, which latches into the notched plates P′ and insures the periphery of the sector engaging the screw thread. Fixed on the same shaft D is a lever *d* which is connected to the starting valve lever by a connecting-rod F. When the propellers are set in motion the eccentric on A″, Fig. 20, causes the wheel A and shaft B to rotate; the screw thread on B carries the sector E aft until the latch P clears the notches in the latch-plates P′. Then the revolving cam G comes in contact with the stud H on the after face of the sector, lifts it and the lever *d* about the axis of D, and, through the medium of the connecting-rod F, Fig. 21, closes the starting valve. The sector E then springs forward along D under the action of the spring R, which is secured aft and doubled back over the roller *p* to secure to the lug *e* on the sector. When the starting valve is opened, as the torpedo is launched, the sector is latched into P′. Before placing the torpedo in the launching tube the sector can be set for a desired run by pushing the sliding leaf *m*, Fig. 21, which is in contact with the lug *e*′, along a longitudinal groove *v* in the torpedo envelope. The edge of this groove is graduated for different runs.

The shaft B extends forward of the wheel A, Fig. 22, and has fixed on its forward end a pinion *a*, Figs. 20 and 23, which works the arrangement for restraining the horizontal rudders. This consists of a bronze sector J, Fig. 20, pivotted at *j*³, and having a flange on its periphery, and also, pivotted to it on a stock at *j*, a rack K. The spring *o* tends to press the rack and sector always to the right and to keep the teeth of the rack always up against the pinion *a*. To set this apparatus, move the horizontal rudders by hand to bring the jaws *j*″ on the vertical rod I in line with the flange *j*. Then insert a key, through a hole in the torpedo envelope, into a socket in a lug *t* on the sector J, and push the latter to the left. The flange *j* enters the jaws *j*″ and the rack K engages with the pinion *a*. The rod I is thus held immovable until, by the rotation of the propeller shaft A′, the rack K, released tooth by tooth, and forced to the right by the spring *o*, pushes the sector to the right until the flange *j* clears the jaws *j*″. The duration of immobilisation can be regulated by the set screw T working in the lug *s* on the rack, for its head T′, bringing up against the pinion *a* when the sector J is set, limits the arc of *j* engaged by the jaws *j*″. The sinking valve in these later models is inclined in the machinery bulkhead, but its mode of action is unaltered.

The following is an abridged, but not otherwise altered, description of the Howell automobile torpedo now being manufactured for the United States, furnished us by Mr. E. W. Very, of the Hotchkiss Ordnance Company.

(*To be continued.*)

Victorian Coal.—A diamond drill, which has been working at Korumburra, South Gippsland, passed, at a depth of 410 ft., through a seam of black coal 3 ft. thick.

Elliott's Smoke Annihilation.—Elliott's method of "annihilating" smoke from boiler and other furnaces is now being shown on the Thames Embankment near the City of London schools. The method consists in drawing the smoke from the smokebox by a fan, and delivering it into a box half filled with water. By means of a rotary paddle the water is churned up into spray through which the smoke passes. The object is to wash the carbon particles out of the smoke, together with the tar, ammonia, and sulphuric acid, and to let nothing escape but invisible and inodorous gases. As far as can be judged, this result is very fairly attained, but the apparatus is too small for a really adequate test. We understand, however, that the invention can be seen applied to a boiler of 100 horse-power, and that it has been found that the increased amount of fuel required to drive the fan which produces the artificial draught, is 2½ per cent. of the consumption. The inventor's address is 83, Queen-street, Cheapside, E.C.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

Middlesbrough, Wednesday.

The Cleveland Iron Market.—Yesterday the weekly iron market was very dull and unsatisfactory. The attendance was small and the tone was cheerless. Very little iron changed hands, buyers being difficult to find notwithstanding the lowness of prices. Some merchants were very anxious to sell. First thing in the morning business was recorded at 45s. 6d. per ton for prompt f.o.b. delivery of No. 3 g.m.b. Cleveland pig iron, but only a small quantity was sold at that figure, and those who obtained it were indeed fortunate. As the day wore on affairs eased considerably, and plenty of No. 3 might have been bought at 45s. 3d., but purchasers would not as a rule give more than 45s. Middlesbrough warrants were steady at 45s. cash buyers, but very little business was done in them. Grey forge iron was sold at 43s., but several sellers asked rather more than that figure. No. 4 foundry changed hands at 44s. To-day affairs were a little better and prices advanced slightly, but as a matter of fact very little business was done. A small lot of No. 3 secured 46s., but that was for a special brand. The general figure for No. 3 was 45s. 6d., and that price was paid. Middlesbrough warrants were rather better, closing 45s. 3d. cash buyers. The hematite pig iron trade is rather easier, but a somewhat better demand is reported from the Sheffield district. The price, however, does not improve at all, for Nos. 1, 2, and 3 east-coast brands of makers' iron can be obtained at 56s. 6d., and even less might be accepted.

Manufactured Iron and Steel.—In the manufactured iron industry there is very little new. All the works keep well employed, and some producers have a good number of orders on hand, but others are rapidly getting through their contracts, and are rather anxious about new work, which they experience difficulty in securing. Common bars are 6*l.*; ship-plates, 6*l.*; and ship angles, 5*l.* 17s. 6d., all less 2½ per cent. discount for cash. The steel trade is quiet, but heavy rails are in rather better demand at 5*l.* Steel ship-plates are 6*l.* 5s. to 6*l.* 7s. 6d.

Cleveland Miners' Wages.—On Tuesday the Cleveland Miners' Association made application to the Cleveland Mineowners' Association for a 53 hours' week for mechanics employed about the mines, and requested an advance of 1d. per ton for all men working in fours. The employers will give their answer in the course of a few days.

Cleveland Institute of Engineers.—A day or two ago the annual meeting of the Cleveland Institute of Engineers was held in the hall of the Literary and Philosophical Society, Middlesbrough, the retiring president, Mr. Charles Wood, in the chair. The chairman moved the adoption of the annual report, which showed that during the past year there had been a loss of seventeen members and eight new members had joined, leaving a decrease of nine. The total number of members was now 207. The balance-sheet showed the Institute in debt to the secretary to the extent of 30*l.* 19s. Eight new members were elected, and Mr. Charles J. Bagley was elected president of the Institute for the ensuing year and took his position as chairman of the meeting amidst applause. A hearty vote of thanks was accorded Mr. Wood for his services as president during the past year. The new president said a good many of their friends had recently visited America, and he was sorry that none of them had come forward to read a paper on their experience. As they had not done so he would relate some of his experience in a visit to America in 1886. He was more struck with the progress made in the blast furnaces of America than in any other branch of the iron trade. He pointed out that in England they were a long way behind in the production of pig iron. It behoved them to do all in their power to bring themselves in a line with their competitors in America. He trusted they would soon regain their position. Mr. W. Henry Fryer presented a paper on "Desiccation of the Blast in the Manufacture of Pig Iron," which was taken as read. A discussion on the paper followed.

The Average Selling Price of Manufactured Iron and Steel.—The report of Mr. Waterhouse in connection with the wages sliding scale arrangement of the Board of Conciliation and Arbitration for the Manufactured Iron and Steel Trade of the North of England, has just been published by the joint secretaries, Messrs. G. R. Winpenny and Edward Trow. The report is for the two months ending October 31, and regulates the wages for the ensuing months of December and January. Having collected all information on the sales of manufactured iron during the period under consideration, Mr. Waterhouse certified the net average selling price per ton to have been 6*l.* 0s. 9d., as compared with 5*l.* 19s. 11.30d. for the preceding two months, an increase of 9.10d. per ton. The detailed particulars show that 708 tons of rails have been sold at an average net selling price of 5*l.* 14s. 9.29d., 23,529 tons of plates at 5*l.* 19s. 7.86d., 15,184 tons of bars at 6*l.* 6s. 8.24d., and 6782 tons of angles at 5*l.* 11s. 11.89d. Totals 46,202 tons 5 cwt. 3 qrs., averaged net selling price 6*l.* 0s. 9.19d. against 41,242 tons 18 cwt. 1 qr. 10 lb., and 5*l.* 19s. 11.30d. average net selling price last month, showing an increase both in quality and price. The improvement is not yet sufficient to bring an advance of wages, which are at present on the 6*l.* basis, above which they will not rise until the net selling price gets above 6*l.* 2s. 6d., or below which they will not fall until it gets below 5*l.* 17s. 6d.

American Intercontinental Railway.—Commissioners appointed to consider the most feasible plan for a grand trunk railway to connect the northern and southern continents of America are about to assemble at Washington.

LITERATURE.

The Patentee's Manual. A Treatise on the Law and Practice of Patents for Inventions, with an Appendix of Statutes, Rules, and Foreign and Colonial Patent Laws, International Convention and Protocol. By JAMES JOHNSON, of the Middle Temple, Barrister-at-Law, and J. HENRY JOHNSON, Solicitor, Assoc. Inst. C.E., Past President of the Institute of Patent Agents. Sixth Edition, revised and enlarged. London: Longmans, Green, and Co., Paternoster-row; Stevens and Sons, Limited, 119 and 120, Chancery-lane. 1890.

PROBABLY the old saying respecting the man who is his own lawyer is equally true of the inventor who is his own patent agent. Those who doubt this cannot do better than study with care the excellent work now before us. It is the sixth edition of a well-known manual, the bulk of which has necessarily increased with successive editions; and it is full of valuable and necessary information, skilfully condensed; this information, so far as regards our own law and practice, being based largely upon decided cases. In preparing the present edition of their work for the press, the authors —one of whom, as is well known, has had during the past forty years large experience in obtaining patents, and in the conduct of litigation arising out of them—have made considerable changes, not only by way of enlargement, but also in the arrangement of the matter. It is to be remembered that various alterations have been effected by recent Acts of Parliament: thus, as the authors tell us in their preface, the Act of 1883 abolished the Commissioners of Patents, who were replaced by the Board of Trade as the governing body of the Patent Office. The Comptroller-General is the chief officer of the Board, and upon him devolves the charge of managing the business and superintending the work of the office. The Board was authorised to make rules, having the same effect as if forming part of the Act, for regulating the conduct of patent business; and it has accordingly promulgated a long series of rules for that purpose, accompanied by forms. Then the following amongst other important alterations in the procedure are noticed. Non-inventors may join with inventors in applying for a patent. The applications and specifications are referred to official examiners, who report whether the documents are in proper form; if they are not in proper form the Comptroller may reject them or require them to be amended before acceptance, subject to appeal to a law officer. Oppositions to the grant of patents are decided by the Comptroller, subject to appeal to a law officer. The steps necessary to be taken for obtaining a patent are fewer. The Government fees are reduced from 25*l.* for a three years' patent to 4*l.* for a four years' patent, and the remaining fees of 50*l.* and 100*l.* may be paid in small annual sums. Applications for leave to amend specifications are decided in the first instance by the Comptroller, and on appeal by a law officer, and a new mode of obtaining the repeal of invalid patents is substituted for the old proceeding of *scire facias*.

Whilst the procedure has undergone great alterations, the substantive law has been but little touched. The old decisions of the Courts regarding the subject matter of patentable inventions, the incidence of utility and novelty which every patentable invention must possess, the contents of specifications, and the infringements of patents, still remain applicable to patents issued under the late Act. The duration of a patent is the same as before the Act of 1883, and its extent is practically the same, being only smaller by the omission of the Channel Islands. The principal changes to which the authors draw attention are that the Board of Trade is empowered to order patentees to grant licenses should they make default in granting them on reasonable terms; the right of the Crown to use patented inventions without making compensation is abolished. A patent may be assigned for any place in or part of the United Kingdom, and a British patent no longer comes to an end at the expiration of any earlier foreign patent for the same invention.

So much for the Act of 1883. Three supplementary Acts have made a few alterations in the details of procedure, and cleared away some doubts as to the meaning of certain provisions in the master Act. And by the latest of those Acts a Register of Patent Agents has been established, which has been committed to the charge of the Institute of Patent Agents.

As the authors truly remark, the changes effected have undoubtedly served to stimulate inventive talent. This has resulted largely from two changes that we strongly advocated prior to the passing of the Act of 1883, namely, the reduction in the Government fees payable for obtaining a patent in the first instance, and the provision for maintaining a patent by payment of the remaining fees in comparatively small annual sums. But in so far as the Act has had the effect of inducing inventors to rush to the Patent Office in reliance upon the sufficiency of the official examination, it is to be doubted whether the net result has been advantageous. It is well recognised that an official examination of documents does not, and cannot, insure that they shall be in the form best calculated to protect the inventor's interest, or in a form that will clearly convey to the public generally, and to manufacturers in particular, what it is that they are precluded from doing without the patentee's license. In a quite recent case the judge, before whom an action for infringement was being tried, remarked that the patentee had not been wise in preparing his own specification, and that the claims were by no means happily drawn. As a matter of fact, a badly drawn specification frequently leads to difficulties, and to outlays in respect of amendments far exceeding what would have been the cost of obtaining professional assistance in preparing the specification and obtaining the patent in the first instance. We say this because, whilst the work before us constitutes undoubtedly a most valuable book of reference for the inventor and patentee, we should not wish the reader to suppose that it will necessarily qualify him to act with advantage as his own patent agent. Whilst on the subject of patent agents, it may be remarked that the creation of a roll of patent agents, to which allusion is made in the work before us, has been of benefit in the past, and is likely to prove still more so in the future. No doubt admission to the register has, owing to the language of the Act itself, been obtainable in some instances more easily than is altogether desirable so far as the interests of inventors and the public are concerned. But this is a matter that will ultimately adjust itself, and year by year it is to be expected that the fact of a person being on the Register of Patent Agents will afford more and more satisfactory proof of his ability and integrity. Meanwhile the intending patentee, who diligently studies the work before us, will, at least, gain such an insight into the law and practice as will enable him to form a good judgment as to the qualification of any professional adviser he may consult. Not only are the provisions of the three supplementary Acts of Parliament, and of four new sets of official rules now consolidated with the previous rules noticed, but numerous decisions of the Courts during the last six years, many of which have an important bearing on the law of patents, are cited. Several chapters have been divided, with a view, as the authors tell us, to a fuller and more convenient treatment of the subjects, and additional chapters on other branches of the law have been introduced.

Reprints are given of all the Acts of Parliament which have any direct bearing on the subject of the work, as well as of the rules and forms issued by the Board of Trade under the authority of the Acts, of the rules framed by the law officers in regard to proceedings before them, and of the rules of the Privy Council with respect to applications for the extension of patents.

Great additions to and alterations in the patent laws of foreign states and British colonies have been made of recent years. The appendix contains summaries of the whole of these laws to date.

The Disposal of Household Wastes. By WILLIAM PAUL GERHARD, C.E., Consulting Engineer for Sanitary Works, New York City. New York: D. Van Nostrand Company. [Price 50 cents.]

This work is the 97th volume of the Van Nostrand Science Series, and may be said to be a companion to Mr. Gerhard's book on "House Drainage and Sanitary Plumbing," published in 1882 in the same series. Having regard to the necessity of universal acquaintance with the methods disposing of household waste and sewage, it is satisfactory to note that the language adopted is simple and free from technical details, the author treating the subject more as belonging to social than to engineering science. Dealing primarily with small cottages and farmhouses, where there is usually sufficient garden space to enable the farmer or labourer to return to the soil as manure the garbage from the household, the author offers general hints to stimulate common sense in the disposal of domestic refuse—vegetable matters, mineral waters, and miscellaneous coarse rubbish. Valuable suggestions are given as to earth closets. Liquid sewage is really what presents the greater difficulties. He condemns leaching cesspools, as all matter is thereby buried deep in the ground, remote from the cleansing and oxidising effect of the atmosphere, the purifying action of plant life, and of the help rendered by bacteria in the process of nitrification and destruction of organic matter, all of which are necessary in a satisfactory purifying scheme. Although not open to such serious objections and admissible where no other method can well be adopted, the tight cesspool is not advisable, as the stagnating sewage decomposes and generates injurious gases. Nor should sewage be discharged into streams nor into the sea, for obvious reasons. Purification is therefore desirable if not necessary, and natural processes are preferable. Mechanical filtration, subsidence, or precipitation with milk of lime, sulphate of alumina, perchloride of iron, or other chemicals, are alternatives, where natural methods cannot be adopted. Of the methods of applying sewage to land, broad irrigation is the least favourable, as it requires a large area of land, and in cases where the field is located close to the house it becomes objectionable on account of possible noxious odours. Intermittent downward filtration, while requiring a much smaller surface, is yet open to the second objection made to broad irrigation. Far preferable to these methods is the sub-surface irrigation system. This method consists of an absolutely tight receptacle or sewage tank, and a network of common 2-in. distribution drain tiles, laid in channels a few inches below the surface of the ground, with open joints for the liquid to ooze out of at numerous points. The discharge into the pipes must be intermittent, once a day, so as to scour the pipes and secure even distribution, and to afford time for the sub-surface to perform the work of purification. The system is based on the well-established fact that the well aërated layers of soil next the surface possess the power of destroying organic substance buried in them. The advantages and disadvantages of all methods are discussed in such a way as to give the reader the means of discerning the merits of all systems, while for large institutions similar details are published, with descriptions of works carried out in various parts, instructions to be observed by dwellers in towns are included; and in an appendix are given draft specifications for various methods of disposing of sewage.

BOOKS RECEIVED.

Utilisation de la Force Motrice des Marées. Par J. DIAMANT. Paris: Baudry et Cie.

Handbook for Mechanical Engineers. By HENRY ADAMS. Second Edition, revised and enlarged. London and New York: E. and F. N. Spon.

Elementary Mechanics. By EDWARD P. CULVERWELL, M.A. London and New York: Longmans, Green, and Co. [Price 3s. 6d.]

Blackie's Modern Cyclopædia of Universal Information. Edited by CHARLES ANNANDALE, M.A., LL.D. London: Blackie and Son, Limited.

Fuels, Solid, Liquid, and Gaseous; their Analysis and Valuation. By H. JOSHUA PHILLIPS, F.C.S. London: Crosby Lockwood and Son.

MODERN FRENCH ARTILLERY.
No. XLV.
CANET NAVAL GUNS.

MOST of the standard types of heavy ordnance are available either for coast defence or for mounting on board ship, and in dealing with this class of guns made by the Forges et Chantiers de la Mediterranée on the Canet system, it may be understood that they can be used indifferently for either purpose. The gunshops at Havre are adapted for producing such ordnance from 9 to 42 centimetres (3.54 in. to 16.54 in.) bore, and of lengths up to 50 calibres. The heaviest pattern, however, made up to the present time at the works is the 32-centimetre (12.60 in.), 66 tons in weight, and of which three are being executed for the Japanese Government. It is not probable, indeed, that this calibre and weight will be exceeded, as the experience derived with the largest guns, points to a reduction rather than an increase of proportion. The section we published in a previous issue (see Fig. 192 on the two-page engraving of our issue of May 16th last) shows the form adopted for this heavy ordnance, while the fullest particulars

CANET BREECHLOADING MECHANISM FOR NAVAL GUNS.

(*For Description, see Page* 653.)

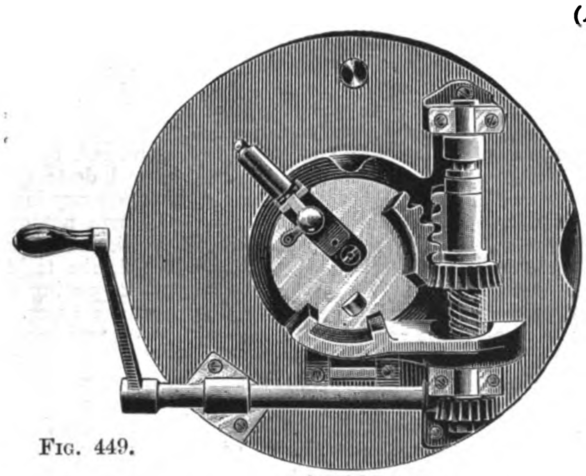


FIG. 449.

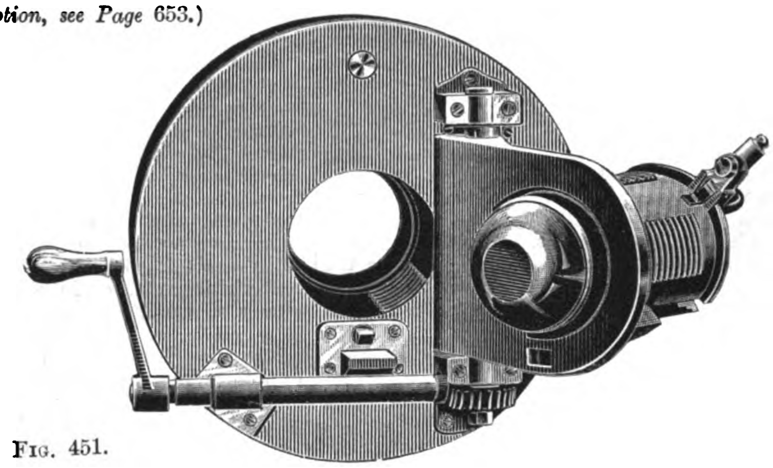


FIG. 451.

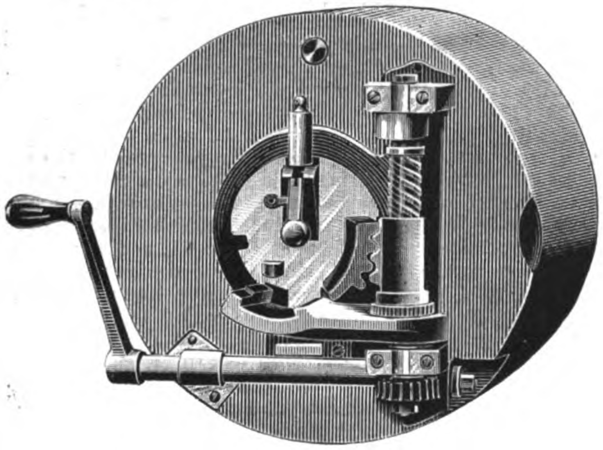


FIG. 450.

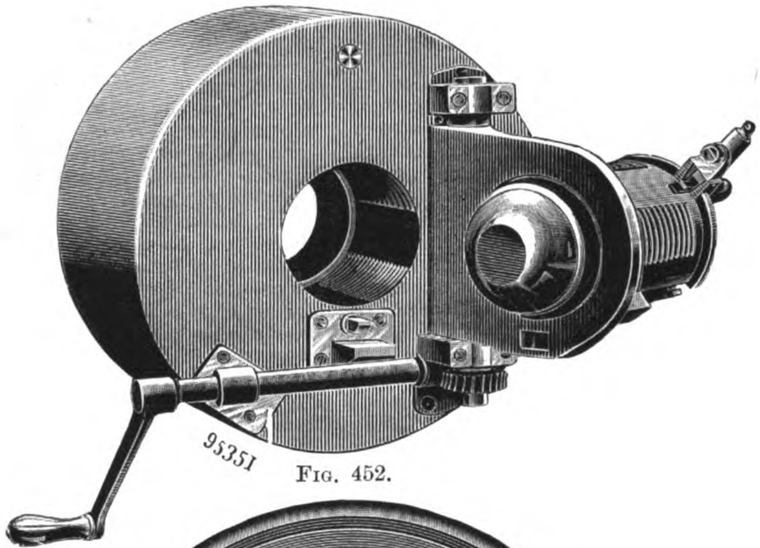
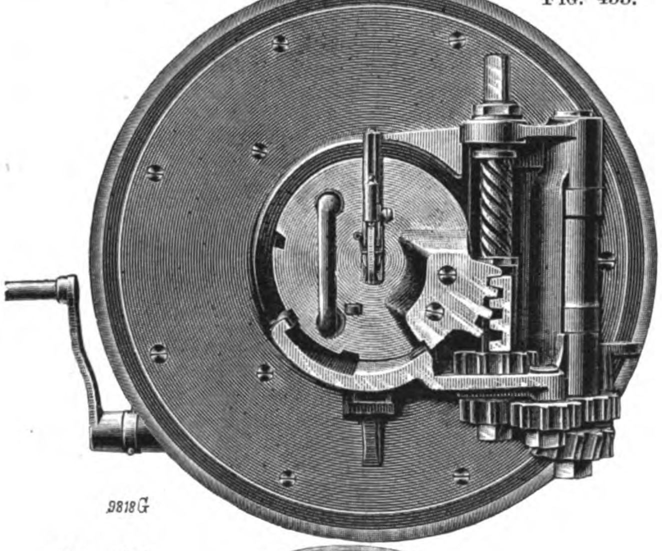


FIG. 452.

FIG. 453.



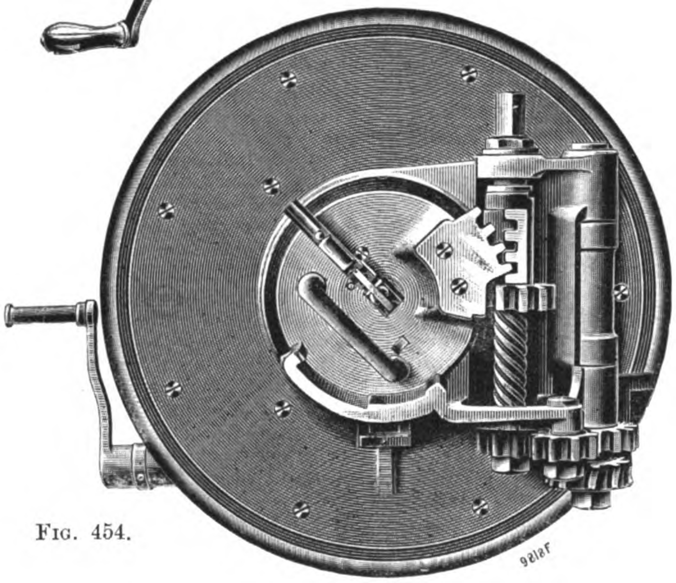


FIG. 454.

FIG. 455.

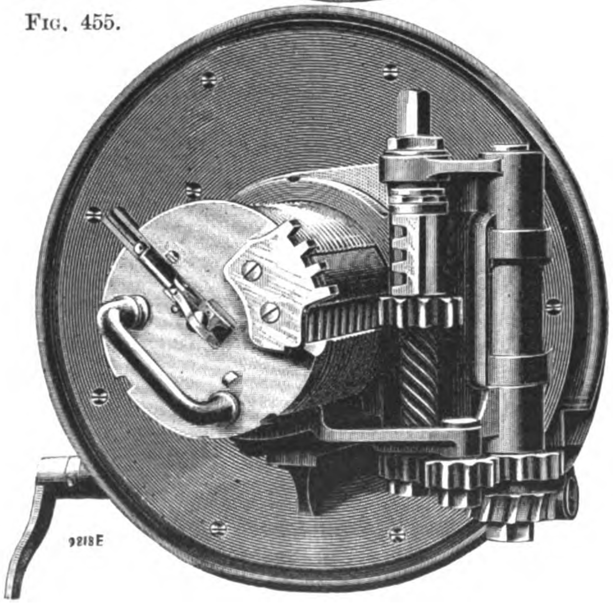
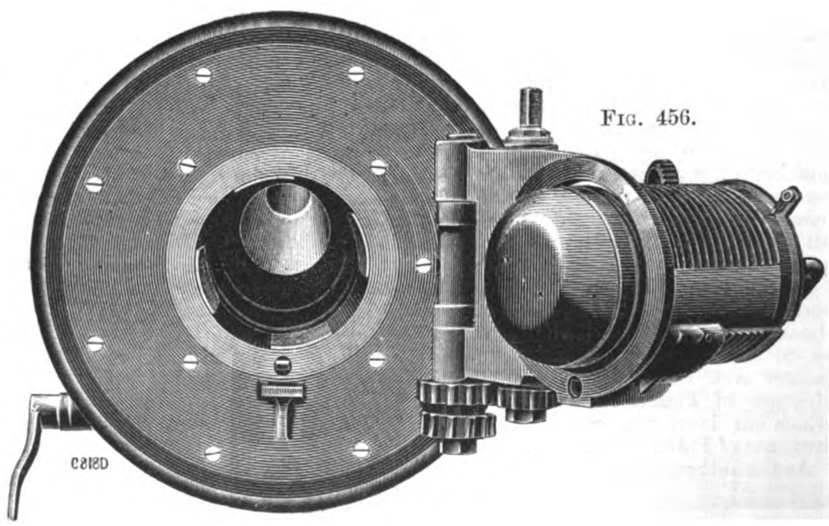


FIG. 456.



14-CENTIMETRE NAVAL GUN AND CARRIAGE; CANET SYSTEM.

(*For Description, see Page 657.*)

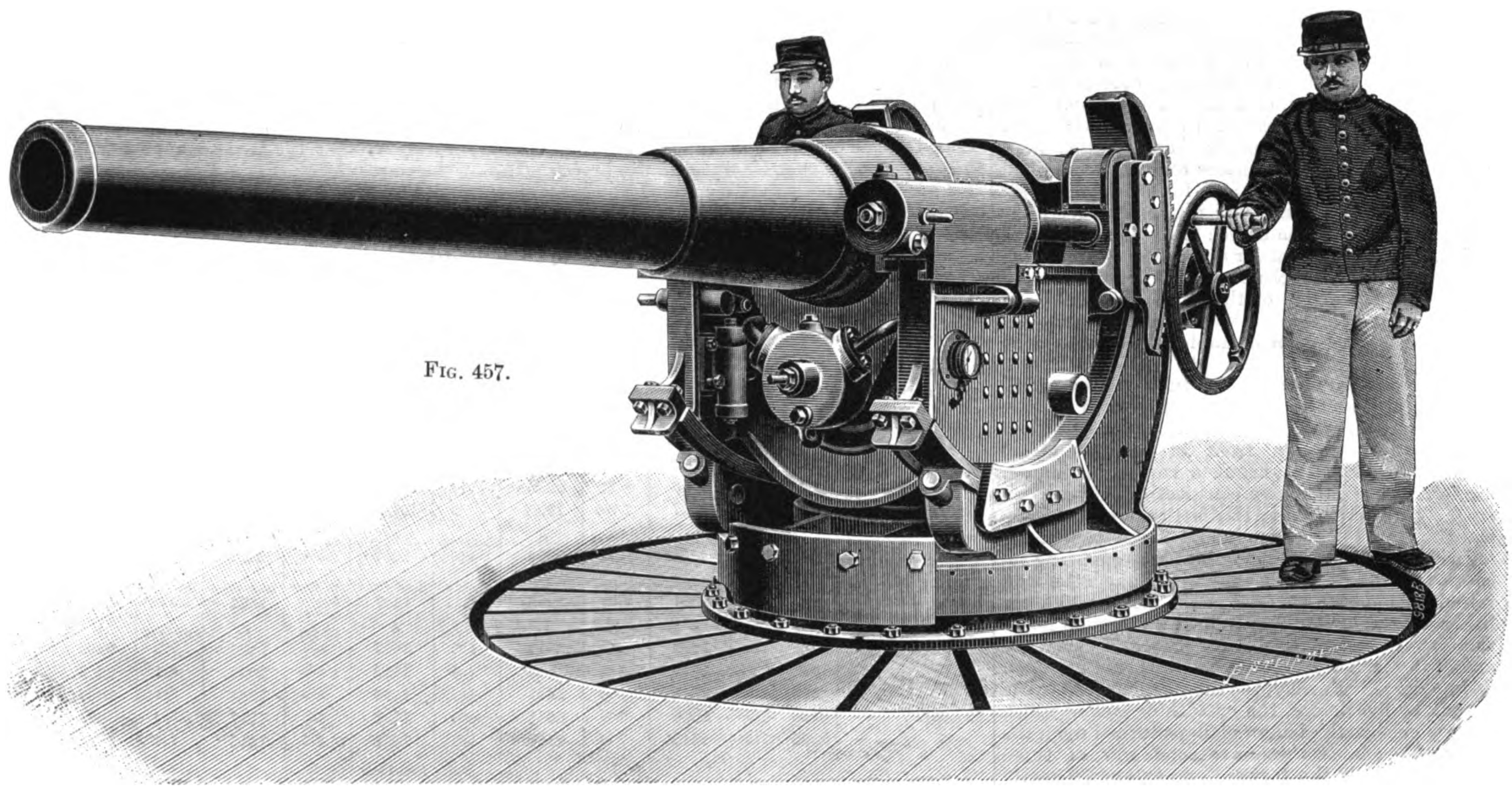


Fig. 457.

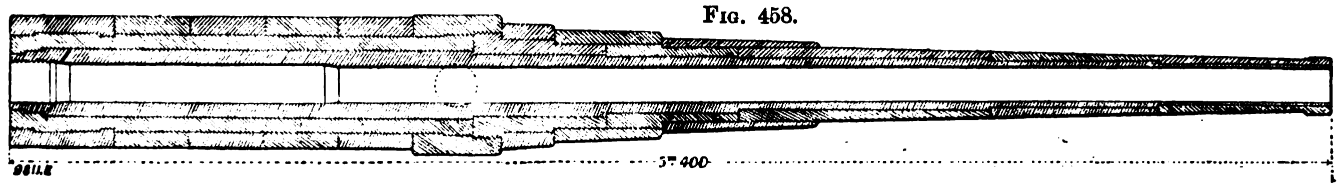


Fig. 458.

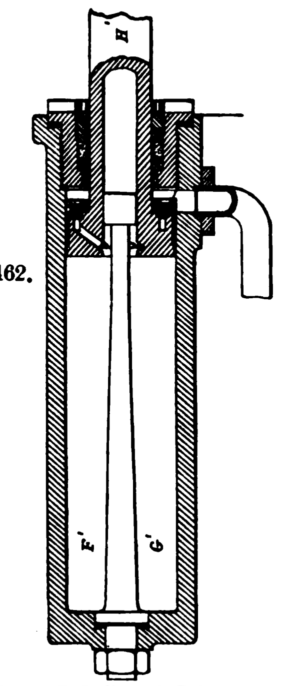


Fig. 462.

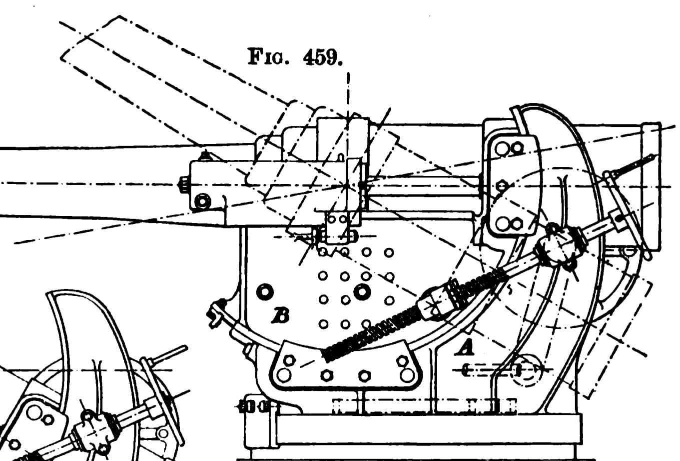


Fig. 459.

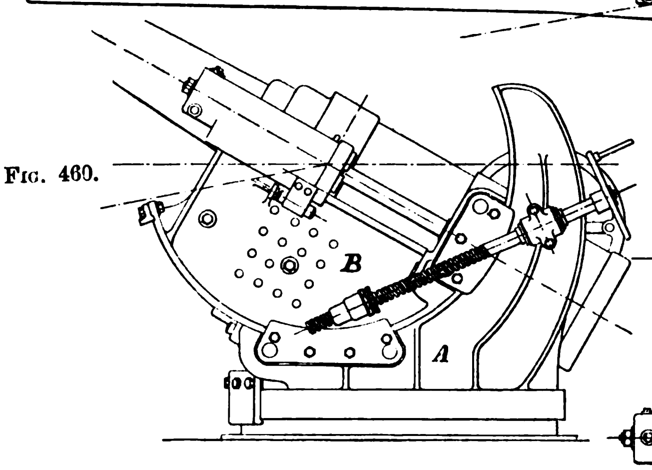


Fig. 460.

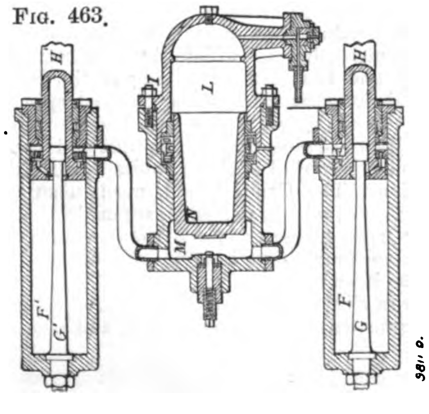


Fig. 463.

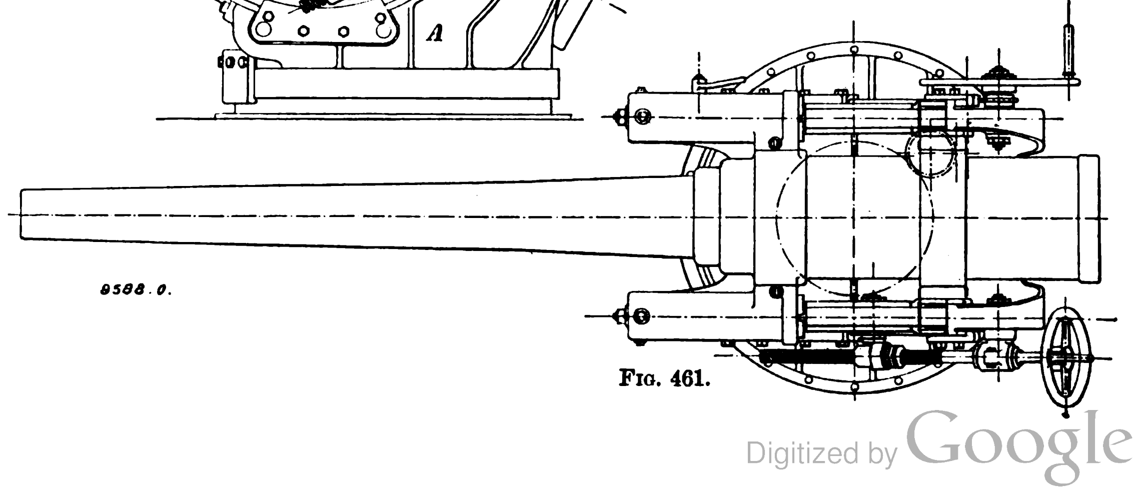


Fig. 461.

are given in the series of Tables accompanying these articles. We may however give a few details as to the mode of manufacturing these guns, which will apply in general to the various sizes made. It may be mentioned that they differ in some details according to the purpose for which they are intended, and of course the mode of mounting them also varies. From the section of the naval gun shown in Fig. 458, page 655, it will be seen that it consists of a long central tube extending for the whole length of the gun; this tube, however, is not by any means of uniform thickness. Its maximum outside diameter extends to a point in front of the trunnions, and for this length the outer diameter is uniform; inside, however, the tube is enlarged at the breech to receive the breech screw, and beyond that for a considerable distance to form the powder chamber. Beyond the trunnions the diameter of the tube is reduced by five successive steps, so that at the muzzle its thickness is very inconsiderable. It will be seen from the engraving that at the breech two shoulders are turned upon the tube; these projections form an abutment for the ends of the jacket which extends as far as the first reduction in the tube in front of the trunnions. Around this jacket is shrunk a row of six hoops, the most forward of these constituting the trunnion ring. The section shows that both the breech hoop and the trunnion ring are bound to the jacket, the former by projections fitting into corresponding recesses turned out of the jacket, and the latter by a raised shoulder on the end of the jacket which fits into a corresponding recess in the trunnion hoop; the forward end of this latter projects beyond the end of the jacket and has a screw thread cut upon its inner face. Beyond, the tube is reinforced to the muzzle by five hoops, the breadth of each of which corresponds to the length of steps turned upon the inner tube; over these a second row of three hoops is shrunk, the forward one extending nearly midway between trunnions and muzzle. It will be seen from the foregoing description and the section, that the object aimed at in designing this gun is to obtain a high degree of longitudinal strength by the system of interlocking adopted; it may be mentioned that all the guns made at Havre above 15 centimetres (which is the calibre illustrated in Fig. 458) have the same principle of construction. The diameter of the powder chamber for the 15-centimetre gun is 7.08 in. and its length is about 6.5 calibres; the length of the rifled portion is about 27.5 calibres. The normal charge of this gun is 60 lb. of prismatic brown powder, which corresponds to the French regulation powder PB_3S; the projectile weighs 92.5 lb. and the initial velocity is 2300 ft.

Various devices for actuating the breech mechanism are employed, all of them characterised by the screwed breech-block and De Bange (modified) obturator, and having the same feature in common of a swinging bracket to receive the block when it is withdrawn from its seating. Figs. 442 to 446 (page 658) illustrate one form of mechanism. In this arrangement the block is temporarily attached to the bracket by means of a latch *a* hinged in the centre, and having a projection at each end, engaging respectively in a recess in the block and one secured to the breech of the gun. The hand lever by which the block is turned is set at an angle of 60 deg., when the breech is closed. The movable head of the obturator and its auxiliary parts have a special arrangement to which attention should be called, the object being to maintain the fuze always in contact with the bolt, in spite of any reduction in thickness of the obturator in consequence of repeated firing. For this purpose the bolt is formed of two pieces so connected together that they have a certain range of movement on one another; one of these pieces D carries the striker, and the other, the hammer *c* and the various parts of the safety device. At the rear of the movable head is placed the piece *c* containing a groove in which the part D of the bolt slides, while the part E is retained by the groove in the face of the breech. In order to fire the gun the hammer is withdrawn by hand, but this can only be done when the end *b* of the bolt occupies the enlarged part of the groove B. As will be seen from the engravings, when the block has been turned by the starting lever till the threads are disengaged, it can be withdrawn on to the bracket, which is bolted to the breech of the gun, and swung back out of the way for reloading. A cam placed at the end of the starting lever serves to increase the effort that is necessary to move the block in its seating, to subdue the expansion of the obturator wad.

Figs. 447 and 448 illustrate another system of mechanism, in which all the operations of opening and closing the breech are performed by a continuous rotary movement. This is specially designed for large calibres, in order to avoid the use of hydraulic or other mechanical appliances, sometimes necessary in handling the heavy weights involved. The block A, which has four sectors of screw threads cut on it, is supported, when out of the gun, by a bracket C hinged to the breech. The ring carrying the block is secured to the bracket by a bolt *h* of the ordinary Canet system, and which turning, the sleeve F is forced to rise, and the movement of the rack *b* makes the screw block turn; one-eighth of a revolution of the latter is completed when the sleeve arrives at the top of its travel. By this movement the teeth of the pinion *e* are brought opposite an opening formed in the groove on the bracket mounting; it begins to turn, and gearing, first with a rack cut in the block, and afterwards with its screw threads, it withdraws the block from its seating. When this is done the bolt *i* is thrown into action and holds the block securely, so that the latter can be swung back out of the way. A reverse series of operations is required to close the gun. The firing mechanism comprises the bolt G that slides in a groove cut in

TABLE LVI.—BALLISTICAL DATA OF 12 CENT. NAVAL CANET GUNS, CONSTRUCTED BY THE FORGES ET CHANTIERS DE LA MEDITERRANEE, HAVRE.

Length of Gun.			25 Calibres.		30 Calibres.		36 Calibres.		43 Calibres.		50 Calibres.	
			in.	mm.	in.	mm.	in.	mm.	in.	mm.	in.	mm.
Calibre			4 72	120	4.72	120	4.72	120	4.72	1.0	4.72	120
Total length of gun			118.1	3000	141.7	3600	170.1	4320	203.2	5160	236.2	6000
			tons	kilos.	tons	kilos.	tons	kilos.	tons	kilos.	tons	kilos.
Weight of gun			1.772	1800	2.411	2450	2.757	2800	3.546	3600	4.200	4250
			lb.		lb.		lb.		lb.		lb.	
„ shell			46 3	21	46.3	21	46.3	21	46.3	21	46.3	21
„ powder charge ..			15.87	7.200	19.84	9	24.25	11	28.67	13	33.2	15
			ft.	metres	ft.	metres	ft.	metres	ft.	metres	ft.	metres
Initial velocity			1770	540	2000	610	2230	680	2421	740	2625	800
			foot-tons	m. tns.	foot-tons	m.-tns.	foot-tons	m. tons	foot-tons	m. tons	foot-tons	m.-tns.
Energy at muzzle			1007	3120	1285	398.15	1597	494.77	1891	585.93	2211	684.8
	yds.	m.	ft.	metres	ft.	metres	ft.	metres	ft.	metres	ft.	metres.
Remanent velocities at	547	500	1600	488	1810	552	2017	615	2205	673	2402	733
	1094	1000	1449	442	1636	499	1822	556	2036	621	22.6	676
	1641	1500	1311	400	1481	452	1649	503	1881	574	2050	625
	2188	2000	1200	366	1341	409	1491	455	1737	530	1894	578
	2735	2500	1113	340	1222	373	1357	414	1606	490	1751	534
			foot-tons	m. tns.	foot-tons	m.-tns.	foot-tons	m. tons	foot-tons	m. tons	foot-tons	m.-tns.
Striking energy at	547	500	823	254.81	1052	326.03	1303	404.70	1565	484.63	1857	574.90
	1094	1000	675	209.04	859	266.03	1068	330.77	1332	412.64	1580	488.96
	1641	1500	653.6	171.20	706.1	218.61	874	270.72	1136	352.54	1350	417.97
	2188	2000	463.2	143.33	578.2	178.99	715.6	221.52	969	300.56	1155	357.47
	2735	2500	340	123.69	480.7	148.87	592.6	183.39	830	256.91	985	305.12
Striking energy in foot and metric tons per inch and per cent. of circumference of projectile ..	At muzzle		63.8	8.38	87.70	10.69	109.0	13.29	129.0	15.74	150.9	18.39
	547	500	56.1	6.84	71.75	8.75	89.15	10.87	106.8	13.02	127.6	15.44
	1094	1000	46.0	5.61	58.66	7.15	72.8	8.88	90.95	11.08	107.7	13.13
	1641	1500	37.71	4.60	48.15	5.87	59.65	7.27	77.7	9.47	92.0	11.22
	2188	2000	31.53	3.85	39.39	4.80	49.00	5.95	66.21	8.07	78.71	9.60
	2735	2500	27.22	3.32	32.81	4.00	40.36	4.92	56.60	6.90	67.12	8.19
			in.	cm.	in.	cm.	in.	cm.	in.	cm.	in.	cm.
Thickness of wrought-iron plate penetrated (Gârve formula)	At muzzle		6.49	16.5	7.75	19.7	9.05	23.0	10.19	25.9	11.37	28.9
	547	500	5.62	14.3	6.69	17.0	7.83	19.9	8.89	22.6	10.05	25.5
	1094	1000	4 87	12.4	5.73	14.7	6.76	17.2	7.95	20 2	8.97	22.8
	1641	1500	4 25	10.8	5.03	12.8	5.86	14.9	7.07	18.0	7.99	20.3
	2188	2000	3.71	9.5	4.33	11.1	5.07	12.9	6.33	16.1	7.16	18.2
	2735	2500	3.33	8.5	3.82	9.7	4.44	11.3	5.27	13.4	6.41	16.3
	deg.		yards	metres	yards	metres	yards	metres	yards	metres	yards	metres
Ranges at different angles	3		2.435	2,225	2,906	2,655	3,300	3,025	3,710	3,390	4,030	3,685
	5		3,610	3,300	4,320	3,945	4,893	4,470	5,343	4,885	5,768	5,270
	7		4,811	4,400	5,510	5,035	6,195	5,660	6,716	6,130	7 278	6,560
	10		6,255	5,720	7,081	6,470	7,835	7,250	8,330	7,615	8,950	8,180
	15		8,220	7,515	9,170	8,375	10,040	9,180	10,630	9,760	11,250	10,285
	20		9,730	8,895	10,805	9,885	11,750	10,735	12,440	11,360	13,030	11,905
	25		10,353	9,925	12,100	11,045	11 975	11,940	13,780	12,580	14,370	13,140
	30		11.618	10,625	13,060	11,925	14,055	12,835	14,770	13,495	15,380	14,065
	35		12,120	11,085	13,730	12,540	14,750	13,465	15,430	14,130	16,080	14,705

has been already described; part of the bolt moves up and down vertically in the bracket, and engages in the ring when it is desired to lock it. The axis on which the bracket turns is vertical, and is carried in suitable bearings X bolted to the breech of the gun; the axis is cut with four threads as shown, and at the bottom, under the lower bearing, is a wormwheel Y gearing into an endless screw mounted on the end of the horizontal spindle by which motion is imparted through the handle E. On the screwed axis, and extending for about half its length, is a deep nut, that carries below a toothed wheel *e*. Round the nut is placed the sleeve F; on the forward part of this sleeve is a projection *d* that works in the vertical guides made in the back of the bracket, and on one side is the rack *b* that gears into a toothed quadrant arm *c* made in one piece with the breechblock. When the hand lever E is turned, the axis D is caused also to turn through the wormwheel Y, but at first the teeth of the wheel *e* on the nut working on the axis D are held by the sides of the groove *l* of the bracket; as it is prevented from the block, and having a small roller *m* at the upper end. As the block is turned, this roller travels up an inclined face *n* formed on the outside of the bracket and lifts the bolt. In this position the heel of the hammer H strikes against the stop *p*, and the coiled spring *s* is compressed, ready for firing. The movement of the bolt is also made use of for extracting the fuze. Figs. 449 to 452, page 654, show the mechanism in four successive positions.

Figs. 453 to 456 show a very similar form of this arrangement, but in which the axis carrying the bracket and the supporting ring of the block is only used for that purpose, a screwed spindle being introduced between this axis and the ring, which carries the rising and falling nut and rack, motion being imparted to this spindle by an additional pinion. The Canet breech mechanism for quick-firing guns, which, of course, are made almost wholly for naval purposes, have been already described in so much detail as to render further reference to it unnecessary.

We may in this place refer to a mode of mounting naval guns employed by M. Canet, and a modi-

MODERN FRENCH ARTILLERY; PARTICULARS OF NAVAL GUNS.

TABLE LVII.—BALLISTICAL DATA OF 14 CENT. NAVAL CANET GUNS. CONSTRUCTED BY THE FORGES ET CHANTIERS DE LA MEDITERRANEE, HAVRE.

Length of Gun			25 Calibres.		30 Calibres.		36 Calibres.		43 Calibres.		50 Calibres.	
			in.	mm.	in.	mm.	in.	mm.	in.	mm.	in.	mm.
Calibre			5.51	140	5.51	140	5.51	140	5.51	140	5.51	140
Total length of gun			137.3	3500	165.4	4200	196.5	5040	237.0	6020	275.6	7000
			tons	kilos.	tons	kilos.	tons	kilos.	tons	kilos.	tons	kilos
Weight of gun			2.811	2860	3.830	3890	4.33	4450	5.61	5700	6.64	6750
			lb.		lb.		lb.		lb.		lb.	
" shell			74.9	34	74.9	34	74.9	34	74.9	34	74.9	34
" powder charge			25.6	11.6	33.1	15	39.7	18	46.3	21	52.9	24
Initial velocity			1770	540	2000	610	2230	680	2424	740	2625	800
Striking energy			1631	505.31	2031	644.81	2587	801.29	3064	948.94	3581	1109.06
	yds.	m.	ft.	metres	ft.	metres	ft.	metres	ft.	metres	ft.	metres
Remanent velocities at	547	500	1626	496	1840	561	2045	624	2230	680	2433	742
	1094	1000	1495	456	1685	514	1879	573	2052	626	2259	689
	1641	1500	1374	419	1551	473	1691	526	1885	575	2066	630
	2188	2000	1285	386	1423	434	1583	483	1731	528	1902	580
	2735	2500	1177	350	1309	399	1456	444	1590	485	1804	550
			foot-tons	m. tons	foot-tons	m. tons	foot-tons	m. tons	foot-tons	m. tons	foot-tons	m. tons
Striking energy at	547	500	1376	426.32	1771	545.38	2180	674.75	2590	801.29	3081	954.07
	1094	1000	1164	360.33	1479	457.82	1837	568.96	2191	679.08	2655	822.64
	1641	1500	932	304.29	1252	387.70	1547	479.45	1850	572.94	2220	687.79
	2188	2000	834	258.19	1054	326.40	1307	404.27	1560	483.10	1882	582.95
	2735	2500	721.1	223.34	890.5	275.88	1103	341.62	1315	407.62	1683	524.20
Striking energy in foot and metric tons per inch and per cent. of circumference of projectile	At muzzle		95.2	11.61	121.5	14.82	151.0	18.41	179.0	21.81	2089	25.49
	547	500	80.4	9.80	102.75	12.53	127.20	15.51	151.0	18.41	179.0	21.93
	1094	1000	67.9	8.23	84.2	10.52	107.2	13.07	128.8	15.61	155.0	18.90
	1641	1500	57.42	7.00	73.10	8.91	90.4	11.02	108.0	13.17	129.60	15.81
	2188	2000	43.65	5.93	61.5	7.50	76.2	9.29	91.0	11.10	109.9	13.40
	2735	2500	42.03	5.13	52.0	6.34	64.4	7.85	76.88	9.37	98.75	12.05
			in.	cm.	in.	cm.	in.	cm.	in.	cm.	in.	cm.
Thickness of wrought-iron plate penetrated (Gâvre formula)	At muzzle		8.19	20.8	9.76	24.8	11.41	29.0	12.87	32.7	14.41	36.6
	547	500	7.28	18.5	8.66	22.0	10.08	25.6	11.41	29.0	12.91	32.8
	1094	1000	6.45	16.4	7.63	19.4	8.93	22.7	10.11	25.7	11.61	29.5
	1641	1500	5.70	14.5	6.76	17.2	7.91	20.1	8.87	22.8	10.23	26.0
	2188	2000	5.07	12.9	5.98	15.2	6.96	17.7	7.95	20.2	9.09	23.1
	2735	2500	4.56	11.6	5.31	13.5	6.21	15.8	7.04	17.9	8.42	21.4
	deg.		yards	metres	yards	metres	yards	metres	yards	metres	yards	metres
Range at different angles	3		2,483	2,270	2,975	2,720	3,413	3,120	3,823	3,495	4,173	3,815
	5		3,702	3,385	4,446	4,065	5,059	4,625	5,551	5,075	6,015	5,500
	7		4,955	4,530	5,698	5,210	6,431	5,880	6,989	6,390	7,175	6,560
	10		6,469	5,915	7,339	6,710	8,192	7,490	8,717	7,970	9,390	8,585
	15		8,536	7,805	9,565	8,745	10,516	9,615	11,167	10,210	11,856	10,840
	20		10,134	9,265	11,309	10,340	12,332	11,275	13,092	11,970	13,754	12,575
	25		11,331	10,360	12,682	11,595	13,743	12,565	14,525	13,280	15,170	13,870
	30		12,146	11,105	13,694	12,520	14,793	13,525	15,597	14,260	16,220	14,830
	35		12,660	11,575	14,410	13,175	15,496	14,170	16,346	14,945	16,969	15,515

TABLE LVIII.—BALLISTICAL DATA OF 15 CENT. NAVAL CANET GUNS. CONSTRUCTED BY THE FORGES ET CHANTIERS DE LA MEDITERRANEE, HAVRE.

Length of Gun			25 Calibres.		30 Calibres.		36 Calibres.		43 Calibres.		50 Calibres.	
			in.	mm.	in.	mm.	in.	mm.	in.	mm.	in.	mm.
Calibre			5.9	150	5.9	150	5.9	150	5.9	150	5.9	150
Total length of gun			147.6	3750	177.2	4500	212.7	5400	253.9	6450	295.3	7500
			tons	kilos.	tons	kilos.	tons	kilos.	tons	kilos.	tons	kilos.
Weight of gun			3.411	3470	4.670	4750	5.61	5700	7.47	7600	8.41	8550
			lb.		lb.		lb.		lb.		lb.	
" shell			92.59	42	92.59	42	92.59	42	92.59	42	92.59	42
" powder charge			31.53	14.3	39.63	18	48.50	22	57.32	26	66.14	30
Initial velocity			1770	540	2000	610	2230	680	2424	740	2625	800
Striking energy			2016	624.22	2571	796.5	3197	980.85	3790	1172.3	4424	1370
	yds.	m.	ft.	metres	ft.	metres	ft.	metres	ft.	metres	ft.	metres
Remanent velocities at	547	500	1637	499	1850	564	2060	628	2250	686	2443	745
	1094	1000	1511	461	1709	521	1906	581	2080	634	2265	691
	1641	1500	1400	427	1577	481	1758	536	1919	585	2094	639
	2188	2000	1295	395	1460	445	1626	496	1774	541	1937	591
	2735	2500	1206	368	1350	412	1503	458	1639	500	1790	546
			ft.-tons	m. tons	foot-tons	m. tons	foot-tons	m. tons	foot-tons	m. tons	foot-tons	m. tons
Striking energy at	547	500	1786	553.0	2200	680.9	2725	844.24	3254	1007.4	3838	1188.10
	1094	1000	1470	454.9	1877	581.2	2333	722.61	2781	860.45	3300	1021.10
	1641	1500	1261	390.3	1599	494.9	1987	615.0	2333	732.59	2823	874.08
	2188	2000	1079	334.0	1369	423.9	1700	526.64	2022	626.53	2410	745.93
	2735	2500	938.5	290.6	1174	363.4	1450	449.04	1729	535.17	1960	606.92
Striking energy in foot and metric tons per inch and per cent. of circumference of projectile	At muzzle		110.0	13.42	140.5	17.13	174.5	21.29	206.9	25.21	241.5	29.46
	547	500	94.0	11.46	120.	14.64	149.0	18.16	177.6	21.67	209.5	25.55
	1094	1000	80.2	9.78	102.3	12.49	127.4	15.54	151.8	18.51	180.1	21.98
	1641	1500	68.7	8.39	87.4	10.65	108.4	13.23	129.1	15.75	154.0	18.79
	2188	2000	58.88	7.18	74.8	9.12	100.6	12.27	110.4	13.47	131.5	16.04
	2735	2500	51.26	6.25	64.05	7.81	792.2	9.66	94.5	11.51	112.5	13.72
			in.	cm.	in.	cm.	in.	cm.	in.	cm.	in.	cm.
Thickness of wrought-iron plate penetrated (Gâvre formula)	At muzzle		9.09	23.1	10.82	27.5	12.64	32.1	14.29	36.3	15.55	39.5
	547	500	8.15	20.7	9.68	24.6	11.30	28.7	12.79	32.5	14.41	33.6
	1094	1000	7.24	18.4	8.62	21.9	10.12	25.7	11.45	29.1	12.95	32.9
	1641	1500	6.10	15.5	7.32	18.6	9.01	22.9	10.19	25.9	11.57	29.4
	2188	2000	5.82	14.8	6.88	17.5	8.54	21.7	9.13	23.2	10.31	26.2
	2735	2500	5.27	13.4	6.17	15.7	7.2	18.3	8.15	20.7	9.25	23.5
	deg.		yards	metres	yards	metres	yards	metres	yards	metres	yards	metres
Range at different angles	3		2,494	2,280	2,991	2,735	3,470	3,170	3,850	3,520	4,206	3,845
	5		3,726	3,405	4,490	4,095	5,108	4,670	5,596	5,115	6,056	5,535
	7		4,990	4,560	5,744	5,250	6,505	5,945	7,060	6,450	7,579	6,925
	10		6,515	5,955	7,415	6,775	8,280	7,565	8,800	8,045	9 480	8,670
	15		8,605	7,865	9,655	8,825	10,650	9,740	11,330	10,365	11,990	10,960
	20		10,200	9,330	11,415	10,440	12,510	11,430	13,250	12,105	13 940	12,730
	25		11,405	10,430	12,795	11,695	13,940	12,740	14,700	13,430	15,400	14,070
	30		12,230	11,185	13,830	12,645	15,020	13,725	15.800	14,430	16,500	15,080
	35		12,785	11,685	14,565	13,315	15,885	14,515	16,550	15,125	17,270	15,790

fication of which for coast defence has been referred to. This system is illustrated by Figs. 457 to 463, page 655; the special object of the arrangement is to reduce to a minimum the shock upon the deck of a ship resulting from firing. In this arrangement the underframe, which is circular, rests upon a bedplate by means of a ring of rollers and is attached to it by clips; the gun and carriage are thus free to turn upon the central pivot of the bedplate. The form of the underframe A is shown clearly in the drawings, where it will be seen that the bearing surface for the carriage is the arc of a circle, the bottom of the carriage being made to the same curve; this carriage constitutes in effect a part of the gun, it being secured to the latter by hoops shrunk over it, and to which are secured the two brake cylinders that take their bearing on the top horizontal surface of the carriage. In order to give any desired angle of inclination to the gun, it is caused to turn with the carriage in the circular bearing for the underframe with which it is held in contact by the clip-plates shown. The lower clip on each side is fixed to the underframe and serves as a guide to a projecting rib in the carriage; the upper one is bolted to the carriage and is guided by a rib on the underframe. The position of the brakes is shown clearly in the perspective view, and the section Fig. 463 illustrates the connection between the brake cylinders and the central compressed air cylinder, by means of which the gun is brought back into firing position. From this section it will be seen that the principle upon which the brakes are constructed is similar to that which has been already described in previous articles, with the difference that in the present case the cylinders F F move to and fro with the counter-rods of varying section bolted to them, while the pistons H and H' are fixed. The compressed air cylinder shown between the two brake cylinders is placed within the frame and immediately beneath the gun, as seen in the perspective view; the section shows the hemispherical cover which is bolted to the cylinder at L, and which forms the reservoir for the compressed air. In the lower part of the cylinder is a trunk piston, on the outer side of which is a space communicating freely by pipe connections with the brake cylinders. As soon as the action of recoil is set up, the liquid in the cylinders F F' is forced into the central reservoir, driving up the piston and compressing the air on the other side; the air thus stored up, as soon as the action of recoil is terminated, forces back the piston, restoring the brake cylinders to their normal posi-

CANET BREECHLOADING MECHANISM FOR NAVAL GUNS.

(*For Description, see Page* 656.)

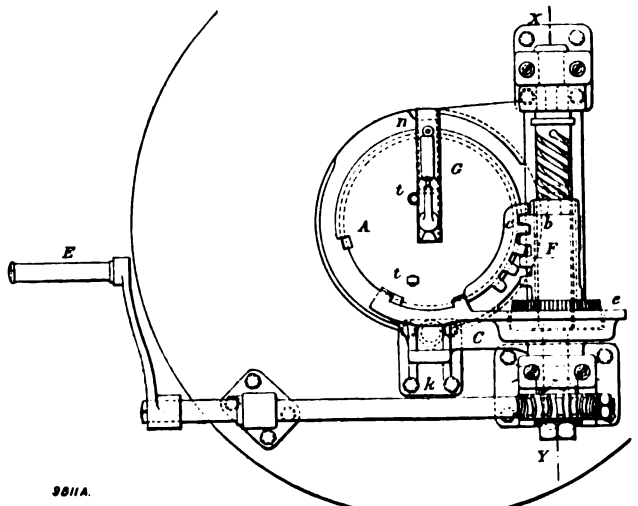


FIG. 447.

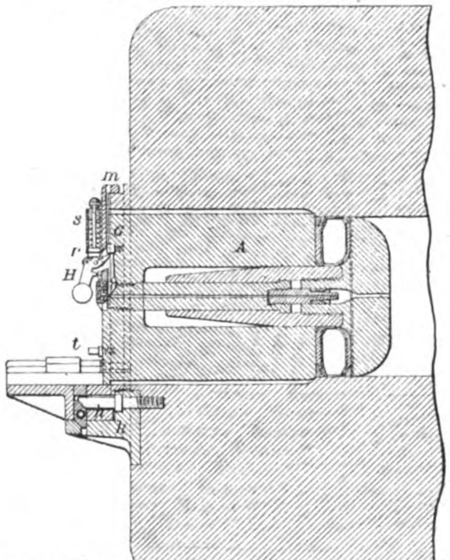


FIG. 442.

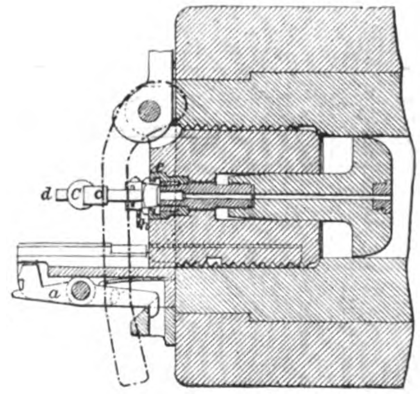


FIG. 443.

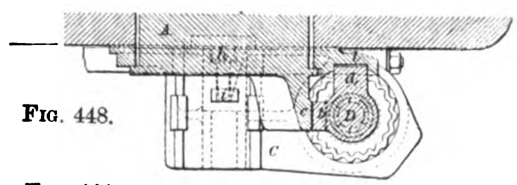


FIG. 448.

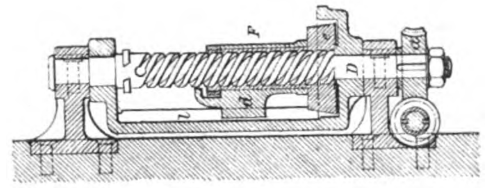


FIG. 449.

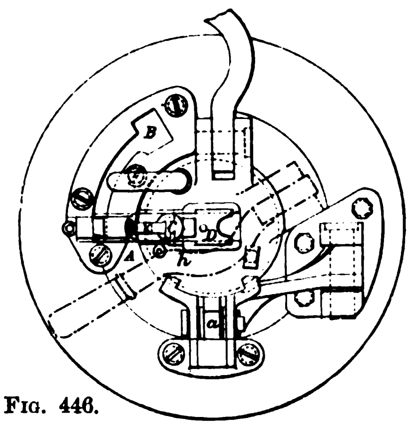


FIG. 446.

FIG. 444.

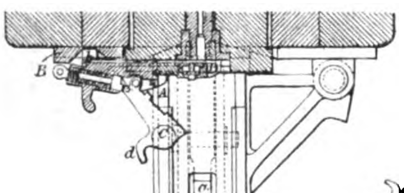
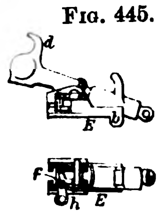


FIG. 445.



tion, and bringing the gun into place. Fig. 462 is an enlarged view of one of the brake cylinders. Training for elevation is effected either by means of a toothed quadrant and pinion gearing into it and worked direct by a handwheel as shown in the perspective view, or by an inclined screw acting on a nut bolted to the carriage. The gun is trained horizontally by an endless chain driving a pinion that gears into a circular rack on the bedplate. The weight of this mounting for the gun illustrated (14-centimetre) is about 3.4 tons.

SUBMARINE MINES.

Critique on Major G. S. Clarke's Second Paper on "Submarine Mines in relation to War."

By Lieut.-Colonel J. T. BUCKNILL, late Major R.E.

(*Concluded from page* 643.)

MAJOR CLARKE honours me with some notice by criticising the mine defence for New York Harbour, which is described in my book on "Submarine Mines and Torpedoes" (1889). He states that the New York defence design is based upon the plea that a hostile force can be landed with ease on Long Island. This statement is utterly incorrect, as any one may read for himself.

The only portion of the proposed mine defence that rests on such plea is the location of the firing and observing stations for the East River; viz., placing them on the main land in preference to Long Island. It is true that a string of forts was also recommended on the above plea, to stretch between Jamaica Bay and the East River, but the mine defence would not be altered thereby, either in the East River itself or in front of the Narrows. Major Clarke says "it does not ever appeared to have occurred to the designer that the United States could, without any difficulty, place 20,000 men on Long Island before any power in the world could land 2000 men there, and that but for the absurdity of the measure, they would raise the number to 100,000 without any real strain whatever. Take away the major premiss, and the whole elaborate structure, with its charming electrical possibilities, dissolves like the baseless fabric of a vision." But this shaft falls short of the mark, for the simple reason that the "major premiss" is both misquoted and misapplied. The owlish idea that 2000 men could be of any possible use in an attack on Long Island is certainly not mine, the words employed in the book being "a strong force landing on Long Island . . . and advancing by the East River shore under the covering protection of a fleet." In a subsequent passage concerning the defence of rivers, Major Clarke says, "The very last place selected by an enemy, for his operations would, however, be such channels as the Thames, the Medway, and the Clyde, at least until the British Navy is effaced, and in this case, an enemy's squadron would be accompanied by a large force operating on shore." "Unless this force could be defeated in the field, the Thames defences would quickly fall, and with the possession of the river banks by an enemy all possibility of utilising mines must end." In what essential point does this action, suggested by Major Clarke, differ from the one at New York? Sober language is too weak to state his contempt for the idea of landing a strong force on Long Island and advancing along the shore under the protection of a fleet, yet shortly after he acknowledges that a foe might attack the Clyde in a precisely similar manner. Moreover, have we forgotten the Crimea landing and Aboukir? As for the string of forts across Long Island, that matter is, I believe, receiving very careful consideration at the present moment.

Major Clarke next attacks the "new demands" for sea mines which "appear to require to-day safeguards of which the Confederates did not dream." As the nature of these new demands is not specified, it is only necessary to point out that war matériel has developed somewhat since the War of Secession. It is refreshing to note the acknowledgment by such a critic that "very rough appliances proved efficacious in the American war . . . in the hands of a power which possessed no sea-going navy," and although this is used as an argument against the "new demands," it in reality forms the strongest claim possible for perfecting our mining defences, where they have been considered necessary, so as to make them equally efficient with the extemporised appliances of the past.

Major Clarke is severe on countermining as conducted by our Royal Navy, and in this matter he is probably correct. The arrangements are almost childish in their wild temerity.

"The requirements of the perfected submarine mines of to-day" are then enumerated, but these cannot be the "new demands" before mentioned, for most of them are very old indeed.

1. "Powerful electric lights". . . . an old demand, partially supplied so far back as 1878. The artillery are now waking to the necessity of same for their own purposes, and insist that the lights should be directed by them rather than by the miners.

2. "Smokeless powder." . . . Artillerymen hope for it too, and for similar reasons. It cannot be termed a "new demand" for safeguarding the mines.

3. "Special works for the defence of mine fields" are very seldom asked for, or required. Make your artillery defence as perfect as you can, and the mines can usually be fitted thereto like a glove on the hand.

4. "Quick-firing guns on small steamers," advocated by distinguished naval officers and others. And may not the poor miner speak also?

5. "Guard boats," an old demand to repel boat attacks. Not so necessary to-day in narrow waters if protected by quick-firing guns and electric lights.

6. "Boat mines." The same remark applies as to (5).

7. "Secrecy." Not a new demand by any means, and—this can be "solemnly assured"—very inexpensive.

These requirements are mentioned to prove that "the great advance of electrical science since the American war must apparently have merely rendered submarine mines helpless to a degree." How so? Was there ever a more decided *non sequitur?*

To proceed—"The best known instance of a fleet being stopped by mines and obstructions, occurred at Charleston, where not a single one of

MODERN FRENCH ARTILLERY: MANCERON'S APPARATUS FOR EXAMINING THE BORES OF GUNS.

(*For Description, see opposite Page.*)

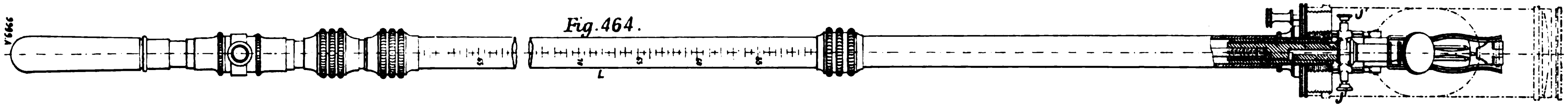


Fig. 464.

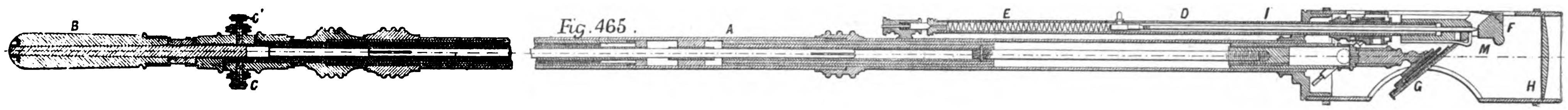


Fig. 465.

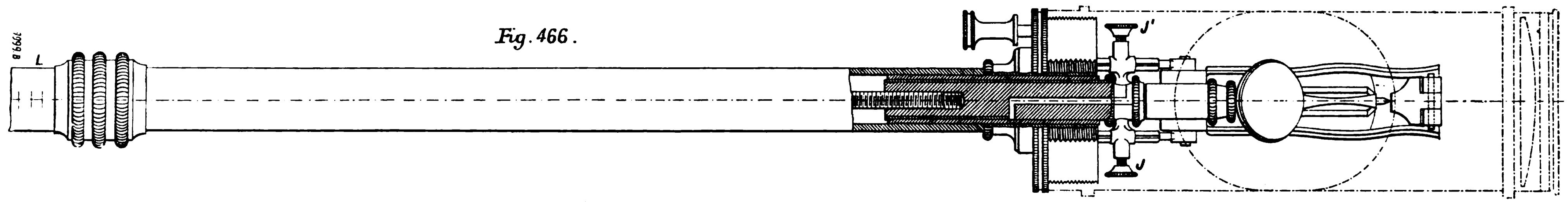


Fig. 466.

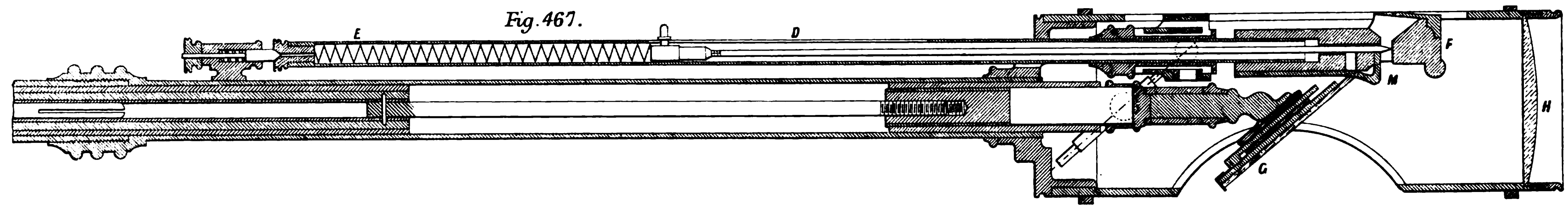


Fig. 467.

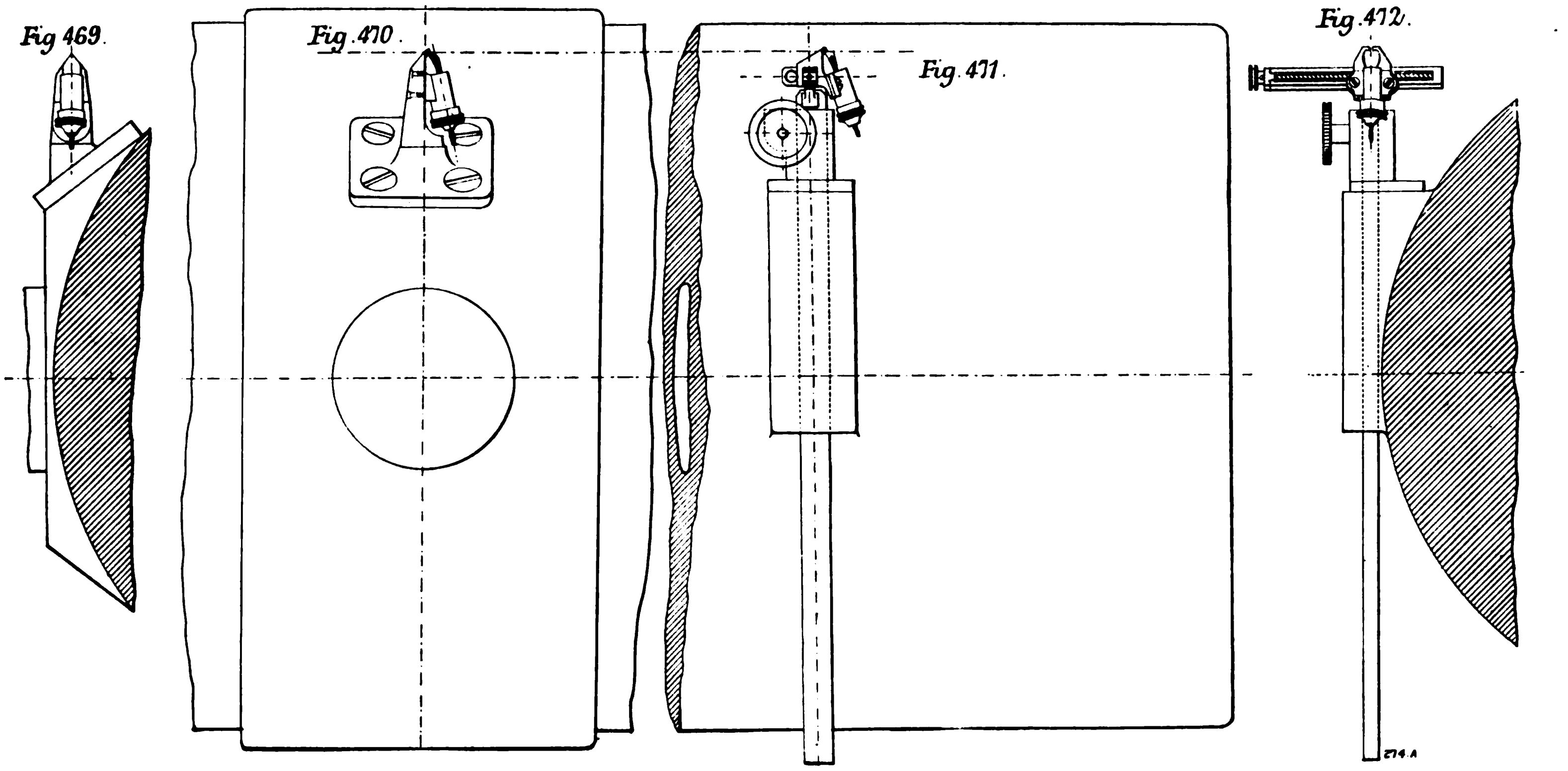
of steam when full strokes are given; and in short strokes—at bottom of cylinder—the valve ought not to admit any steam to upper side of piston. Drain cocks to carry off the water of condensation should always be fitted to these cylinders, otherwise a breakage might easily occur, for unlike the common slide valve, piston valves, when they cover the eduction ports, give no relief to water.

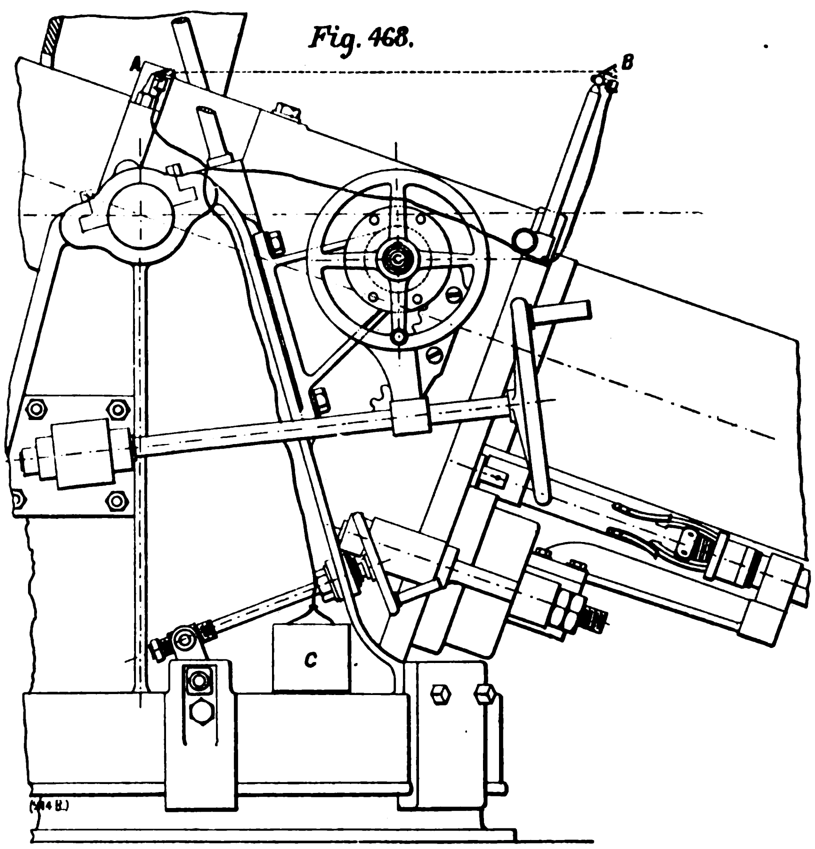
Some shipbuilders make their own heavy forgings, such as the keel-bars, stern-frames, rudders, &c. In the forge for that purpose much heavier hammers are required, from 30 cwt. to 3 tons being sufficient. And it is right to allude to a kind of steam hammer that has come into use quite recently for welding up the stern-frames. These are most conveniently forged in two pieces and afterwards united together by welding in their proper relation to each other when the parts are formed. Different systems of welding are adopted by workmen in different localities. Some prefer "scarf welding," *i.e.*, forming one part of the join like a wedge, and the other with a corresponding recess, butting the two parts together and welding them when properly heated. Others have the ends cut off a little short of meeting each other, the parts being strapped and held fast in proper position by straps and bolts while so laid together. They are then heated, and a plug of iron that will fill up the space fully between ends is heated at the same time. When ends and plug piece are brought to a welding heat the plug is put in by hammering, and thus the ends are welded together by the uniting piece. This is called "glut" welding. It is not for us to say which of the methods are preferable. Each has its advocates, and they are both good when properly and skilfully done. But there was a difficulty when these stern-frames were large and heavy. They could not easily be brought under an ordinary fixed steam hammer to be welded. They are too cumbrous, and the fixed hammer could not reach the parts to be operated upon. So they were for a long time hammered by hand hammers of great weight, some of them having three shanks radiating from one side, to allow of a sufficient number of men to lift them. The work done thus was not only laborious but imperfect and unsatisfactory. Hand hammers could have little effect on sections of nearly 6 in. or 8 in. square. The weld was apt to be purely superficial. The heart of the metal could hardly ever be properly united. Lloyd's issued instructions that all such forgings must be welded entirely by steam hammers. So a means had to be devised. In some forges there is a steam cylinder with hammers fixed on a kind of girder, the span of which is of sufficient width to take in the frame. Others have a steam hammer constructed to work from a jib or radial arm, so that the cylinder and hammer can work by swinging round into any position over the forging, and moved in or out on jib as may be necessary. Suitable steam joints are constructed to allow of this movement; and now the process of welding is all that could be desired. The latter form of hammer seems preferable to the fixed hammer or girder; for the forging is allowed to remain at rest while being welded. In the other case the forgings must be moved a little to bring the parts properly under the action of the hammer.

Rivetting Machines.

In boiler and bridge construction some form of mechanical rivetter has been found of incalculable benefit in respect of economy and excellence of work. But rivetting machines can hardly yet be classed among shipyard tools. In the portable hydraulic form they have been found useful in some shipyards for rivetting beams, keelsons, and several other small parts that can be conveniently put together before placing in the hull. Attempts have indeed been made to rivet up the shell plates of the hull when in their place, but these efforts have not yet been so successful as to meet with much approval or imitation. If some means could be devised for rivetting up a ship's side without the necessity for hand rivetting a most important advance in the system of construction would be effected. The builders would be able to rid themselves of a class of workmen who, perhaps more

MODERN FRENCH ARTILLERY: DETAILS OF SIGHTS.





than any other, are so liable to break out into strikes when trade shows the least sign of increased briskness. It would be easy enough to apply some kind of portable machine hammer, but the difficulty is the "holder on." That must move on from hole to hole in correspondence with the rivetter—forming in fact a part with it. It is not easy to see how a handy machine can be applied at the same instant to both the inside and outside of a ship's plate. A portable tool, with gap deep enough to rivet each strake as it is laid on, has been tried, but the inconvenience and loss of time in shifting and applying the tool to every position required is too great for any advantage otherwise gained. The mechanical rivetting of a ship has formed a standing problem with inventors and still remains unsolved. So much trouble has been experienced with the human rivetters in busy times, shipbuilders would be glad to see a way of checkmating them when their demands become unreasonable. The rates of wages paid them are usually out of all proportion to any skill required in the work. A youth of ordinary intelligence can learn the art of hand rivetting in a very few months. And yet when this art, which is hardly entitled to be called a "craft," has been acquired, these knights of the hammer are among the first of the shipyard artisans to find fault with the remuneration paid them. This is the unwise policy which has stimulated inventors at all times to find a way of superseding hand labour; and the time may not be far off when the rivetting of a ship's hull may be accomplished exclusively by mechanical means. Far more extraordinary appliances as substitutes for human skill are now at work; and it will be strange indeed if such a simple operation as the stitching of the plates to a ship's frames should remain much longer dependent entirely upon hand hammers.

MODERN FRENCH ARTILLERY.
No. XLVI.

Inspecting Apparatus and Sights.

Figs. 464 to 467 illustrate the device invented by Commander Manceron, Chef de l'Atelier de Précision à St. Thomas d'Aquin, and which is used for inspecting the bores of guns. In small calibres it is possible, after the bore has been carefully cleaned, to inspect it by placing a light at one end and looking through the other, or by directing it against the sun. When, however, long guns of large bore, such as are in constant service, have to be examined, it is necessary to have recourse to more accurate methods. The principle of the Manceron apparatus consists in shifting within the bore, a light carried by a graduated arm so that the exact position of any part of the bore which it is desired to examine, can be subjected to powerful illumination. A small lamp is used for this purpose inclosed within a metallic cylinder to which a reflector is fitted and which is pierced with a circular opening opposite the mirror. The beam thrown by the lamp and reflected by the mirror, strikes against the surface of the bore and is again reflected upon a second inclined mirror which deflects the beam a third time and throws it parallel to the axis of the gun. In its passage this beam is directed against a convex lens which magnifies the image; the lens is placed in a convenient position for the inspector. By means of this arrangement all the light is reflected towards the opening in the cylinder and strikes against the interior of the gun at a point opposite the lamp. The metallic cylinder which incloses the lamp cuts off all the rays excepting those that are transmitted by the reflector, so that everything is in complete darkness except the point which is being examined, an arrangement which facilitates a minute inspection of any part of the bore.

The apparatus consists of a long bar A which is graduated as shown in Fig. 464; at the rear end is the handle B that serves to control the rod, and at C C' are two terminals by which the conductors leading from the lamp can be connected to any convenient source of electrical power. The current passes through isolated rods carried in ebonite rings and flows through the carbon D held by an isolated carrier; the coiled spring E presses it against the metallic surface F which is put into communication by the body of the lamp with the second terminal. The luminous point is at m when the current is

MODERN FRENCH ARTILLERY.

TABLE LIX.—Ballistical Data of Canet 19-Cent. (7.47-In.) Coast and Naval Guns, 1889 Model. Constructed by the Forges et Chantiers de la Mediterranee.

Length of Gun			25 Calibres.		30 Calibres.		36 Calibres.		43 Calibres.		50 Calibres.	
			in.	mm.	in.	mm.	in.	mm.	in.	mm.	in.	mm.
Calibre			7.47	190	7.47	190	7.47	190	7.47	190	7.47	190
Total length of gun			187.0	4750	224.5	5700	269.3	6840	321.7	8170	374.0	9500
			tons	kilos.	tons	kilos.	tons	kilos.	tons	kilos.	tons	kilos.
Weight of gun			6.72	7050	9.480	9630	11.30	11,480	15.208	15,450	17.098	17,370
			lb.		lb.		lb.		lb.		lb.	
" shell			185.2	84	185.2	84	185 2	84	185.2	84	185.2	84
" charge			63.93	29	79.37	36	99.21	45	114.64	52	132.28	60
			ft.	metres	ft.	metres	ft.	metres	ft.	metres	ft.	metres
Muzzle velocity			1772	540	2001	610	2231	680	2428	740	2624	800
			foot-tons	m. tons	foot-tons	m. tons	foot-tons	m. tons	foot-tons	m. tons	foot-tons	m. tons
" energy			4031.0	1248.43	5144.0	1593.07	6392.0	1979.7	7569.5	2344.4	8848.0	2740.03
	yds.	m.	ft.	metres	ft.	metres	ft.	metres	ft.	metres	ft.	metres
Remanent velocities at	547	500	1663	507	1880	573	2093	638	2287	697	2477	755
	1094	1000	1562	476	1765	538	1965	599	2146	654	2336	712
	1641	1500	1466	447	1657	505	1847	563	2014	614	2201	671
	2188	2000	1378	420	1555	474	1732	528	1890	576	2070	631
	2735	2500	1296	395	1460	445	1627	496	1775	541	1945	593
			foot-tons	m. tons	foot-tons	m. tons	foot-tons	m. tons	foot-tons	m. tons	foot-tons	m. tons
Striking energy at	547	500	3552.8	1100.29	4533.9	1404.27	5626.8	1742.7	6715.6	2079.85	7879.1	2440.34
	1094	1000	3132.1	970.04	4000.4	1239.01	4960.1	1536.2	5916.2	1832.40	7008.1	2170.62
	1641	1500	2762.1	855.44	4534.0	1091.73	4382.0	1357.1	5211.5	1614.05	6220.3	1926.58
	2188	2000	2438.8	755.22	3110.3	963.29	3854.1	1193.6	4589.7	1421.39	5507.9	1705.96
	2735	2500	2156.8	667.99	2737.0	847.70	3401.0	1053.3	4046.7	1253.13	4866.1	1507.02
Striking energy in foot and metric tons per inch and per cent. of circumference of shell	At muzzle		173.3	21.13	221.2	26.97	274.9	33.52	324.1	39.52	380.5	46.40
	547	500	152.7	18.62	195.0	23.77	242.1	29.52	288.8	35.21	338.9	41.32
	1094	1000	134.7	16.42	172.0	20.97	213.3	26.01	254.4	31.02	301.4	36.75
	1641	1500	118.7	14.48	151.5	18.48	188.4	22.97	223.9	27.30	267.5	32.62
	2188	2000	104.8	12.78	133.8	16.31	165.7	20.20	197.4	24.07	236.8	28.88
	2735	2500	92.77	11.31	117.7	14.35	146.2	17.83	174.0	21.22	209.2	25.51
			in.	cm.	in.	cm.	in.	cm.	in.	cm.	in.	cm.
Thickness of wrought-iron plate penetrated (Gâvre formula)	At muzzle		12.60	32.0	15.00	38.1	17.48	44.4	19.69	50.0	22.09	56.1
	547	500	11.49	29.2	13.70	34.8	15.99	40.6	18.11	46.0	20.32	51.6
	1094	1000	10.51	26.7	12.52	31.8	14.61	37.1	16.54	42.0	18.70	47.5
	1641	1500	9.00	24.4	11.40	29.0	13.35	33.9	15.12	38.4	17.17	43.6
	2188	2000	8.78	22.3	10.47	26.6	12.56	31.9	13.82	35.1	15.75	40.0
	2735	2500	8.07	20.5	9.52	24.2	11.14	28.3	12.64	32.1	14.41	36.6
	deg.		yards	metres	yards	metres	yards	metres	yards	metres	yards	metres
Range at different angles	3		2,543	2,325	3,062	2,800	3,554	3,250	3,970	3,630	4,347	3,975
	5		2,723	3,490	4,604	4,210	5,266	4,815	5,796	5,300	6,294	5,755
	7		5,124	4,085	5,927	5,420	6,726	6,150	7,338	6,710	7,907	7,230
	10		6,726	6,150	7,688	7,030	8,596	7,860	9,197	8,410	9,941	9,090
	15		8,918	8,155	10,057	9,195	11,111	10,160	11,899	10,880	12,613	11,535
	20		10,630	9,720	11,931	10,910	13,069	11,950	13,932	12,740	14,681	13,425
	25		11,910	10,890	13,390	12,245	14,600	13,350	15,485	14,160	16,267	14,875
	30		12,789	11,695	14,501	13,260	15,741	14,395	16,65	15,230	17,453	15,960
	35		13,374	12,230	15,278	13,970	16,550	15,135	17,475	15,980	18,273	16,710

TABLE LX.—Ballistical Data of Canet 22-Cent. (8.66-In.) Coast and Naval Guns, 1889 Model. Constructed by the Forges et Chantiers de la Mediterranee.

Length of Gun			25 Calibres.		30 Calibres.		36 Calibres.		43 Calibres.		50 Calibres.	
			in.	mm.	in.	mm.	in.	mm.	in.	mm.	in.	mm.
Calibre			8.66	220	8.66	220	8.66	220	8.66	220	8.66	220
Total length of gun			216.6	5500	259.8	6600	311.8	7920	372.4	9460	437.0	11,000
			tons	kilos.	tons	kilos.	tons	kilos.	tons	kilos.	tons	kilos.
Weight of gun			10.78	10,950	14.77	15,000	17.52	17,800	23.63	24,000	26.58	27,000
			lb.		lb.		lb.		lb		lb.	
" shell			286.6	130	286.6	130	286.6	130	286.6	130	286.6	130
" charge			97.0	44	123.4	56	152.1	69	176.4	80	202.8	92
			ft.	metres	ft.	metres	ft.	metres	ft.	metres	ft.	metres
Muzzle velocity			1772	540	2001	610	2231	680	2428	740	2624	800
			foot-tons	m. tons	foot-tons	m. tons	foot-tons	m. tons	foot-tons	m. tons	foot-tons	m. tons
" energy			6238.5	1932.1	7960.3	2465.5	9892.0	3063.8	11,716	3628.3	13,821	4280.6
	yds.	m.	ft.	metres	ft.	metres	ft.	metres	ft.	metres	ft.	metres
Remanent velocities at	547	500	1676	511	1896	578	2109	643	2297	700	2480	756
	1094	1000	1588	484	1791	546	1995	608	2172	662	2349	716
	1641	1500	1499	457	1696	517	1890	576	2054	626	2224	678
	2188	2000	1420	433	1604	489	1788	545	1942	592	2103	641
	2735	2500	1345	410	1460	445	1690	515	1840	561	1985	605
			foot-tons	m. tons	foot-tons	m. tons	foot-tons	m. tons	foot-tons	m. tons	foot-tons	m. tons
Striking energy at	547	500	5586.4	1730.1	7144.0	2212.6	8866.0	2745.8	10,483	3246 7	12,228	3786.9
	1094	1000	5012.0	1552.2	6377.8	1975.3	7906.0	2449.4	9376.0	2903.8	10,969	3396.8
	1641	1500	4468.0	1383.8	5718.1	1771.0	7098.2	2198.2	8383.5	2596.5	9834.0	3045.8
	2188	2000	4011.4	1242.3	5115.8	1584.4	6377.9	1975.3	7498.0	2322.1	8790.0	2722.4
	2735	2500	3595.9	1113.8	4236.3	1312.0	5673.6	1757.3	6733.4	2085.3	7830.3	2425.2
Striking energy in foot and metric tons per inch and per cent. of circumference of shell	At muzzle		231.4	28.21	295.2	35.99	366.8	44.73	434.3	52.96	507.7	61.91
	547	500	207.2	25.26	265.0	32.31	327.7	39.96	388.7	47.39	453.4	55.28
	1049	1000	185.8	22.66	236.5	28.84	293.3	35.76	347.7	42.39	406.7	49.59
	1641	1500	165.7	20.20	212.0	25.85	263.2	32.09	310.8	37.90	364.6	44.46
	2188	2000	148.7	18.13	189.8	23.13	236.5	28.84	278.	33.90	325.9	39.74
	2735	2500	133.3	16.26	157.9	19.15	210.4	25.65	249.6	30.44	290.3	35.40
			in.	cm.	in.	cm.	in.	cm.	in.	cm.	in.	cm.
Thickness of wrought-iron plate penetrated (Gâvre formula)	At muzzle		15.47	39.3	18.43	46.8	21.58	54.6	21.50	61.6	27.12	68.9
	547	500	14.29	36.3	17.05	43.3	19.85	50.4	22.41	56.9	25.00	63.5
	1094	1000	13.23	33.6	15.71	39.9	18.31	46.5	20.67	52.5	23.19	58.9
	1641	1500	12.16	30.9	14.33	36.4	16.97	43.1	19.10	48.5	21.42	54.4
	2188	2000	11.26	28.6	13.42	34.1	15.71	39.9	17.64	44.8	19.77	50.2
	2735	2500	10.43	26.5	11.73	29.8	14.45	36.7	16.34	41.5	18.19	46.2
	deg.		yards	metres	yards	metres	yards	metres	yards	metres	yards	metres
Range at different angles	3		2,619	2,395	3,171	2,900	3,707	3,390	4,150	3,795	4,571	4,180
	5		3,953	3,615	4,795	4,385	5,549	5,075	6,118	5,595	6,670	6,100
	7		5,342	4,885	6,222	5,690	7,102	6,495	7,791	7,125	8,436	7,715
	10		7,048	6,445	8,114	7,420	9,136	8,350	9,825	8,985	10,669	9,755
	15		9,410	8,605	10,690	9,775	11,887	10,870	12,793	11,700	13,630	12,465
	20		11,273	10,310	12,740	11,650	14,051	12,850	15,047	13,760	15,926	14,565
	25		12,717	11,630	14,347	13,120	15,702	14,360	16,780	15,345	17,696	16,185
	30		13,685	12,515	15,571	14,240	16,899	15,455	18,086	16,540	19,020	17,395
	35		14,324	13,100	16,430	15,025	17,652	16,145	18,992	17,370	19,921	18,220

passed through the lamp, and the beam reflected by the bore of the gun strikes against the inclined mirror G; the latter is free to turn round its circular support I, which is so arranged that the angle of the reflector can be varied at will. The reflected beam then passes through the convex lens H, the inclination of the mirror being regulated by means of the springs J and J'. A great many experiments have been conducted in order to determine the most convenient source of electrical energy to be employed. Primary batteries were found to be somewhat cumbersome and fragile; accumulators were too heavy to form part of an apparatus that may be required at various places, as for example if the guns on board a ship are to be examined. M. Manceron finally decided on the use of a magneto-electric machine, which can be driven either by hand or by means of a pedal. A very small number of revolutions of this machine suffices to give sufficient current to the lamp and to produce a light of ample brilliancy and great steadiness. It is not only the bore of heavy guns that can be examined with this apparatus, but the interior of high capacity shells can also be inspected. It has been found to be of very great service in the French War Deparment; by means of the sliding scale any part of the bore can be measured to the one hundredth of a millimetre, and the optical portion of the device is arranged in such a way as to bring out in strong relief the minutest defects in the surface under examination; it is obviously of especial use in examining the interior of guns which have been subjected to heavy fire when the officer in charge is anxious to satisfy himself that the steel has not suffered from the strain to which it has been exposed.

Figs. 468 to 472 illustrate some of the forms of sights and training gear which are usually applied to the guns made by the Forges et Chantiers. The question of exact and rapid training has obviously an importance that increases with the power of the guns on the one hand, and the means of firing them rapidly on the other. Bearing in mind the disastrous consequences which a single well-directed round might produce on an enemy's ship or guns fired from the formidable weapons now at the disposal of the artillerist, it is obviously a primary object to inflict the utmost possible damage at the commencement of an engagement; but in order to do this it is necessary to open fire at long range, and the gun must be trained with a precision as nearly as possible absolute. The principal elements which effect the accuracy of fire are the stability of the projectile in its line of flight and the lowness of its trajectory. The best types of modern artillery, such as those on the Canet system, are well adapted to secure these advantages, owing to the high initial velocity; the trajectory even at long ranges is comparatively low, and the dangerous zone is proportionately increased, so that with such guns there is a possibility of striking the object aimed at, even with a relatively large error in estimating its distance. But even with these advantages the importance of accurate training cannot be overestimated, and this question, as well as that of sighting devices, has been very carefully studied at the gun factory of Havre. Some of the standard arrangements adopted are very clearly shown in the illustrations, where it will be seen that the forward sight is placed on the trunnion ring, while the rear sight is held in a slotted bracket made either on the body of the gun or on a special ring passed around it. The axis of this slot and that of the forward sight are placed in a plane exactly parallel to that of the axis of the gun. In field batteries a forward sight on the Braca system is employed, by means of which the line of sight passes between two points placed very close together; this arrangement gives more accurate results than can be secured when a single point is used to cover the object aimed at. The rear sight is made of brass; it carries at its upper end the adjustable device shown in Figs. 471 and 472. The bar is triangular in section and is graduated with the various ranges and their corresponding angles of elevation and of deviation, as well as the corresponding period of flight, so that the length of time fuzes, when these are employed, can be very rapidly regulated. The object of this arrangement is to enable the officer in charge of the gun to ascertain by a single reading all the different firing elements, and consequently to be able to adjust immediately the training of the gun for different distances. For siege and garrison guns, M. Canet employs the sights of the type which we have just described, or those of Colonel Peigné, and in which a telescope and a level are used. By this arrangement the gun can be trained without the use of a vernier, and the angular divisions can be read off without any difficulty; it consists of an arc which is mounted on the trunnion and on a ring placed close to the breech; an angle of 2 min. corresponds to a division of one half a millimetre. On the arc is a bracket carrying the eye-piece and a spirit level. The man training the gun places the bracket upon the desired point on the graduated scale and shifts the gun until the object covered is in the axis of the telescope, or until the level is horizontal.

For coast defence guns, M. Canet employs the sighting apparatus of M. Depert, by which the gun can be trained automatically upon a fixed or moving target by simply sighting the object with a telescope. This arrangement, which has been adopted by the French Government in all their coast defence batteries, especially in those occupying elevated positions, as well as by various other governments, possesses special advantages as regards accuracy of fire and rapidity of training. For training guns on board ship M. Canet employs single-pointed forward sight, and a rear sight of a pattern similar to that in use in the French Navy. The elevation or depression of the rear sight is effected by turning a button controlling an endless screw. In certain cases, when it is desired to train a gun rapidly and to avoid obstructions which might interfere with the line of sight, especially when the gun is mounted in a turret, two rear sights are employed, one on each side. In turrets which are protected by a revolving roof shield, the man training the gun stands in a shelter made in the back of the turret, an arrangement which has been already illustrated and described. A special device allows the officer to raise the gun from this shelter by means of a sighting line placed above the roof of the turret and laid out under the same conditions as an ordinary sighting line. The officer in charge can thus obtain an uninterrupted view of the horizon and can follow a moving object without difficulty. Usually the rear sights have graduated scales on which are marked divisions corresponding to different ranges; a set of such scales is provided, with graduations corresponding to various powder charges and ranges. By this arrangement it is possible to allow for all variations in fire by simply changing the scale, and the inconvenience of having to exchange the rear sights is thus avoided. The new form of sighting apparatus designed by Captain Jacomy is sometimes fitted to the guns made at Havre. In this arrangement also the varying conditions of range and powder charge are allowed for by interchangeable scales adapted to the rear sights. The approximate deviations are also recorded automatically during the operation of elevating or depressing the sight, and in this way corrections for wind and the speed of a moving target can be made very rapidly. The same system includes a very ingenious arrangement of brake, the function of which is to prevent any disarrangement of the rear sights by the shock of firing or other movement of the gun, but which does not in any way interfere with the easy adjustment of the sights. These latter are raised or lowered by means of racks and pinions placed under the hand of the pointer, so that the operation can be very easily and rapidly performed.

Many of the new quick-firing Canet guns are fitted with automatic sighting apparatus, by means of which when the rear sight has been set in a position corresponding to the desired elevation, the gun is also raised to the same angle; in this way the rapidity of fire is considerably increased. In some guns of this class the trajectory is so much flattened that point blank aiming is almost possible. In such cases, and when a quick and concentrated fire is required, as for example on an approaching torpedo boat, only two positions of the rear sight are necessary, one for average and the other for close ranges.

Until recently gun sights were arranged only for firing during the day; but the problem of usefully employing guns during the darkness has long attracted the attention of many artillerists and at the present time various devices are in use by which considerable efficiency is secured in firing at night. In the early experiments in this direction, phosphorescent substances were used, but the luminous points thus obtained were not sufficiently sharp. Subsequently small incandescent lights were used, but this method presented a similar disadvantage. After a great number of experiments M. Canet has adopted a system very similar to that of Captain Grenfell. On each of the ordinary sights a small incandescence lamp is fixed; this lamp is placed within a small tube in which an opening is made, and through this opening the light is reflected in the direction of the eye of the pointer by an inclined mirror which is covered with a non-oxidisable material. In the latest type the sight carries two small reflectors that give two luminous points of red light. The forward sight shows a white beam which can be ranged between the two red points, and thus give with great sharpness a sighting line parallel to the actual line. The incandescence lamps are fed either by a primary battery or by small accumulators placed on the sides of the carriage, and which are of sufficient capacity to furnish current for at least ten hours. By means of resistances the intensity of the beam can be varied at will, and this is a matter of importance, as a considerable range of light is necessary according to the degree of darkness of the night. This system presents very special advantages because the luminous points have sufficient definition without in any way interfering with the vision of the man training the gun upon an indistinct object in the distance. They can be easily adapted to all classes of sights, and during the day they can be removed with but little delay, and replaced when required.

The torpedo firing tubes made at Havre are fitted with sights that make the necessary allowances for the speed of the torpedo and the velocity of the ship against which it is directed. Some of these torpedo tubes are, like the guns, fitted with luminous sights, so that boats engaged on a night attack can direct torpedoes with great precision against hostile ships. These sights are placed on one side of the firing tubes or in large vessels in an observing shelter placed above the tube, and from which the officer in charge can himself discharge the torpedo by closing an electric circuit.

We have only given some very general indications of the sighting devices used in modern French artillery. Enough has been said, however, to show that the important question of accurate day and night firing has been made the subject of careful investigation, and that M. Canet has selected from the various systems in use those which appeared best suited for his purpose, or has made in them such modifications as appeared necessary. In such a selection there was indeed a superfluity of types to choose from, as the problem of gun sighting has been made the subject of many inventions. Thanks to the great progress in the science of modern ballistics, it is now possible to compile accurate firing tables without preliminary long and expensive experiments, which a few years ago were absolutely necessary. By obtaining a limited number of very exact data these tables can now be calculated with a certainty that leaves very little to be desired in point of accuracy. As has been pointed out above, precision of fire is also further guaranteed by the flatness of trajectory in that class of guns which is rapidly growing to be the most formidable nature of weapon especially in the Navy. In Tables LIX. and LX. we publish some further ballistic data of Canet naval guns.

EXTENSION OF FAIRFIELD WORKS.

(*Concluded from page* 600.)

THE first machine which attracts the attention of the visitor in passing through the extensive machine shed is a set of plate-bending rollers, of unique design, which, by the way, was prepared in the establishment. The details and construction of the machine have been carried out by Messrs. Hugh Smith and Co., Possil Works, Glasgow. Of this machine we give an engraving (Fig. 42) on page 688. The machine is constructed entirely of steel, the end frames and gearing being of cast steel, while the rollers are of forged steel, each drawn down from a single ingot. Hitherto objection has been taken to large rolls, owing to their great diameter, particularly in the case of the upper rolls, and large diameter is necessary to give the required strength to prevent springing. As all shipbuilders well know, an increase in the diameter of the rolls reduces in great measure their efficiency. We have stated these well-known facts, because the unique feature of the Fairfield machine is that the rollers, while of great length, are kept of moderate diameter. The lower rolls are supported by three sets of under-rollers, while the upper roll is kept down to its work by a very massive wrought-steel girder having on its under side three pairs of rollers which act on the upper quarters of the main roll. So far as experiments have shown, the upper roll, although of moderate diameter, does not spring under the heaviest strains. The top roll with its girder is carried in strong cast-steel sliding guide blocks, so arranged as to take up all twist, and it is raised or lowered by cast-steel worm gearing. The advantages claimed for a set of rolls made on this principle in preference to a machine with a large top roll are: (1) That a much greater factor of safety is obtained with less weight; (2) that the pressure is taken up by the two end trunnions of the main top roll, and the twelve smaller trunnions of the small roll, and a suitable bearing surface in relation to the pressure is obtained, which it is difficult to get when one large top roll alone is used; and (3) that the probability of breakage is reduced to the minimum, as the steel plates, &c., of which the girder is built, are of thoroughly reliable material, and can be examined periodically, whereas the manufacture of a large roll of the diameter necessary is a difficult operation, and the material is liable to have latent flaws and defects. The gearing of this set of rolls, as already stated, is of cast steel, and the wheels and pinions are all made with double helical teeth.

In punching machines considerable advance has been made both in size and capability as compared with the older tools. In an extension bay it is the intention to increase the number of these machines. At present there are four large lever double punching and shearing machines, capable of punching 1½ in. holes through 1½ in. steel plates and having a gap of 42 in., so that plates up to 7 ft. broad may have every hole punched in them. The shear blades are 36 in. long. The machines are so arranged that plates up to 32 ft. long can be manipulated without interfering with the adjacent machines. In this case Fairfield seems to be anticipating the times, for if these punching and other machines are to be worked to their utmost capability, the steelmakers will require to produce larger plates than at present; but we doubt not any of the leading producers will willingly comply with a request for plates of this size when the demand arises. These machines have also a special feature in that they are arranged with a large punch at the side of each machine capable of punching the frame holes in stringer plates up to 8 in. square, which not only makes a much cleaner job, but is also a great saving of time. These machines were made by James Bennie and Sons,

GUN MOUNTINGS ON BOARD THE SPANISH CRUISER "PELAYO."

(*For Description, see Page* 715.)

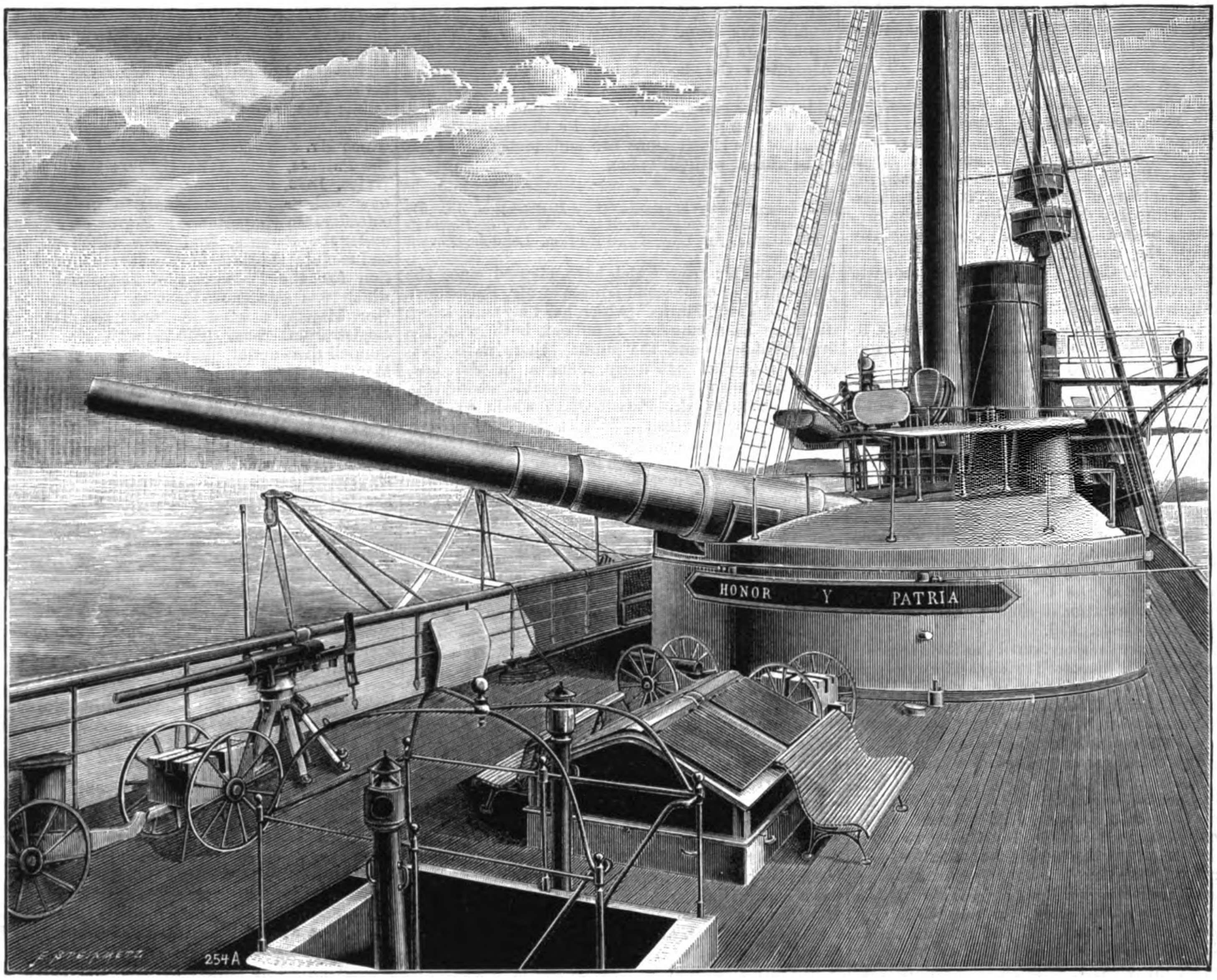


Fig. 475. 32-centimetre Hontoria Gun Mounted in Canet Central Loading Turret.

LITERATURE.

Waterways and Water Transport in Different Countries. By J. Stephen Jeans, M.R.I., F.S.S. London and New York: E. and F. N. Spon.

Mr. Jeans' admirably arranged historical work has been published at an opportune time. He himself divides the history of modern canals into three epochs: (1) The era of waterways, designed to facilitate transport of heavy traffic more speedily and cheaply than by the wagon and packhorse, which commenced with the Bridgewater Canal between 1766 and 1770, and terminated with the installation of the railway system; (2) the era of interoceanic canals inaugurated by the completion in 1869 of the Suez Canal, and still in progress; and (3) the era of ship canals connecting large inland cities with the sea. There is at present a great revival of interest in canals, and projects have been organised, in some cases started with the promise of success, although in other cases great failures have to be recorded.

While somewhat questioning the contention that the era of small canals, of which there are in this country about 2750 miles, is altogether past, or as Mr. Jeans says that "their mission is ended; their use is an anachronism," we find abundant evidences in the works in progress to concur in the opinion that we are living in an age when the belief in interoceanic and inland ship canals is increasingly great. In this country alone there is the Manchester Canal, with the works of which good progress is being made, and in addition there is the project for a ship canal between the Firths of Forth and Clyde agitating the minds of commercial Scotland; the Sheffield and Goole Canal scheme is in high favour; Mr. Samuel Lloyd has advocated the construction of a great national canal linking all the principal centres of England with each other and with the sea—Birmingham connecting with London, the Bristol Channel, the Humber and the Mersey, with other subsidiary connections; and others are projecting a waterway to allow ships to pass from Birkenhead to the Irish Sea, without sailing down the Mersey and being subjected to the inconveniences of the bar. These, however, are all projects, but since their feasibility is beyond doubt they only await the education of public opinion to the point when capital may be subscribed freely.

Abroad there is the same indications of a quickening interest in waterways. There is in progress the North Sea and Baltic waterway, of comparatively simple construction, 50 miles long; the Scheldt and Rhine Canal; and there is also a proposal to unite the Rhine and Ems by a canal 54½ miles long and 46 ft. width at bed. These, with other projects, indicate that Germany is still perfecting the magnificent means of transport which are declared to be superior to those in any other nation. Russia is also active. Having completed the great Poutiloff Canal, they have in hand other works, including the Perekop Canal, 72 miles long, one between the Baltic and White Sea, 140 miles long, Volga and Don, 35 miles in length, and the Black Sea and Azov, over 26 miles long. These projects indicate that the Government consider strategic importance as well as commercial utility. In the case of the first-named canals, vessels will not require in passing from the Azov to Odessa and other ports in the vicinity, to sail round the Crimea, and they thereby avoid the risk of capture by foreigners in case of war. The completion, in 1886, of the canals from the Caspian to the Baltic Sea is an important item in Russian history. Another notable Continental canal is that proposed between the Mediterranean and the Bay of Biscay, which would give France the advantage of avoiding Gibraltar, where Britain stands sentinel over the Mediterranean; but the Languedoc Canal at present serves all commercial purposes for small crafts, and the construction may not therefore meet with great favour. In Greece there is the Isthmus of Corinth Ship Canal. It is in America, however, that the greatest projects are now in progress.

The whole system now in operation in America extends to 2926 miles, and the cost of constructing these was over 34 millions sterling, and in addition 1953 miles have been abandoned. The average cost per mile varies from 53,300*l*. per mile in the case of the Chesapeake and Delaware, which has locks 220 ft. long, to about 3000*l*. per mile in the case of subsidiary ways in communication with the Ohio. In Britain, as we have already stated, there are 2641 miles of canals. There are 2998 miles in France, the traffic being about 4005 tons per mile, while the average distance each ton is carried is 84 miles. In Germany there are about 3000 miles, and in Belgium 1013 miles. Of the other countries' systems reliable statistics are not obtainable.

The new projects in the new world include some of the remarkable works of the age—the Panama and Nicaragua Canals, and these with the Suez, Manchester, Corinth, and other Continental schemes are described and their history detailed in the work before us. One commendable feature of the treatment of the subject is the absence of criticism. Mr. Jeans has recognised his position as a historian and compiler with the result that facts are consecutively stated with a clearness which enables the reader, if he chooses, to pass judgment on any development recommended by an engineer. Of the Panama, he says by way of introduction, "If the question were asked, 'What is the greatest constructive work that has yet been undertaken by man?' there would, without question, be a great many different replies. There can, however, be only one reply as to the most costly. Perhaps, also, there can be but one answer as to the most disastrous to human life. The Panama Canal would almost certainly secure pre-eminence in these attributes. It might or might not rank equally high as a work of engineering genius and possible public utility." It is not necessary to enter into any detailed reference to the projects we have named, all of which are intelligently described by the author. In the reports of the proceedings of the Canal Congress, which recently appeared in this journal, the leading features of some of the works were discussed.

Mr. Jeans devotes the third part of his book to consideration of such topics as the cost of water and land transport, systems of transport and haulage, locks, planes, sluice gates, and lifts; tunnels, viaducts, embankments, and weirs; canal boats, and generally with the making of artificial waterways. River improvements in this and other countries are also dealt with, the comprehensiveness of the title of the work demanding this. All the topics are discussed in a way which may interest all readers, although such a work of compilation cannot be freed from a wealth of detail which is not attractive to the general reader. Evidently with the intention of seducing such Mr. Jeans has introduced poetry at the beginning of nearly all chapters—some quotations appropriate enough, others somewhat far-fetched.

In his last chapter the question of the State acquisition of waterways is discussed briefly. The author is a strong advocate of State ownership of canals. Individual State governments have proprietary interests in canals in America; in France canals are largely owned and almost wholly controlled by the State; in Germany the State owns the greater part of the railways and a great part of the canals, and it is extending the latter at the public cost; to Italy and Russia the same remark applies; and in the British colonies, particularly India and Canada, both railways and waterways have been and are being provided at the public expense and are administered by officials responsible to the people generally. It is therefore evident that Britain is about the only country not nationally interested in the canals. That State ownership would result in the present canals being more beneficial is undoubted. Mr. Jeans in one part of his work thinks the mission of the small canal is ended; but in another part he expresses the opinion that with locks of uniform and sufficient size and with the expenditure of a few millions sterling, they could be utilised for immense traffic to the seaboard at rates which although suitable for transit by waterways would be too low to be remunerative to railway companies. The series of canals between London, Liverpool, Hull, Birmingham, and other cities are owned by many distinct companies, some of them railway companies, whose interests do not quite lie in the direction of developing canals, consequently the locks are continued at small dimensions and improvements in other parts of the series are nullified. The London and North-Western Company, for instance, own 488 miles of canals; the Great Western, 258 miles; the Manchester, Sheffield, and Lincolnshire, 180½ miles; North Staffordshire, 121; Midland, 50; and the Caledonian, in Scotland, 60. There are owned by public trusts 927¼ miles; independent companies, 1445¾; and in the case of 118½ miles the canals are derelict; while 120 miles have been converted into railways. If all canals were under Government control, there could be uniformity of dimensions, of dues and of rules, and genuine competition with the railway system made possible; monopoly would be avoided; and money could be borrowed for extensions and improvements at low rates of interest. Thus would traffic be developed and trade fostered. There would be a better chance, too, of efficient carrying companies being organised for trading on the canals. The economical results in Belgium, France, and Germany, where the freight is under one-tenth of a penny per ton per mile, or half the railway freight, should encourage the experiment here, while the fact that goods can be taken from the heart of Belgium to this country at 5s. per ton and yet take 10s. to 12s. to convey them from the seaboard to the Midlands of England, shows the necessity of something being done.

The work is enhanced with valuable statistics in the appendix, although throughout the work it would have been better to have given English equivalents for foreign measurements and values. Altogether the book contains a vast amount of interesting information well arranged, and copiously indexed for ready reference. Of the "get-up" of the work we cannot speak in the same terms. Some of the illustrations are sufficiently indistinct to be almost without value.

The Law of Trade Marks and their Registration, &c. By LEWIS BOYD SEBASTIAN, B.C.L., M.A., of Lincoln's Inn, Barrister-at-Law. Third Edition. London: Stevens and Sons.

During the six years which have elapsed since the publication of the second edition of Mr. Sebastian's "Law of Trade Marks" (which has long since taken its place as a standard handbook both with the legal profession and the public), there have been many important statutory changes in the law, many new decisions, and considerable changes in the practice of the Patent Office which render a new edition welcome. The Trade Marks Acts, 1875-7, for instance, have been replaced by the Patent Acts 1883-8, which contain a much wider definition of the marks which come within the category so that the precise distinctions which made up so much of the old law are largely swept away. The remedies for infringement, again, are by no means so limited as they formerly were. Under the Merchandise Marks Act, 1887, the offence is criminally punishable under an indictment for obtaining money by false pretences, so that delinquents will no longer be able to get off as in the old days, on the ground that an indictment for forgery cannot be sustained. It is true that since 1862 the forgery of a trade mark has been punishable as a misdemeanour, and the criminal law was not powerless. In 1881 the infringement of a gunmaker's trade mark was punished with six months' imprisonment. In 1885, again, Mr. Justice Hawkins passed a sentence of six years' penal servitude on a person who had offered for sale watches of base metal thinly coated with gold, and bearing a forged Goldsmiths' Hall mark. Mr. Justice Day, too, it will be remembered, punished a forgery of the "Low Moor" mark on iron tubes by three years' imprisonment. But that the Act of 1887 materially strengthened law in this respect, and has rendered the common practice of imitation considerably more dangerous, is usefully indicated in the volume. A criminal conviction, as Mr. Sebastian points out, is, moreover, no bar to civil proceedings. But, although criminal proceedings may prove more useful in the future than they have in the past, the civil remedy is likely to remain the most popular. Actions on the case for deceit are, perhaps, likely to become more common in view of the new activity with regard to false indications of origin, but since proof of fraud is of the essence of the action, it will always remain an uncertain remedy. Juries have always been apt to lean in favour of the defendant and acquit him of "fraudulent intention," unless the evidence the other way was overwhelming. In fact trade mark cases will probably still almost invariably be brought in courts of equity by way of applications for injunctions to restrain infringement. We can safely recommend any who may feel themselves aggrieved to study Mr. Sebastian's pages on this point, they are admirably clear and by no means uninteresting. It is important to remember that intention is immaterial in equity. Fraud must, no doubt, be committed to entitle the owner of a trade mark to redress, but it must consist in actual deception, and is altogether independent of the intent with which the act was committed. In equity, too, even innocent infringement is checked. The Merchandise Marks Act, 1887, introduced a new principle by enacting that any person selling or contracting to sell any goods bearing a trade mark or trade description is to be deemed to warrant the genuineness of the trade mark or the correctness of the trade description unless he expresses the contrary in signed writing delivered to and accepted by the vendee. We are not aware that this section has received judicial construction, but it seems to us that it must universally affect the position of defendants. Trade marks will, of course, always remain more or less an unsatisfactory kind of property. But there can be no question that the tendency of recent legislation has been to enhance their value if not to facilitate their protection. The provisions for registration under the Patent Acts are no doubt irksome and the decision of the Comptroller is often arbitrary, but on the whole it seems to increase security, and to afford the public a better guarantee that the marks are genuine. It is, indeed, the public that are really mostly concerned in the law of trade marks, for it is the public that are defrauded by their imitation.

It should be mentioned that among the statutes which Mr. Sebastian gives by way of appendices are the Patents, &c., Acts, 1883-8; the Trade Marks Rules, 1890, issued under them, which, with their new and arbitrary classification of goods, are of considerable importance; Forms and Precedents under the Patents, &c., Acts, which are very full and useful; the text of the International Convention for the Protection of Industrial Property, which was signed at Paris in 1883, and to which Her Majesty acceded in 1884; the Trade Marks Registration Acts, 1875-7, with the Orders in Council thereunder, and the Cotton Marks Rules; Merchandise Marks Act, 1887, and the Customs regulations and general order, and innumerable other enactments relating to Sheffield marks, Hall marks, marks of special classes of goods, and so on. There is, too, a useful appendix on the United States statute law. From all this it will be seen that the third edition is even more complete and comprehensive than its predecessors, which is saying much.

A Miner's Guide. By HENRY A. GORDON. Wellington, New Zealand: George Didsbury, 1889, 8vo., pp. 276.

The mining industry of New Zealand appears, at times, to suffer like that of other countries from the maladministrations of inefficient mine managers, a state of things which it is obviously desirable to abolish. Now the author recognises the incontrovertible fact that mining, to prove remunerative, must be carried on systematically "under the direction of men having a competent knowledge of the metalliferous ores that are likely to be met with and the rocks that may be expected to be found in, as well as a thorough knowledge of the working and opening out of mines and the machinery employed. They should also be able to make surveys and plans of the underground workings, as well as have a knowledge of the strength of such materials as they have to use." And recognising this fact he has produced the present volume with the object of assisting those who wish to qualify for mine managers, in accordance with the New Zealand statute requirements.

To achieve this laudable object the author treats in successive chapters, of: Precious metals; metalliferous ores; theories on origin and formation of metalliferous lodes; mineral lodes, their characters, displacements, and modes of working them; alluvial mining; damming back water in mines; explosives; ventilation of mines; mine surveying; flow of water from orifices and pipes; construction of pipes, nozzles, water motors, &c.; water races; winding ropes, hauling and winding, roads, &c.; steam boilers for land purposes, steam engines, &c.; and strength of materials. But he does not touch upon ore-dressing.

In the chapters named there is a large amount of useful information, much of which is treated in an intentionally elementary manner which ought to add to its appreciation by and its utility to not alone those for whom it is primarily intended, but also mining students and mining dilletante generally. For example various formulæ, &c., required in surveying, and in the calculations and computations incident to mining, are illustrated by problems and examples fully worked out.

On the other hand some portions can scarcely be regarded as furthering the object of the book; for instance: The historical fragments; the theoretical considerations relating to the origin of metalliferous lodes; then Chapter II., we are afraid, will impress the tyro as a chapter of

"... words of learned length and thund'ring sound,"

without being of much use to him unless he be conversant with mineralogical terms, and even then an exhaustive list of metalliferous minerals appears somewhat out of place in this book. The chapter on explosives contains much good matter, but here again, having already made a selection, descriptions might well have been restricted to the useful and safe explosives only. The composition of haloxylene, page 95, would scarcely lead one to regard it with such confidence as to permit of men going into the face directly after firing a number of shots. The important question of ventilation, although well treated, might perhaps have been profitably embellished by illustrated brief descriptions of simple methods of natural and artificial ventilation; moreover, the ventilative value of the use of compressed air as a motive power in mines should not be overlooked, whilst the account of the causes of vitiation of the atmosphere in mines, and the summary of the Report of the Royal Commissioners, would not lose in value, but would gain in utility by curtailment. It is hardly correct to state that carbonic anhydride is "of a highly poisonous character," p. 117; if such were the case, what would become of the drinkers of aërated waters?

A curious feature of the book is the significance given to familiar terms: "Adit" is applied to any horizontal gallery, "cross-cutting" is what we should call driving on the lode, "driving an adit" takes the place of our cross-cutting, whilst winzes appear under the aliases "passes," "uprises," and "uprise shafts."

The diagrams and drawings are mostly inconveniently placed for reference, and the numbers in them do not always correspond with the numbers in the letter-press description; this might perplex a novice. An index, too, would be a useful addition.

But in spite of the few less favourable features we consider the book ought, undoubtedly, to prove of much use to many occupied and interested in mining.

A Text-Book of Assaying, for the Use of those connected with Mining. By C. and J. J. BERINGER. With numerous Diagrams. London: Charles Griffin and Co., 1889. 8vo, pp. 400.

The authors, who are evidently engaged in general chemical analysis as well as assaying, lead us to infer, and they are quite right in doing so, that the latter art must henceforth be deprived of the remnant of the privilege it has enjoyed for many years of being regarded as a species of magic, by the aid of which those initiated into its mysteries became imbued with the power of discovering the quantity and quality of the valuable matters contained in natural mineral products. In fact we gather from this book and its preface that a reliable examination of ores can, in most cases, only be satisfactorily executed by ordinary chemical processes, for although other methods are described their effectiveness is qualified by such phrases as: "It is not pretended that this method gives the actual content of copper," p. 136; "The dry assay of lead . . . only gives approximate results," p. 171; "The dry assay of zinc . . . is unsatisfactory," p. 217. The book, however, being intended for those connected with mining, who prefer having their ores "assayed" to analysed, is called by courtesy, we suppose, "A Text-Book of Assaying," although its scope and character would be better described by some such title as *A Treatise on Analysis Applied to Mining Produce and Accessories*, containing as it does a large amount of matter never included hitherto in works on assaying. It is divided into three parts: Part I. comprises an introductory chapter, in which many useful points are recorded, these relating to sampling and other preliminaries of assaying and to calculating, noting and reporting results. Then follow seven other chapters treating of methods of assaying, dry, wet, and volumetric; weighing and measuring; reagents and specific gravity. Part II., in the next six chapters, deals with the metals, and besides the ordinary metals usually recorded in books on assaying, it includes many of the rarer metals, which may be met with and are likely to interfere with assays, as well as the earthy, alkaline earthy, and alkaline metals. Part III., containing four chapters, is devoted to non-metallic constituents encountered in the various materials met with in mining operations; arsenic, selenium, and tellurium being included in this section, which moreover embraces the examination of waters, shale, coal, oil, and even *assaying* the air of mines for carbonic acid gas. Then there is the inevitable appendix with tables, which may prove of interest to the inquisitive reader. A very good feature of the book is that on all these points the authors give some reliable information mostly based on practical experience, and in many cases substantiated by special experiments. The comprehensive character of the book precludes a detailed account of all the methods mentioned and could scarcely be expected or regarded as necessary in the case of the materials and substances rarely met with, but some other descriptions, more especially those of wet methods, suffer from want of working detail. In other portions of the book there are other points here and there which are not conducive to good workmanship and satisfactory results; for example, sampling bars or ingots of alloys in the way described, page 3, would lead to erroneous results in some cases; a danger which is realised by the authors, page 113, but there is no suggestion as to how it is to be avoided. Dividing the weight of the flaskful of water by the weight of the flaskful of liquid, page 78, would not give the specific gravity required; this is probably an oversight, as, of course, it is not the mode of calculation adopted by the authors themselves. Giving descriptions and directions, although they be correct, without reasons or explanations, such as, the statement "a pinch of powdered culm wrapped in tissue paper is added;" the description of the various appearances and modes of obviating errors arising therefrom, pages 89 and 90; the direction for stopping a copper assay when the button has "the appearance of good copper," and such like, are not quite satisfactory in a modern text-book; nor should the use of impure reagents and tap water for analytical purposes be countenanced.

Moreover, considering the object and size of the book, some inconvenience, much repetition, and not a little confusion, may be or even is occasioned by reasons and precautions being more or less detached from the methods to which they apply; the account of cupellation, which, as the authors truly say, is "at once the neatest and most important of the dry methods of assaying," suffers in this way. For many readers it would also be simpler if a letter-press summary of the application of the results of the authors' various experiments were given either in addition to or instead of the numerical data now furnished.

The drawings are clear and happily not overburdened with embellishments; the sulphuretted hydrogen apparatus, Fig. 32, page 57, should, however, be provided with an acid supply funnel, and the position of the suction jet, Fig. 17, page 31, might prove misleading.

With regard to the complaint, pages vi., vii., concerning the use of the originator's or the improver's name in connection with analytical methods, it must not be forgotten that it is a custom not alone regarded as convenient and courteous, but also usually adopted by a very preponderating proportion of scientists throughout the world, and is, moreover, very generally employed in various scientific journals for the same reasons.

The book may undoubtedly be recommended to those requiring information on the subject matter, inasmuch as the material furnished, if in some cases somewhat empirical, is generally well explained and is, moreover, reliable as far as it goes.

BOOKS RECEIVED.

Le Grisou et ses Accidents. Par M. H. LE CHATELIER. Paris: Octave Doin.

The Physical Properties of Gases. By ARTHUR L. KIMBALL. London: William Heineman. [Price 5s.]

Soap Bubbles and the Forces which Mould them. By C. V. BOYS, A.R.S.M., F.R.S. London: Society for Promoting Christian Knowledge.

Spinning Tops. With numerous Illustrations. By PROFESSOR JOHN PERRY, M.E., D.Sc., F.R.S. London: Society for Promoting Christian Knowledge.

Hazell's Annual for 1891. Edited by E. D. PRICE, F. G. S. Sixth Year of Issue. London: Hazell, Watson, and Viney, Limited.

The Mechanical World Pocket Diary and Year Book for 1891. Manchester: Emmott and Co. [Price 6d.]

The "Practical Engineer" Pocket Book and Diary, 1891. Manchester: Technical Publishing Company, Limited.

The Railway Diary and Official Directory for 1891. London: McCorquodale and Co., Limited. [Price 1s.]

Quantity Surveyors' Tables and Diary. Revised and rewritten by a Fellow of the Surveyors' Institution. London: Metchim and Son.

Reports on the Mining Industry in New Zealand, including Goldfields, Roads, Water Races, and other Works in Connection with Mining. Wellington: George Didsbury, Government Printer.

New South Wales Government Railways and Tramways. Annual Report of the Railway Commissioners for the Year ending June 30, 1890. Sydney.

An Introduction to Dynamics, including Kinematics, Kinetics, and Statics. With numerous Examples. By CHARLES V. BURTON, D.Sc. London and New York: Longman, Green, and Co. [Price 4s.]

Report of the Queensland Railway Commissioners for the Eighteen Months ended on June 30, 1890. Brisbane: James C. Beal, Government Printer.

HUDSON BAY.—An area of 200 square miles of pine lumber has been discovered at the southern end of Hudson Bay, but at present it is cut off from market by transport difficulties.

MODERN FRENCH ARTILLERY.
No. XLVII.

THE GUN CARRIAGES OF THE "PELAYO."

THE official trials of the Spanish ironclad Pelayo, afford interesting information on the behaviour of the Vavasseur-Canet carriages on which the guns forming the ship's armament are mounted. The Pelayo, which is a first-class ironclad, was built by the Forges et Chantiers Company at their La Seyne Works, for the Spanish Government; the design of the vessel was prepared by M. Lagane, engineer-in-chief of the company. The following are the leading dimensions:

Extreme length to end of spur ...	346 ft. 5 in.
Width (not including armour) on water line	40 ft. 9 in.
Depth of hull amidships	24 ft. 1 in.
Draught of water aft	24 ft. 9 in.
Displacement	9900 tons.
Indicated horse-power (natural draught)	6800
Speed without forced draught ...	15 knots.

The armament consists of the following guns and other means of defence:

1. A powerful steel ram framed with the vessel and armour-plated.

2 and 3. Two guns (Hontoria type) of 32-centimetre (12.60 in.) calibre; one of these is mounted forward and the other aft in barbette turrets of the Canet system.

4 and 5. Two guns of the same type, 28-centimetre (11.02 in.) calibre; one on each side and about amidships; these are mounted on Canet carriages.

6. A bow gun (Hontoria) of 16 centimetres (6.29 in.), mounted forward and firing only on the prolonged axis of the ship.

7. Twelve Hontoria guns of 12 centimetres (4.72 in.) placed six on each side in the battery, on Canet mountings.

8. A large number of machine and quick-firing guns on the upper decks and tops of the military masts.

9. Seven torpedo tubes placed on the intermediate deck above the armoured deck.

The general form of the Hontoria guns with which the Pelayo is armed is shown in the illustrations, Figs. 473 to 475. They are made wholly of steel and the breech is closed with the interrupted screw. The inner tube is reinforced near the breech with a steel jacket and a single row of rings, on one of which are the trunnions for the 12 and 16-centimetre calibres, and the projections in the larger sizes (28 and 32-centimetre) that rest in the cradles. In these last-named natures, the breech-block is locked and unlocked by means of a rack and pinion, but the block is removed and replaced by hand. The plastic obturator is of the De Bange type, with tin discs and bronze rings. The charge is fired by means of an obturating percussion fuze. The heaviest of these guns were made in Spain at the Trubia Arsenal, and the smaller ones were also produced in Spain at Carraca.

The carriages for the 12 and 16-centimetre guns are of the Vavasseur-Canet system with a forward pivot. They are of bronze and cast steel, and comprise the usual three principal parts; the carriage proper, the underframe, and the base plate. During recoil the carriage runs back up the inclined sides of the underframe, and then returns by itself into firing position, the amount of recoil being regulated by hydraulic brakes.

The mounting for the 16-centimetre chase gun is of the same type as those for the 12-centimetre, but it includes a special arrangement which is illustrated by Fig. 473. From this view it will be seen that the carriage is mounted on four wheels which run on rails placed at a level sufficiently above the curved racing path, that when the gun is run back the racers are clear, and the whole weight rests on the rails. On the other hand, when the gun is run forward, the carrying wheels fall into recesses cut in the rails, and the whole weight is carried on the three racing wheels, the curved paths of which are seen in the illustration. The carriage is forward pivotted, and the carriage is connected with the pivot by means of a heavy screw, on which it can be traversed to and fro. The advantage of this arrangement is obvious. Except when in service, the gun can be run back, until it is within the ship, the porthole being closed so that the gun is entirely protected. As will be seen, the brackets carrying the guns mount the inclined slides of the carriages, and the training for elevation is performed by the handwheel, worm and pinion gearing into a toothed rack attached

GUN MOUNTINGS ON THE SPANISH CRUISER "PELAYO."

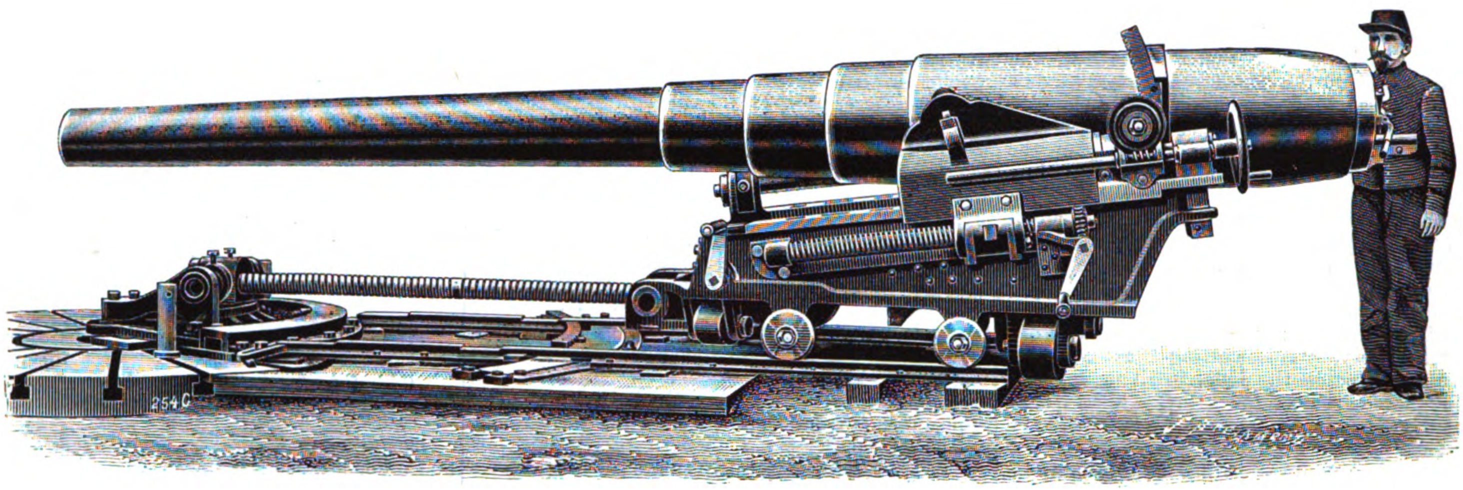


FIG. 473. 16-CENTIMETRE HONTORIA GUN ON CANET FORWARD PIVOTTING TRAVERSING CARRIAGE.

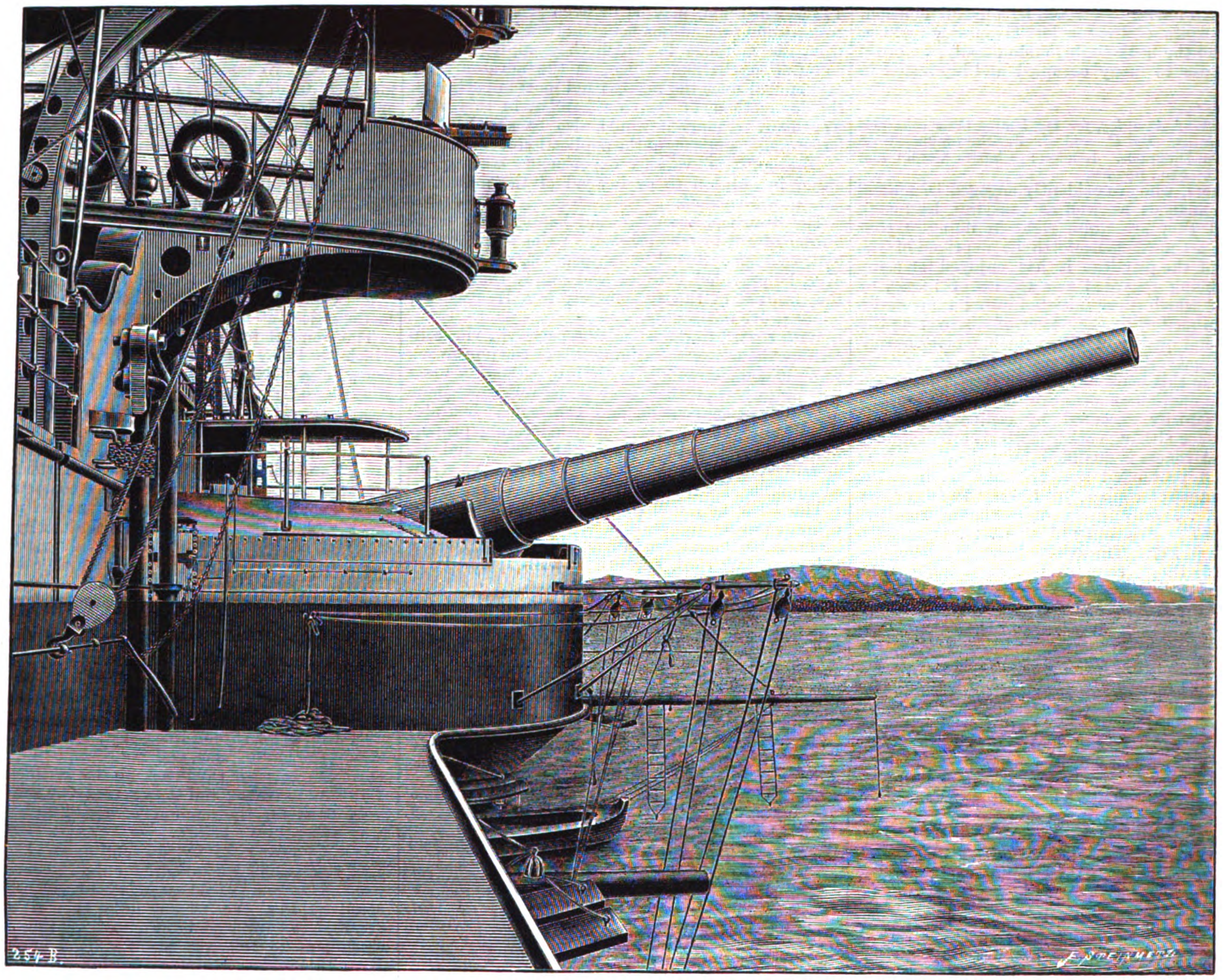


FIG. 474. 28-CENTIMETRE HONTORIA GUN, MOUNTED IN CANET TURRET.

to the gun. The 28 and 32-centimetre guns are mounted in barbette turrets, on carriages of the Canet system, with a central loading tube, so that the gun can be charged in any position (see Figs. 474 and 475, pages 713 and 716). The mounting is practically the same as has been already illustrated and described; it comprises a steel cradle resting on the slides of the underframe which pivots on an axis placed near the wall of the turret and carried on two girders. To the cradle and underframe are attached the cylinders, pistons, and other mechanism for checking the recoil and bringing the gun back into firing position. The mounting and gun are carried on a heavy steel turntable, supported in its turn by a ring of rollers that rest on a circular rail path secured to the deck. In the middle of this table is the loading tube that passes downward through the central pivot into the ammunition compartment. An hydraulic cylinder raises or depresses the gun for vertical training; it is attached to the turntable, and the plunger is connected to the under side of the gun and acts direct on it. The hydraulic presses for training the guns horizontally are placed beneath the deck, and actuate a pitched chain passed around a ring on the central loading tube. As for the ammunition hoists, they are of the ordinary description used with the Canet system and have been already described; hydraulic loading gear is of course employed. The various levers controlling the hydraulic mechanism are grouped together on the platform within reach of the officer employed to train the gun. By an independent brake the turret can be held fast in any desired position; a very desirable arrangement either when the ship is moving, or if it be necessary to keep the gun pointed in one direction. In addition to this a special safety apparatus is employed to prevent any of the numerous manœuvres required to work from interfering with each other, if by accident or error two operations are attempted simultaneously. For example, the ammunition hoist cannot be raised behind the breech till the

GUN MOUNTINGS IN THE FRENCH NAVY.

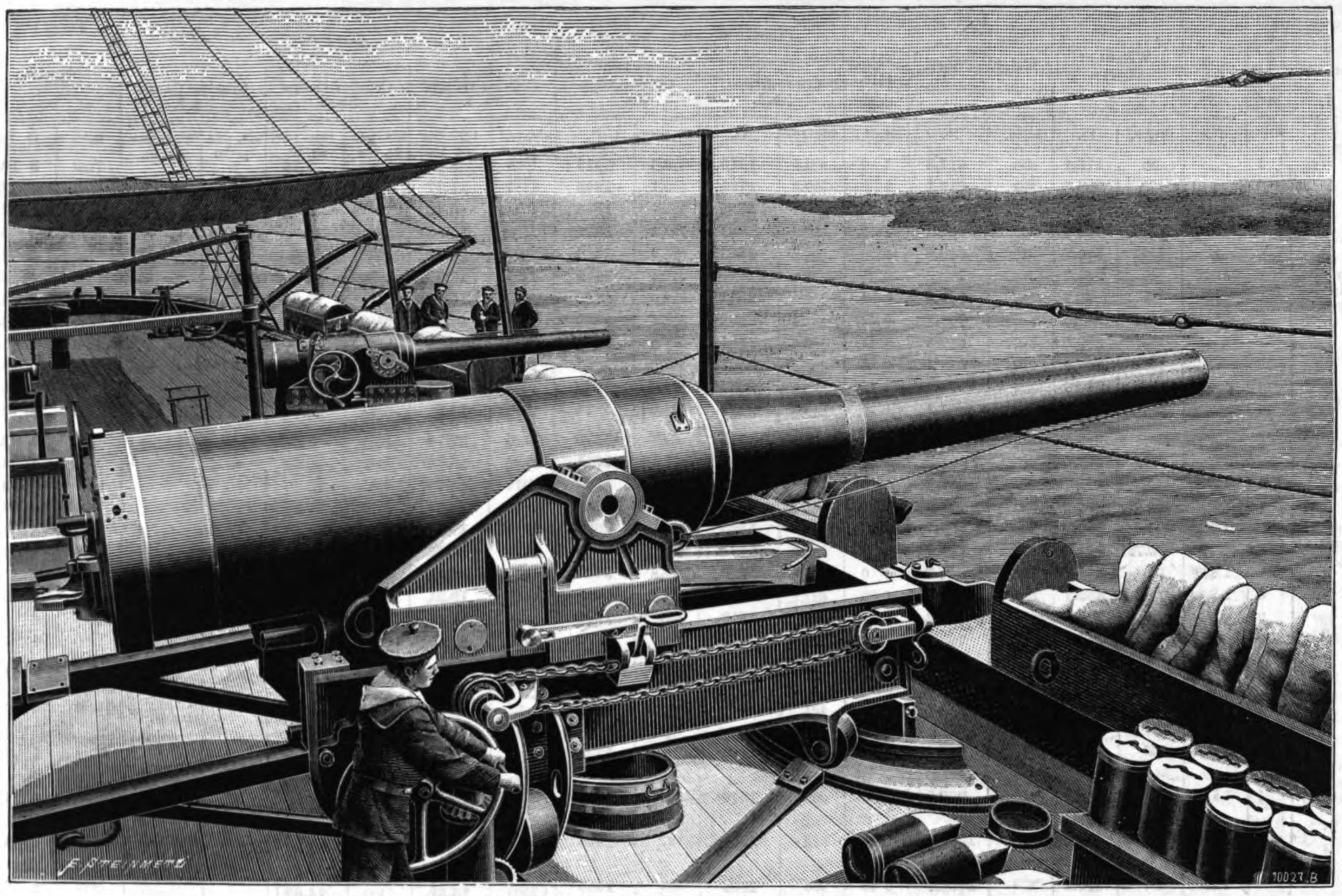


Fig. 476. Deck guns and carriages on the training ship "St. Louis."

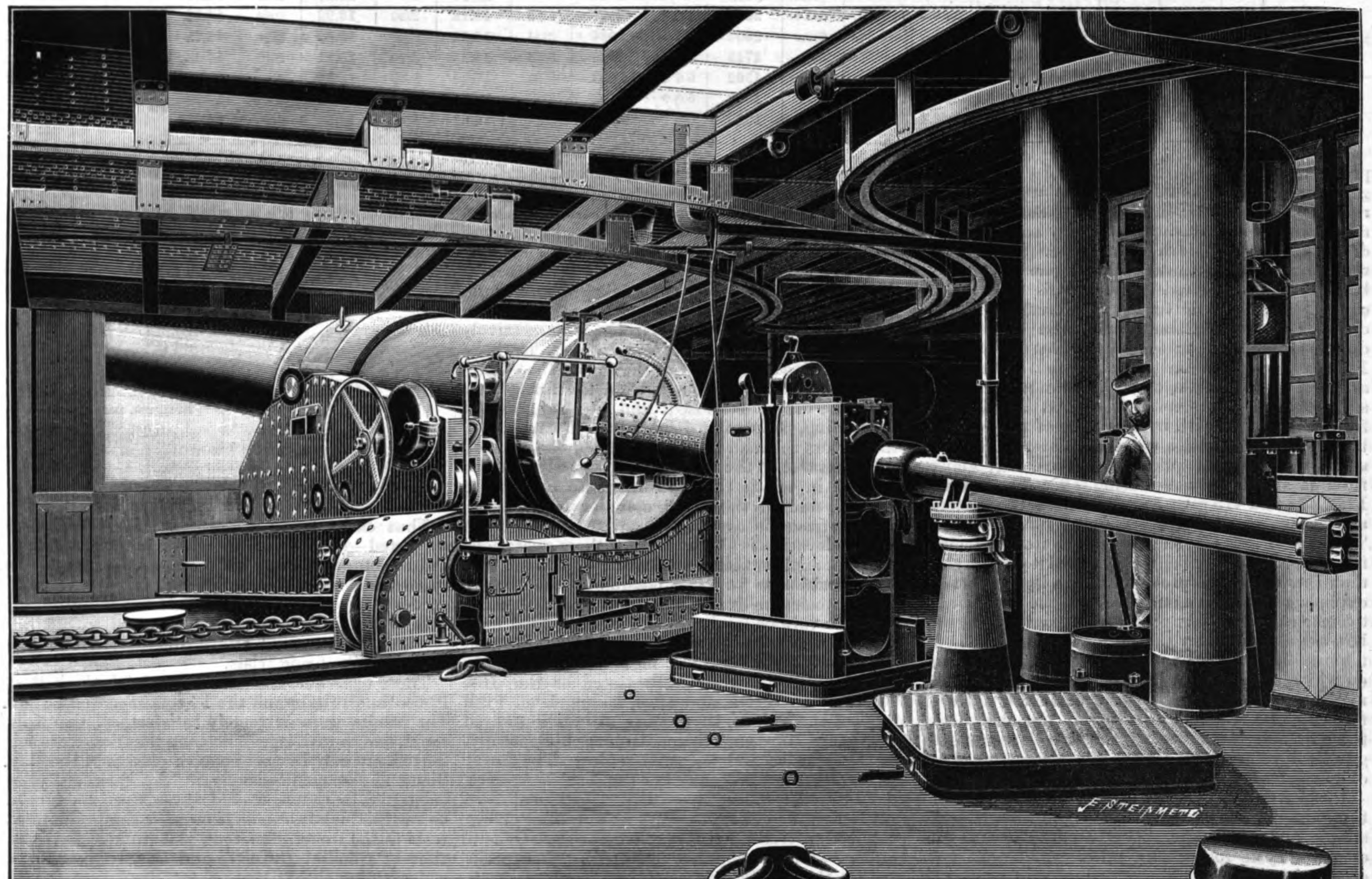


Fig. 477. Carriage and hydraulic loading gear for 34-centimetre breechloading gun on the cruiser "Courbet,"

TABLE LXI.—DETAILS OF PRELIMINARY FIRING TRIALS WITH HONTORIA GUNS AND CANET MOUNTING ON BOARD THE SPANISH CRUISER "PELAYO."

Gun.	Number of Shot.	Density of Powder.	Weight of Charge.		Weight of Shell.		Angle of Fire.	Velocity at 25 deg. Metres. Chronograph. No. 1.		Chronograph No. 2.		Pressures. Crusher Guage No. 1.		Crusher Gauge No. 2.		Crusher Gauge No. 3.		Recoil.		Number of Obturation.
			kilos.	lb.	kilos.	lb.	° ′	metres	ft.	metres	ft.	kls. per sq. cm.	tons per sq. in.	kls. per sq. cm.	tons per sq. in.	kls. per sq. cm.	tons per sq. in.	mm.	ft. in.	
28-centimetre (11.02-in.) No. 1 gun ..	1	..	80	**176.4**	280	**617.3**	1 0	431.5	**1415**	432.3	**1418**	1020	**6.43**	1220	**7.75**			1180	**3 10.4**	1
	2	..	120	**264.5**	279	**615.1**	1 0	537.8	**1764**	550.1	**1805**	1885	**11.97**	1855	**11.78**			1410	**4 7.4**	1
	3	1.839	110	**242.5**	317.5	**699.9**	1 0	485.8	**1593**	486.4	**1596**	1540	**9.78**	1550	**9.84**			1410	**4 7.4**	1
	4	..	140	**308.6**	319.5	**704.4**	1 0	567.5	**1862**	486.4	**1596**	2450	**15.56**	2480	**15.75**			1350	**4 5.1**	1
	5	..	150	**330.7**	317.5	**699.9**	0 50	567.5	**1862**	574.9	**1886**	2650	**16.82**	2660	**16.89**			1330	**4 4.3**	1
	6	1.839	140	**308.6**	318.5	**702.2**	0 50	541.8	**1777**	541.4	**1776**	2325	**14.76**	2350	**14.92**			1330	**4 4.3**	1
	7	..	150	**330.7**	318.0	**701.1**	0 50	559.1	**1834**	537.0	**1762**	2450	**15.56**	2500	**15.87**			1342	**4 4.8**	1
	8	..	160	**352.7**	319.0	**703.3**	0 50	559.1	**1834**	566.4	**1858**	2725	**17.30**	2740	**17.39**			1340	**4 4.7**	1
	9	1.829	130	**286.6**	280	**617.3**	0 45	565.3	**1854**	574.0	**1883**	2010	**12.76**	2045	**12.96**			1350	**4 5.1**	2
	10	..	140	**308.6**	279	**615.1**	0 45	595.2	**1953**	586.2	**1923**	2325	**14.76**	2340	**14.86**			1360	**4 5.5**	2
	11	..	150	**330.7**	320	**705.5**	0 45	589.2	**1933**	591.0	**1939**	2554	**16.21**	2594	**16.47**			1360	**4 5.5**	3
	12	..	160	**352.7**	319	**703.3**	1 0	612.5	**2009**	592.6	**1944**	2475	**15.71**	2926	**18.58**			1345	**4 4.9**	3
28-centimetre (11.02-in.) No. 2 gun ..	1	1.839	110.172	**242.8**	320	**705.5**	1 0	447.4	**1468**	450	**1476**	1220	**7.75**	1280	**8.13**			1300	**4 3.1**	1
	2	..	140.270	**309.2**	280	**617.3**	1 0	578.8	**1899**	582.5	**1911**	2502	**15.88**	2457	**15.60**			1325	**4 4.1**	1
	3	1.828	140	**308.6**	279	**615.1**	1 0	586.7	**1925**	594.1	**1949**	2174	**15.70**	2434	**15.45**			1320	**4 3.9**	1
	4	..	169.865	**374.4**	320	**705.5**	1 0	544.2	**1785**	573	**1880**	2655	**16.85**	2565	**16.28**			1340	**4 4.7**	1
	5	1.828	150	**330.7**	320	**705.5**	1 0	556	**1823**	585.6	**1921**	2683	**17.03**	2604	**16.53**			1345	**4 4.9**	1
	6	..	159.785	**352.2**	319	**703.3**	1 0	597.7	**1961**	600	**1968**	2719	**17.26**	2774	**17.61**			1370	**4 5.9**	1
	7	1.839	145	**319.7**	280	**617.3**	1 0	615.8	**2020**	612.8	**2010**	2459	**15 61**	2285	**14.51**			1370	**4 5.9**	2
	8	1.839	160	**352.7**	320	**705.5**	0 39	621.2	**2038**	618.2	**2028**	3026	**19.21**	2768	**17.57**			1355	**4 5.3**	2
	9	..	145	**319.7**	280	**617.3**	0 42	595	**1952**	581	**1906**	2380	**15.11**	2266	**14.38**			1360	**4 5.5**	3
	10	..	160	**352.7**	320	**705.5**	0 42	598	**1962**	586	**1922**	2755	**17.49**	2900	**18.41**			1350	**4 5.1**	3
32-centimetre (12.6-in.) No. 1 gun ..	1	1.836	120	**264.5**	421	**928.1**	0 45	427	**1401**	430	**1411**	850	**5.40**	1000	**6.35**			950	**3 1.4**	1
	2	1.836	160	**352.7**	478	**1053.8**	0 45	491	**1611**	493	**1617**	1875 1500	**8.73** **9.52**	1360 1550	**8.63** **9.84**			1222	**4 0.1**	1
	3	1.836	190	**418.8**	479.5	**1057.1**	1 0	547	**1794**	548.5	**1799**	1935 1850	**12.28** **11.75**	1900 1800	**12.06** **11.43**			1313	**4 3.6**	2
	4	1.836	210	**463.0**	421.5	**929.2**	1 0	600.5	**1970**	601	**1972**	2125 2125	**13.49** **13.49**	2134 2140	**13.55** **13.59**			1330	**4 4.3**	2
	5	1.836	220	**485.0**	478	**1053.8**	0 45	592	**1942**	597	**1958**	2450 2450	**15.56** **15.56**	2400 2286	**15.24** **14.51**			1390	**4 6.7**	3
	6	1.836	230	**507.1**	479	**1056.0**	0 45	590	**1935**	596	**1955**	2485 2500	**15.46** **15.87**	2300 2300	**14.60** **14.60**			1410	**4 7.4**	3
32-centimetre (12.6-in.) No. 2 gun ..	1	1.838	215	**474.0**	425.5	**938.0**	0 45	622.5	**2042**	623	**2044**	2411	**15.30**	2455	**15.58**	2360	**14.98**	1365	**4 5.7**	3
	2	1.838	230	**507.1**	479	**1056.0**	1 15	611.5	**2006**	612.9	**2011**	3106	**19.72**	2980	**18.92**	2996	**19.02**	1384	**4 6.5**	3
	3	1.838	215	**474.0**	418	**921.5**	0 42	610.9	**2004**	622.0	**2044**	2444	**15.52**	2494	**15.83**	2486	**15.78**	1385	**4 6.5**	3
	4	1.838	230	**507.1**	480	**1058.2**	0 57	533	**1749**	617.5	**2026**	3076	**19.53**	3010	**19.11**	2910	**18.48**	1400	**4 7.1**	2
	5	1.838	220	**485.0**	479.5	**1057.1**	0 54	598	**1962**	607.6	**1993**	2725	**17.30**	2860	**18.16**	2660	**16.89**	1425	**4 8.0**	2
	6	1.838	220	**485.0**	480	**1058.2**	0 42	587.6	**1928**	603 9	**1981**	2765	**17.55**	2634	**16.72**	2566	**16.29**	1400	**4 7.1**	1
	7	1.833	210	**463.0**	421	**928.1**	0 48	587.6	**1928**	608.7	**1997**	2301	**14.61**	2290	**14.54**	2240	**14.22**	1380	**4 6.3**	1

proper moment for loading, that is to say, till the gun, breech-block, and loading ram are all in their respective positions; in this way accidents that may easily occur during the hurry and confusion of an engagement, can be avoided. The pumps used for working the hydraulic gear are placed beneath the armoured deck. This installation comprises, for each turret, a horizontal three-cylinder engine, acting direct on differential double-acting pumps; these compress the water to 1200 lb. per square inch. In addition to the fixed armoured plates of the turret the gun and carriage are protected by a steel roof carried by the platform and turning with it. The form of this roof has been designed in such a way that lighter projectiles, such as those from quick-firing guns, may glance from it and their penetrating effect be reduced. Figs. 474 and 475 give a good idea of the general appearance of the turrets with the guns mounted. The illustrations also show the position of the shelter for the persons training the gun, and it will be seen that this shelter is provided with a light roof that extends over the armoured roof of the turret, and to some extent further protects the gunners. It will be evident that every precaution possible has been taken to insure the safety of the different organs on which the efficiency of the gun depends. The mechanism is shielded by the armoured sides of the ship, the walls of the turret, the steel deck, the roof and turning platform, but of course the gun itself remains exposed to the destructive effect of some chance shot which would render it useless.

Despite the complicated machinery, the operation of manipulating these heavy guns is extremely simple and systematic. The various stages of the complete cycle follow each other with mathematical precision, under the control of one man, who by means of various levers admits power to or shuts it off from one organ after the other. Below in the magazine, the projectile and two half-cartridges are placed in the three compartments of the ammunition hoist, which is then raised, at first vertically, and then at an angle, until it is brought with the compartment carrying the projectile, immediately in the axis of the open bore. The hydraulic loading ram is advanced to force the shell into the gun. When this has been done the hoist is raised by two stages, so that each half-cartridge is successively raised and forced into the powder chamber. The hoist is then lowered, the door at the top of the central tube is closed, and cuts it off from the firing platform; the breech is closed, and the gun, except for training, is ready to be fired. By means of other levers the man in charge causes the pitched chain to travel to the right or left, according to the direction in which the platform is to be turned, while the ram in the small cylinder beneath the upper carriage is caused to rise or fall until the desired elevation is obtained. All these operations follow one another with remarkable rapidity and ease and a precision as nearly as possible absolute.

Before being delivered to the Spanish Government, the various carriages we have described were subjected to severe trials to ascertain their strength and efficient working. The mountings for the 12 and 16-centimetre guns were tested at the Hoc Polygon, near Havre, and after having been fixed on board the Pelayo, three more rounds were fired from them, the guns being trained horizontally, and at positive and negative angles. The heavy turret guns were first tested at the Trubia Arsenal, on two Canet naval mountings, which had been sent to Spain from Havre for that purpose. These preliminary trials were carried out by Général Guillen, who was specially charged with superintending the construction the guns and carriages. These were fired from one of the 28-centimetre calibres, twelve rounds; and from the other, ten rounds; while six rounds were fired from one of the 32-centimetre, and seven from the other. The results of these trials, which are summarised in Table LXI., determined the regulation conditions of service, which are shown in Table LXII.

TABLE LXII.—*Results of Preliminary Firing Trials to Determine Subsequent Tests.*

Calibre.	Powder Charge, P.P., Spanish.	Projectile.	Speed at 82 ft. from Muzzle.	Pressure.	Recoil.
in.	lb.	lb.	ft.	lb. per sq. inch	in.
11.02	319	616	2014	33,808	53.54
	352	704	2034	37,691	53.37
12.60	462	924	1998	32,485	54.33
	484	1056	1981	38,749	55.51

Thus each of the carriages sent to Trubia was subjected—that for the 28-centimetre to 22 rounds, and that for the 32-centimetre to 13 rounds. After these trials the carriages and turrets were mounted on the Pelayo at the Seyne Works of the Forges et Chantiers. The vessel then returned to Spain to receive her guns and afterwards came back to La Seyne for the firing trials.

These tests were commenced by firing the battery 12-centimetre guns and the 16-centimetre chaso gur. The results were extremely satisfactory, the firing rapid, and the carriages efficient; the trials were conducted entirely by the Spanish officers of the ship. Some slight modifications in the carriages were suggested by this test, and these were made prior to the final trials. Some time later the preliminary tests of the turret guns took place under the direction of Général Guillen, and they suggested also some trifling alterations.

The final or reception trials were carried out under the superintendence of the Spanish autho-

TABLE LXIII.—FIRING TRIALS ON THE SPANISH CRUISER "PELAYO," SEPTEMBER 20, 1890.

Gun.	Number of Shot.	Weight of Charge.		Weight of Shell.		Recoil.			Elevation.	Direction.
		kilos.	lb.	kilos.	lb.	metres	ft.	in.		
32-cent. (forward turret)	1	210	**463.0**	420	**925.9**	1.127	**3**	**8.3**	+11 deg.	12 deg. on starboard.
	2	220	**485.0**	480	**1058.2**	1.050	**3**	**5.3**	– 3 ,,	125 deg. on port.
28-cent. starboard ..	1	80	**176.4**	280	**617.3**	0.848	**2**	**9.4**	+ 1 ,,	45 deg. aft.
	2	145	**319.7**	280	**617.3**	1.275	**4**	**2.2**	horizontal	15 deg.
	3	160	**352.7**	320	**705.5**	1.310	**4**	**3 5**	– 3 deg.	90 deg.
	4	145	**310.7**	280	**617.3**	1.320	**4**	**4**	+11 ,,	,,
32-cent. (aft turret)..	1	110	**242.5**	420	**925.9**	0.678	**2**	**2.7**	horizontal	110 deg. aft starboard.
	2	210	**485.0**	420	**925.9**	1.018	**3**	**4.1**	,,	25 deg. port.
	3	210	**485.0**	420	**925.9**	1.054	**3**	**5.5**	,,	30 deg. starboard.
	4	220	**485.0**	480	**1058.2**	1.100	**3**	**7.7**	,,	110 deg. aft port.
28-cent. port ..	1	80	**176.4**	280	**617.3**	0.747	**2**	**5.4**	,,	45 deg.
	2	145	**319.7**	230	**617.3**	1.235	**4**	**0.6**	,,	25 deg. aft.
FIRING TRIALS MADE OCTOBER 2, 1890.										
28-cent. guns of port turret	1	145	**319.7**	320	**705.5**	1.328	**4**	**4.4**	+11 deg.	15 deg. astern.
	2	160	**352.7**	320	**705.5**	1.300	**4**	**3.1**	– 3 ,,	90 deg.
	3	160	**352.7**	320	**705.5**	1.313	**4**	**3.7**	0 ,,	20 deg. astern.
1st Salvo, the Four Turrets Firing together.										
Forward turret ..	..	210	**463.0**	420	**925.9**	1.090	**3**	**6.9**	0 deg.	5 deg. port.
Port battery.. ..	..	145	**319.7**	320	**705.5**	1.265	**4**	**1.8**	0 ,,	10 deg. forward.
Starboard T battery	..	145	**319.7**	320	**705.5**	1.230	**4**	**0.4**	0 ,,	20 deg. aft.
Aft battery	..	210	**463.0**	420	**925.9**	1.286	**4**	**2.6**	+11 ,,	20 deg. port.
2nd Salvo, Three Turrets Firing together.										
Forward	..	220	**485.0**	430	**948.0**	1.090	**3**	**6.9**	0 deg.	90 deg. starboard.
Starboard battery ..	..	160	**352.7**	320	**705.5**	1.280	**4**	**2.4**	0 ,,	,, ,,
Aft battery	..	220	**485.0**	480	**1058.2**	1.208	**3**	**11.5**	0 ,,	,, ,,

rities by their own artillerists. They were divided into three series as follows :

1. This series, with the platform horizontal, referred to: (*a*) Training for direction and elevation. (*b*) The ammunition hoists. (*c*) The loading mechanism. (*d*) Bringing the gun in and out of firing position. (*e*) The working of the steam and hand pumps.

2. The second series dealt with the same points, but with the platform inclined to an angle of 5 deg.

3. The third series was the firing test. The programme of this test is given in Table LXIII. ; it was intended to subject both guns and mountings to very severe trials under different conditions and angles of fire.

The total number of rounds fired were :

For the first 32-centimetre gun mounting			17
,,	second	,, ,,	6
,,	first 28-centimetre	,,	28
,,	second	,, ,,	6

All these rounds were fired to the satisfaction of the Commission, both as regards the strength of the guns, the solidity and efficiency of the mountings, and the ease and certainty in operation of the mechanism. During the whole of the trials it will be thus seen that the two carriages that were sent to Trubia withstood satisfactorily the discharge of 4 tons of powder, and those for the 28-centimetre gun, 3.5 tons. Collectively the energy imparted to the shells during these trials gives some idea of the work thrown upon the mountings; the 32-centimetre carriage sent to Trubia has resisted 461,500 foot-tons, and the 28-centimetre carriage 497,500 foot-tons. This last-named quantity represents the amount of energy necessary to lift the Pelayo to a height of 49 ft., and the fact that the carriages were accepted after such a strain is a sufficient guarantee of their efficiency. It should be added that the ship was not in any degree shaken by the heavy strains thrown on it. After the completion of some slight repairs to the mountings, the Pelayo was formally taken over by representatives of the Spanish Government.

As a comparison we publish on page 717, Figs. 476 and 477, illustrations of two of the standard gun mountings in the French Navy. Fig. 476 represents one of the ordinary types of French naval guns of medium calibre mounted on a forward pivotting carriage. This gun, which is shown in its inboard position, is run in and out by gearing and a chain ; the slides of the under carriage are horizontal, and the upper carriage carries the trunnions. The form of brake is not shown on the drawing, but it presents no novel feature, and the mode of running the gun to and fro will be understood from the illustration. This engraving is from a photograph of the St. Louis, a training ship for gunners stationed at Toulon.

Fig. 477 is an illustration showing the interior of the battery on board the first-class cruiser Courbet, and represents one of its 34-centimetre guns, on a forward pivotted mounting. The form of the gun presents an interesting contrast to those made by the Forges et Chantiers. It will be noticed that from the breech to forward of the trunnions the diameter is nearly equal, and that beyond to the muzzle the size is largely and almost suddenly reduced. The gun is shown with the breech open ready to receive the charge, and the guide is put in position between the breech and the ammunition hoist. The latter is in three tiers and the drawing indicates the hydraulic rammer at the rear. It will be seen that in this arrangement, unlike that on board the Pelayo, the gun must be run back, and traversed into one position before it can be loaded. Overhead is a system of suspended light rails by which projectiles and cartridges can be manipulated in case of necessity.

"COLLIERS"—PAST AND PRESENT.

THE coal miners of Great Britain have, of late years, attracted a considerable share of public attention in many ways, and latterly they have occupied a very prominent place in the conversation and discussions of every-day life, and in newspapers and journals of all classes. The men employed in no other industry, not even in great and important branches of the engineering trades, stand out so prominently in social and industrial movements as the colliers do. Even the very term "collier" is now obsolete as applying to them ; it is now chiefly employed to designate the coal-laden ships which convey coal from the Tyne and other parts to its destination, either at British ports or elsewhere. The term "collier," as applied to the miner, has dropped out of Acts of Parliament relating to mines, and usually out of the annual and other reports, published by the State from time to time. The altered conditions in the life of the "collier," and of the coal-mining population generally, were forcibly pointed out by Mr. Archibald Hood in a lecture delivered at Rosewell, in Scotland, entitled, "Rosewell One Hundred Years Ago." Some particulars gleaned from this lecture, kindly lent for the purpose, supplemented by facts obtained from the statutes of the realm and elsewhere, may be interesting at the present time as showing the enormous progress which has been made in the social condition of the coal-mining population, and indicating, at the same time, the development of the vast mineral resources of the country.

The lecture says that "probably centuries before the Christian era, Great Britain was celebrated for her tin mines, and perhaps the Romans used coal to a small extent when they had possession of the island ; but it was not till the very end of the twelfth or beginning of the thirteenth century that we have any authentic account of coal having been worked." The first attempts at working coal were on the surface, or by levels driven into the banks of rivers, as on the Tyne, at Newcastle, and on the Forth, in Scotland. At these places the coal crops out of the surface, and facilities existed at an early date for transporting it by water to London, or other towns. In the earlier records relating to coal, it is called "black stone," and the expression to some extent survives in relation to "cannel," or gas coal. It appears that this "black stone," or coal, was at first used "for the purpose of driving off serpents," by kindling it at night, where such pests were thought to exist. In any case the inflammable nature of this "black stone" must have been known in very early times, for the very name given to it—coal—means fire, or, in another form, to kindle. But its qualities do not appear to have been sufficiently well known to have led to its being much used as fuel. The chief substances used as fuel were wood, charcoal, and peat, down to even a late period, and in fact the houses were not constructed with chimneys for burning coal as a fuel. In some of the islands of Scotland, and in the West of Ireland, samples of such dwellings may still be seen, with simply a hole in the roof, to let out the smoke from the wood or peat fire in the middle of the floor.

One of the earliest records extant relating to the working of coal is dated 1214, in which certain grants were made by the Government to the monks of Holyrood Abbey, to work coal on the south shore of the Frith of Forth. At about the same period the monks of Newbattle Abbey received the grant of a colliery and quarry. At later periods other monks were authorised to work coal at other places. Evidence exists that, before the middle of the thirteenth century, Newcastle coal was conveyed to London, but its use was objected to, here and elsewhere, on account of the smoke. It is reported that, in the year 1257, Eleanor, Queen of Henry III., was obliged to leave the town of Nottingham on account of the smoke of the "sea coals," this being the name by which that fuel was then known, and for a long time afterwards, as may be shown from references to it in Shakespeare and other writers, from the fact of its being found and worked near the sea. "So obnoxious had the use of coal become to the inhabitants of London that, in 1306, a Royal proclamation was issued forbidding its use." About this time, in the beginning of the fourteenth century, coal was exported from Britain to France, and from that date until within the last fifty years, repeated efforts were made to prevent the exportation of coal, on the ground that we were impoverishing the country by exporting that which was extremely valuable to ourselves. This policy was likewise pursued as regards the exportation of machinery from the year 1696 down to the year 1843, when the prohibition ceased to have effect by the Customs Duty Bill, 6 and 7 Vict., c. 84.

Mr. Hood refers in his lecture to the working of the Whitehill Colliery as early as 1744, but which must have been worked at a much earlier date. A further document, dated 1759, shows that the colliers and coal-heavers belonging to this colliery recognised, by a written declaration, the right of the proprietor to call upon them to come back at any time to work at such colliery, though, at that date, it had been idle for some considerable time. The names attached to this relic of the past are those of eight men and their wives and other dependents, the places where they are to be found being stated. In one instance the collier is about to be married, but it is stipulated that his wife and family will become the property of the landlord when called upon to resume work at the Whitehill Colliery. Another document, dated July 10, 1762, gives a list of names and places where the persons are working, from which it appears that the collieries at Dalhousie, Aitkendean, and Gorton, were still at work, although Whitehill, for some unexplained reason, was still remaining idle. A further document, dated July 4, 1763, gives similar information, the latter being witnessed by George Balfour and by Richard Wilson, described as a gardener at Whitehill. It appears thar the Whitehill Colliery must have restarted work soon after the period named, for

MODERN FRENCH ARTILLERY.

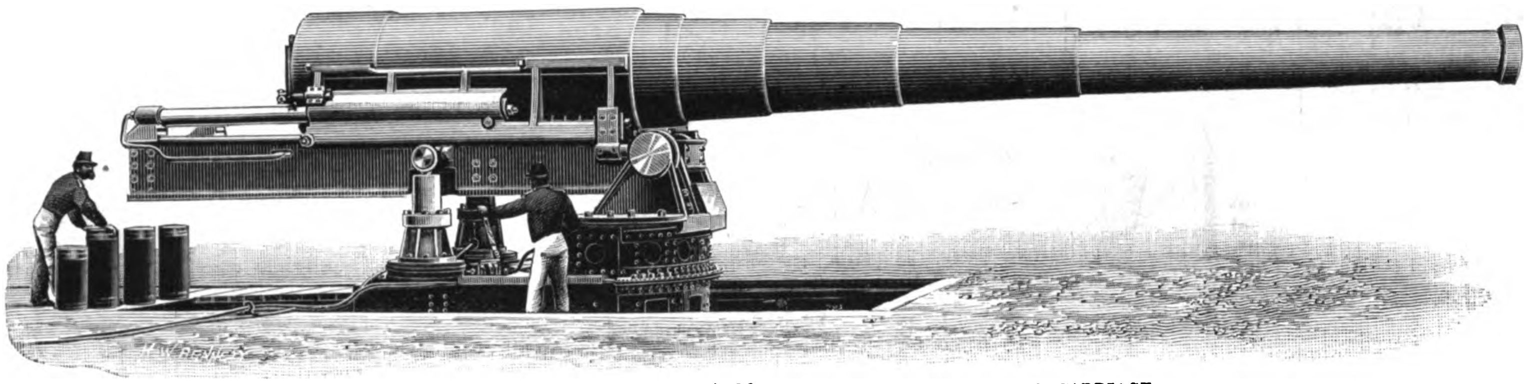
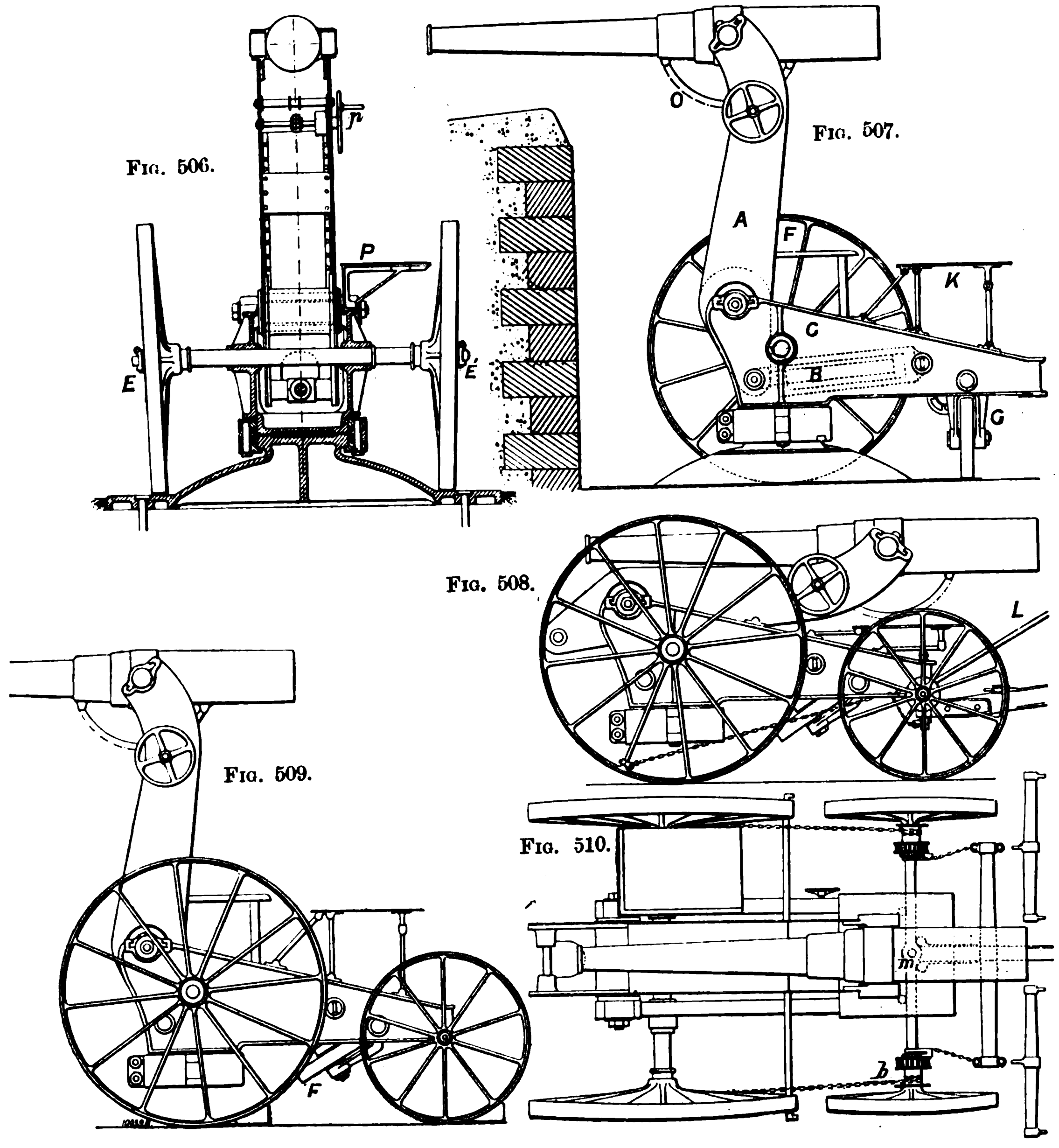


FIG. 505. 32-CENT. (12.60 IN.) 66-TON CANET GUN AND NAVAL CARRIAGE.



DISAPPEARING CARRIAGE FOR COAST DEFENCE AND GARRISON GUNS.

MODERN FRENCH ARTILLERY.
No. XLVIII.

MISCELLANEOUS DETAILS OF THE CANET SYSTEM.

WE have brought our somewhat extended notice of the system of artillery constructed at the Havre Works of the Forges et Chantiers Company, almost to a close; little remains to be described but the torpedo launching guns, which form a distinct class, but which must be regarded as artillery nevertheless. We propose in the present article to notice a few miscellaneous details, which should properly have been included in previous articles, but which have either been overlooked, or were not in existence when these articles were written.

Fig. 478 (see the two-page illustration in this week's issue) shows a collection of the various natures of guns constructed by the Forges et Chantiers de la Mediterranée at Havre, and Fig. 479 (page 748) is a key plan referring to the group, the individual guns of which can be easily identified. The calibres illustrated are as follows:

A. Gun of 32 centimetres (12.60 in.), 40 calibres in length, and mounted in a ship's turret.
C. Gun of 27 centimetres (10.63 in.) 30 calibres in length, on central pivotted coast defence carriage.
D. Howitzer of 27 centimetres (10.63 in.) on central pivotted coast defence carriage.
E. Gun of 15 centimetres (5.90 in.) and 36 calibres, mounted on battery carriage.
F. Ditto ditto ditto.
G. Gun of 15 centimetres (5.90 in.) and 26 calibres, mounted on disappearing carriage.
H. Howitzer, 15 centimetres (5.90 in.), on carriage with circular brake.
I. Mortar, 15 centimetres (5.90 in.), on carriage with swinging beams.
K. Gun of 14 centimetres (5.51 in.) and 36 calibres, on carriage with horizontal frame.
L. Gun of 12 centimetres (4.72 in.) on siege carriage.
M. Carriage with horizontal frame for 10-centimetre (3.94 in.) gun, French naval type.
N. Quick-firing gun, 10 centimetres (3.94 in.), on carriage with oscillating brake.
O. Quick-firing gun, 12 centimetres (4.72 in.), on carriage with movable frame.
P. Quick-firing gun, 15 centimetres (5.90 in.), on carriage with electric training gear.
Q. Field gun (long type), 75 millimetres (2.95 in.), on carriage and limber.
R. Field gun (short type), 75 millimetres (2.95 in.), on carriage and limber.
S. Mountain gun, 75 millimetres (2.95 in.), on boat carriage and limber.
T. Torpedo gun.
U. Torpedo gun adapted for firing powder charges for ironclads.
V. Segments of armour plates showing effect of fire from 2.95 in. gun.

MODERN FRENCH ARTILLERY; PROJECTILES FOR 12-CENT., 24-CENT., AND 32-CENT. GUNS.

TABLE LXIV.—Particulars of Projectiles for 12-Cent. (4.72-In.) Siege Gun.

Fig. 488.—Common Shell.

	kilos.	lb.
Weight of cast iron	16.930	37.246
,, belt	.180	.396
,, fuze	.220	.484
,, bursting charge	.670	1.474
Total weight	18.000	39.600

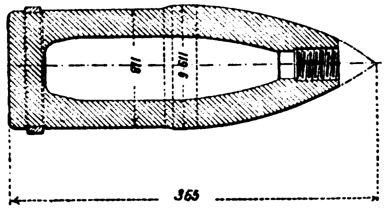


Fig. 489.—High Capacity Steel Shell.

	kilos.	lb.
Weight of steel	14.820	32.604
,, belt	.180	.396
,, fuze	.500	1.100
,, bursting charge	2.500	5.500
Total weight	18.000	39.600

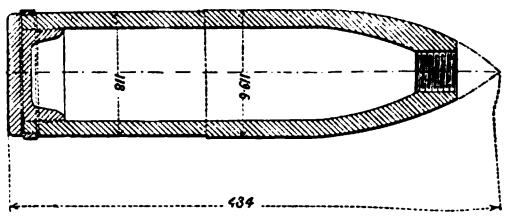


Fig. 490.—Shrapnel.

	kilos.	lb.
Weight of cast iron	13.594	29.906
,, balls	3.720	8.184
,, belt	.180	.396
,, fuze	.220	.484
,, bursting charge	.286	.630
Total weight	18.000	39.600

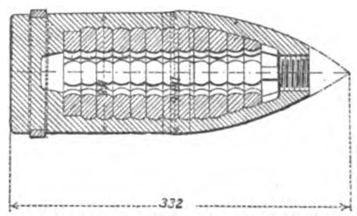


Fig. 491.—Mitraille Shell.

	kilos.	lb.
Weight of cast iron and steel	25.450	55.990
,, balls	8.240	18.128
,, belt	.680	1.496
,, fuze	.220	.484
,, bursting charge	.410	.902
Total weight	35.000	77.000

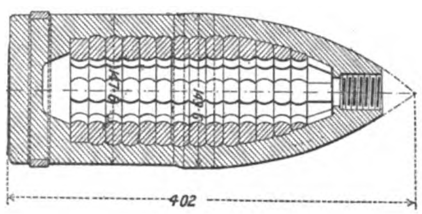


Fig. 492.—Case Shot.

	kilos.	lb.
Weight of box	7.730	17.006
,, balls	25.900	56.980
,, sulphur	1.370	3.014
Total weight	35.000	77.000

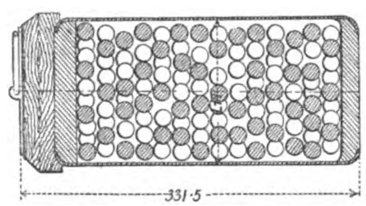


Fig. 493.—Solid Shot.

	kilos.	lb.
Weight of cast iron	34.590	76.098
,, belt	.410	.902
Total weight	35.000	77.000

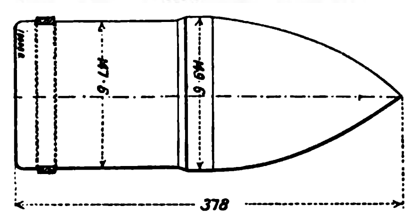


TABLE LXV.—Particulars of Projectiles for 24-Cent. (9.45-In.) Defence Guns.

Fig. 494.—Common Shell.

	kilos.	lb.
Weight of cast iron ..	141.200	310.64
,, belt	1.300	2.86
,, fuze	.510	1.12
,, bursting charge	6.990	15.38
Total weight	150.000	330.00

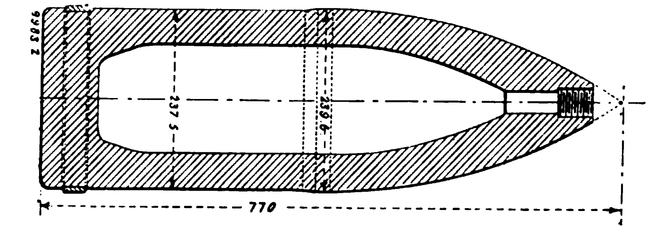


Fig. 495.—Steel Shell.

	kilos.	lb.
Weight of steel	136.190	299.62
,, belt	1.300	2.86
,, fuze	.510	1.12
,, bursting charge	12.000	26.40
Total weight	150.000	330.00

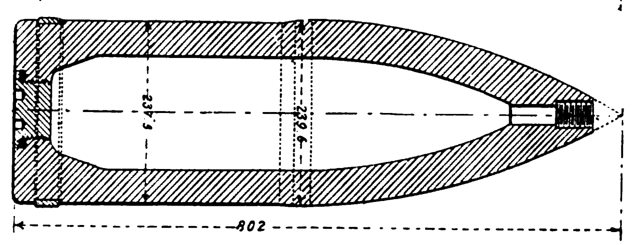


Fig. 496.—Heavy shell.

	kilos.	lb.
Weight of steel	165.00	363.00
,, belt	1.30	2.86
,, bursting charge	3.70	8.14
Total weight	170.00	374.00

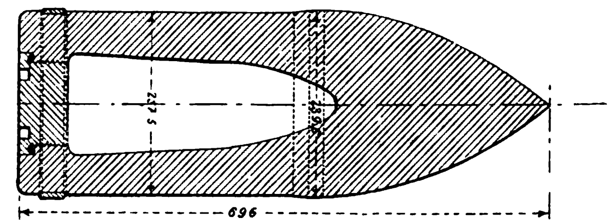


TABLE LXVI.—Particulars of Projectiles for 32-Cent. (12.60-In.) Naval and Coast Defence Guns.

Fig. 497.—Common Shell.

	kilos.	lb.
Weight of cast iron ..	339.430	746.746
,, belt	4.060	8.932
,, fuze	.875	1.925
,, bursting charge	15.635	34.397
Total weight	360.000	792.000

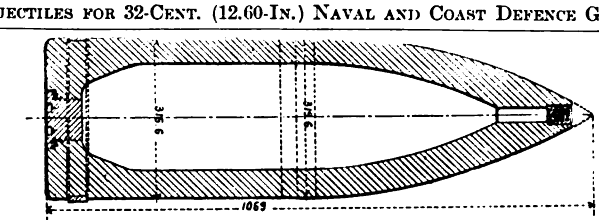


Fig. 498.—Ordinary Steel Shell.

	kilos.	lb.
Weight of steel	330.500	727.100
,, belt	4.060	8.932
,, fuze	.875	1.925
,, bursting charge	24.565	54.043
Total weight	360.000	792.000

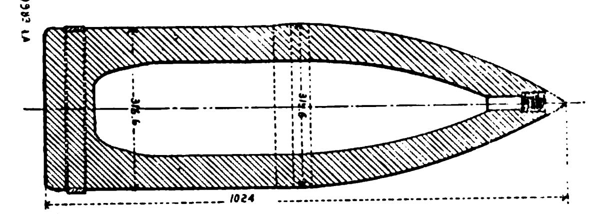
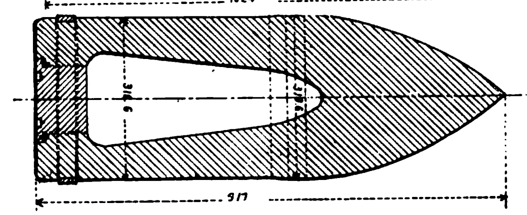


Fig. 499.—Heavy Shell.

	kilos.	lb.
Weight of steel	389.000	855.800
,, belt	4.060	8.932
,, charge	6.940	15.268
Total weight	400.000	880.000



X. Model of breechclosing mechanism for guns of large calibre.

Y. Horizontal training gear for turret adapted for 32-centimetre guns of 40 calibres.

Figs. 480 to 483 (see two-page engraving) illustrate four different positions of one form of breechloading mechanism for naval guns of moderate calibre. This mechanism has already been illustrated and described in detail (see page 656 *ante*). The views now published show very clearly the form and relations of the various parts; the starting lever, locking recess in the body of the gun; the connections between the breech-block, ring, bracket, and locking latch; the curved safety slot and the firing mechanism.

Figs. 484 to 487 illustrate the standard form of breechloading mechanism for Canet mountain guns; this arrangement has also been described. The mechanism is very simple. The block which slides within a ring hinged to the side of the breech has a fixed handle on it and a starting lever; the ring is hinged to the breech and is secured by a spring latch which is engaged or released by turning the block. The latter moves to and fro in guides made in the ring, and corresponding to the projections formed by the screw threads. A safety apparatus is provided in the form of a small shield that rises and falls with the movement of the starting lever, so that the vent for the fuze is uncovered only when the breech is closed and ready for firing, as shown in Fig. 485. Tables LXIV. to LXVI., and Table LXVII. on page 749, give par-

TABLE LXVIII.—FORGES ET CHANTIERS DE LA MEDITERRANÉE. RAPID-FIRING GUNS ON SHIP MOUNTINGS (CANET SYSTEM).

—			12-Centimetre Gun.						15-Centimetre Gun.					
Length of Gun			30 Calibres.		40 Calibres.		50 Calibres.		30 Calibres.		40 Calibres.		50 Calibres.	
			in.	mm.	in.	mm.	in.	mm	in.	mm.	in.	mm.	in.	mm.
Calibre			4.72	120	4.72	120	4.72	120	5.90	150	5.90	150	5.90	150
Total length of gun			141.7	3600	189.0	4800	236.2	6000	177.2	4500	236.2	6000	295.3	7500
Length of bore			131.4	3412	181.6	4613	223.9	5813	168.3	4275	227.4	5775	286.5	7275
			lb.	kilos.	lb.	kilos.	lb.	kilos.	lb.	kilos.	lb.	kilos.	lb.	kilos.
Weight of gun			4232.8	1920	5599.6	2540	6944.5	3150	8267.3	3750	10,957	4970	13,558	6150
" armour piercing shell			46.30	21	46.30	21	46.30	21	88.18	40	88.18	40	88.18	40
			ft.	metres	ft.	metres	ft.	metres	ft.	metres	ft.	metres	ft.	metres
Initial velocity			1649	500	2165	660	2559	780	1640	500	2165	660	2559	780
			lb.	kilos.	lb.	kilos.	lb.	kilos.	lb.	kilos.	lb.	kilos.	lb.	kilos.
Weight of common shell			46.30	21	46.30	21	46.30	21	88.18	40	88.13	40	88.18	40
			foot-tons	metre tons	foot-tons	metre tons	foot-tons	metre tons	foot-tons	metre tons	foot-tons	metre tons	foot-tons	metre tons
Energy at muzzle			863.8	267.5	1505	466.09	2102	650.99	1645.9	509.63	2867.9	888.07	4005.9	1240.36
	yds.	m.	ft.	metres	ft.	metres	ft.	metres	ft.	metres	ft.	metres	ft.	metres
Remanent velocities at	547	500	1427	435	1959	597	2313	705	1512	461	1991	607	2352	717
	1094	1000	1348	411	1771	540	2093	638	1394	425	1834	559	2169	661
	1641	1500	1227	374	1601	488	1893	577	1286	392	1690	515	1995	608
	2188	2000	1135	346	1450	412	1713	522	1197	365	1555	474	1837	560
	2735	2500	1066	325	1315	401	1548	472	1125	343	1430	436	1690	515
			foot-tons	metre tons	foot-tons	metre tons	foot-tons	metre tons	foot-tons	metre tons	foot-tons	metre tons	foot-tons	metre tons
Striking energy at	547	500	708.98	219.57	1251.3	381.36	1717.2	531.82	1399.0	433.27	2425.5	751.17	3384.5	1048.09
	1094	1000	583.61	180.74	1007.5	312.0	1406.3	43[illegible].54	1189.0	368.24	2057.0	637.06	2876.0	890.76
	1641	1500	483.28	149.67	822.79	254.81	1150.3	356.23	1011.7	313.28	1746.0	540.72	2433.7	753.64
	2188	2000	413.6	128.10	674.98	209.04	941.4	291.56	877.0	271.61	1479.0	458.05	2064.4	639.34
	2735	2500	364.93	113.02	555.59	172.06	769.71	238.38	774.4	239.85	1251.3	387.55	1746.0	540.72
Striking energy in foot and metric tons, per inch and per cent. of circumference of projectile	At muzzle		59.13	7.21	103.1	12.57	144.01	17.56	89.89	10.96	156.64	19.10	218.70	26.67
	547	500	48.55	5.92	84.31	10.28	117.61	14.34	76.44	9.32	132.45	16.15	184.86	22.54
	1094	1000	39.94	4.87	68.98	8.41	96.37	11.75	64.96	7 92	112.84	13.70	157.05	19.15
	1641	1500	33.05	4.03	56.34	6.87	78.82	9.61	55.20	6.73	95.37	11.63	132.95	16.21
	2188	2000	28.30	3.45	46.26	5.64	64.47	7.86	47.90	5.84	80.79	9.85	112.86	13.75
	2735	2500	25.01	3.05	38.05	4.64	52.74	6.43	42.32	5.16	68.32	8.33	95.38	11.63
			in.	cm.	in.	cm.	in.	cm.	in.	cm.	in.	cm.	in.	cm.
Thickness of wrought-iron plate penetrated	At muzzle		5.82	14.8	8.70	22.1	11.02	28.0	7.87	20.0	11.69	29.7	14.88	37.8
	547	500	5.07	12.9	7.51	19.1	9.52	24.2	7.00	17.8	10.39	26.4	13.19	33.5
	1094	1000	4.40	11.2	6.49	16.5	8.26	21.0	6.25	15.9	9.25	23.5	11.73	29.8
	1641	1500	3.86	9.8	5.62	14.3	7.16	18.2	5.54	14.1	8.22	20.9	10.39	26.4
	2188	2000	3.43	8.8	4.87	12.4	6.21	15.8	5.03	12.8	7.28	18.5	9.25	23.5
	2735	2500	3.15	8.0	4.25	10.8	5.39	13.7	4.60	11.7	6.45	16.4	8.22	20.9
	deg.		yards	metres	yards	metres	yards	metres	yards	metres	yards	metres	yards	metres
Range at different angles	3		2,176	1,990	3,188	2,915	3,915	3,580	2,198	2,010	3,242	2,965	3,964	3,625
	5		3,324	3,040	4,680	4,280	5,555	5,080	3,363	2,076	4,778	4,370	5,692	5,205
	7		4,320	3,950	5,938	5,430	6,933	6,340	4,391	4,015	6,075	5,555	7,124	6,515
	10		5,638	5,155	7,534	6,890	8,650	7,910	5,741	5,250	7,732	7,070	8,907	8,145
	15		7,458	6,820	9,661	8,835	10,891	9,960	7,622	6,970	9,940	9,090	11,247	10,285
	20		8,912	8,150	11,319	10,350	12,612	11,535	9,131	8,350	11,657	10,660	13,040	11,925
	25		10,063	9,205	12,598	11,520	13,931	12,740	10,312	9,430	12,991	11,880	14,422	13,190
	30		10,936	10,000	13,553	12,395	14,921	13,645	11,220	10,260	13,991	12,795	15,452	14,130
	35		11,517	10,560	14,221	13,005	15,605	14,270	11,854	10,840	14,688	13,430	16,162	14,780

TABLE LXX.—BALLISTICAL DATA OF 34-CENT. AND 37-CENT. CANET NAVAL GUNS. CONSTRUCTED BY THE FORGES ET CHANTIERS DE LA MEDITERRANÉE.

Nature of Gun.	Bore.	Length of Gun. Calibres.	Total Length		Length of Bore.		Diameter of Chamber.		Length of Rifling.		Number of Grooves.	Terminal Angle.	Weight of Gun.		Weight of Projectile.		Weight of Charge.		Initial Velocity.		Total Energy.		Thickness of Iron Plate Penetrated at Muzzle.		Maximum Range.	
	in.		in.	mm.	in.	mm.	in.	mm	in.	mm.			lb.	kilos.	lb.	kls.	lb.	kls.	ft.	m.	ft.-tons	m. tons	in.	cm.	yards	m.
34 cm. gun	13.39	25	334.7	8,500	311.4	7,908	14.09	358	247.6	6,290	102	Uniform rifling at 6 deg.	89,066	40,400	1058	480	325.3	160	1770	540	22,797	7061.68	28.6	72.7	16,668	15,240
Ditto	13.39	30	401.0	10,200	376.2	9,554	14.49	368	309.1	7,850	102		121,473	55,100	1058	480	440.9	200	2000	610	29,091	9011.14	34.1	86.6	19,555	17,880
Ditto	13.39	36	481.9	12,240	456.5	11,594	14.88	378	375.4	9,535	102		145,063	65,800	1058	480	573.2	260	2230	680	36,150	11197.94	39.7	100.8	21,681	19,825
Ditto	13.39	43	575.6	14,620	548.1	13,920	15.28	388	466.6	11,850	102		195,107	88,500	1058	480	661.4	300	2428	740	42,815	13261.33	44.6	113.3	23,308	21,310
Ditto	13.39	50	669.0	17,000	563.1	14,300	15.67	398	548.1	13,920	102		220,460	100,000	1058	480	749.6	340	2625	800	50,046	15498.88	49.4	125.6	24,761	22,640
37 cm. gun	14.57	25	364.1	9,250	338.8	8,606	15.35	390	269.5	6,845	112		114,860	52,100	1367	620	463.0	210	1771	540	29,749	9214.56	32.6	82.8	17,181	15,710
Ditto	14.57	30	436.0	11,100	409.4	10,396	15.75	400	336.4	8,545	112		156,747	71,100	1367	620	595.2	270	2001	610	37,960	11758.36	38.8	98.6	20,255	18,520
Ditto	14.57	36	524.4	13,320	496.7	12,616	16.14	410	408.7	10,380	112		186,950	84,800	1367	620	727.5	330	2231	680	47,175	14611.84	45.2	115.0	22,541	20,610
Ditto	14.57	43	626.5	15,910	596.4	15,148	16.54	420	507.5	12,890	112		251,320	114,000	1367	620	859.8	390	2424	740	55,870	17304.16	51.1	130.0	24,300	22,220
Ditto	14.57	50	728.0	18,500	698.4	17,738	16.93	430	596.5	15,150	112		282,830	128,300	1367	620	970.0	440	2625	800	65,296	20224.0	57.0	145.0	25,881	23,665

ticulars of the projectiles used in four different calibres of Canet ordnance; those of 12 and 15 centimetres and of 24 and 28 centimetres. Table LXVIII. gives full particulars of 12 and 15-centimetre quick-firing guns of different lengths, from 30 to 50 calibres, and Table LXIX. (page 750) contains similar information about the same type of gun and 14-centimetre bore. Table LXX. consists of ballistic data for heavy naval guns on the Canet system of 34-centimetre and 37-centimetre calibre. Table LXXI. (page 751) contains similar details of Canet coast defence mortars of 22 centimetres (8.66 in.); 24 centimetres (9.45 in.); 27 centimetres (10.63 in.); 30 centimetres (11.81 in.); and 32 centimetres (12.60 in.). Table LXXII. (page 751) refers to coast defence howitzers and mortars of 34 centimetres (13.39 in.) Table LXXIII. (page 750) refers to the Canet cast-iron guns of 15 centimetres (5.90 in.) and 19 centimetres (7.47 in.), long and short types.

Fig. 505 (page 745) is a general view of a 66-ton gun of 12.60 in. bore, mounted on its naval carriage; this is one of six now being completed for the Japanese Government by the Forges et Chantiers de la Mediterranée. A section of the gun was published by us in our issue of May 16th last. The carriage is of the Canet naval type, resembling closely those described by us last week in referring to the armament of the Pelayo. The engraving, which is from a photograph, taken at the Hoc Polygon, only shows the mounting in position for trial, but it indicates clearly the general arrangement; the slides, hydraulic brakes, and pivot on the upper carriage, and the position of the elevating and depressing rams on the underframe. It may be added that both the gun and carriage have been subjected satisfactorily to various severe tests.

Figs. 506 to 510 (page 745) illustrate a new form of carriage for coast defence and garrison guns, and may be described in some detail, as it possesses several novel features. The principal object of the designer was to produce a mounting which should be light and easily handled, so that it could be quickly fixed at any desired point, and rapidly removed after being partly taken to pieces, for re-erection at another point. The trunnions of the gun rest

THE MANCHESTER SHIP CANAL WORKS.

(*For Description, see Page 754.*)

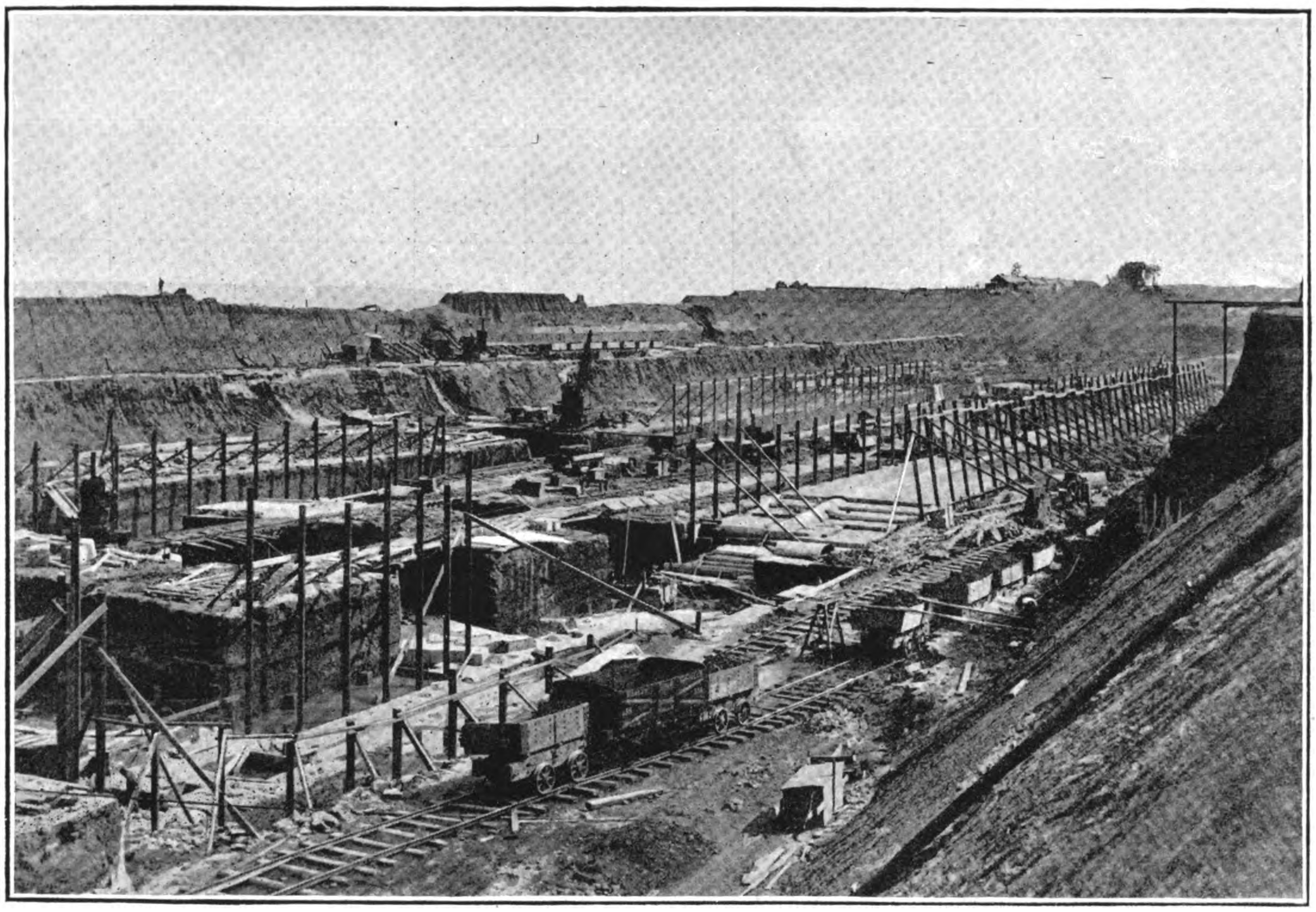
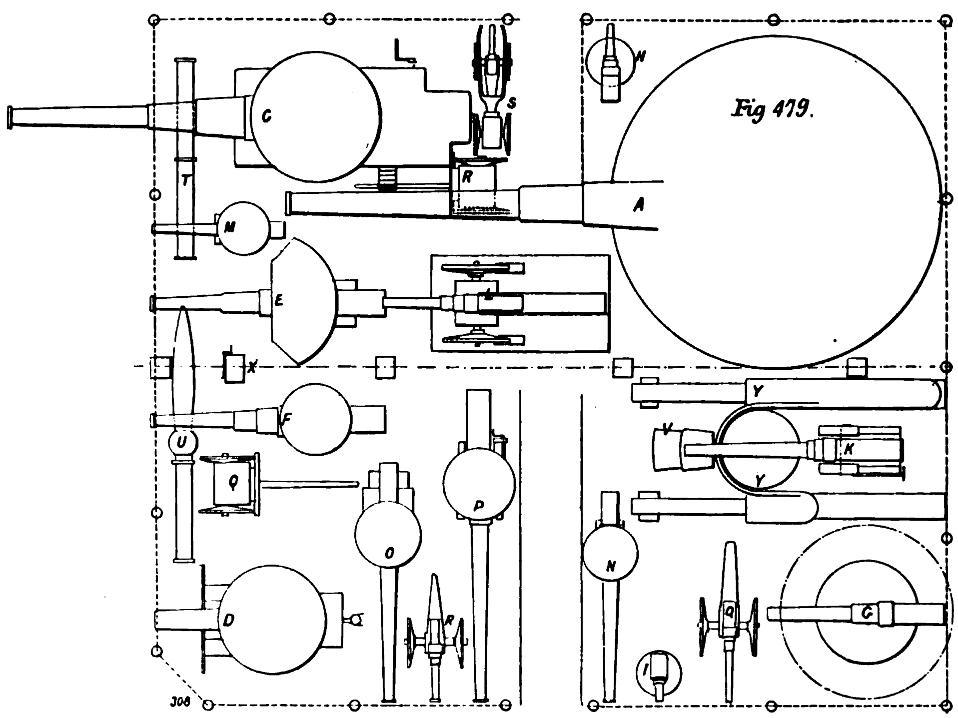


FIG. 3. CUTTING FOR THE EASTHAM LOCKS.

in bearings on the end of a long curved arm *a*, turning on a pivot, below which it is extended to receive the pin *a*, Fig. 507, to which the rod of the brake piston is attached. The pivot on which the swinging beams A are mounted, is inclosed in a rubber sleeve to deaden the shock due to firing. The brake cylinder B, Fig. 507, turns on the pin *b* fastened to the frame, which is formed of two side plates. On the forward part of this frame are the bearings for the swinging arm pivot, and below are the clips by which a connection is made with a fixed baseplate secured to the ground. As will be seen from the illustrations, these clips are hinged together, and can be closed around the neck of the baseplate and fastened by means of bolts. Near the forward part of the frame are also the bearings for the axle of two travelling wheels E E', on which the carriage is mounted. As will be seen in Fig. 506, when the gun is made ready for firing, these wheels rest on extensions of the baseplate. Under the rear of the frame is a traversing wheel F, running in jointed bearing G[1]. This wheel is only down while the gun is being fired; when travelling from place to place it is hinged back, and the general appearance is as shown in Fig. 508. While being fired the wheel F is raised clear of the ground. In Fig. 509 the loading platform is shown at K; this platform is carried by jointed rods and is folded down when travelling, the mounting then being supported by a fore carriage H, Fig. 508, consisting of a pair of wheels on an axle that carries the gearing *t* for raising or lowering the gun; the axle is attached to the frame by a pin *m*, Fig. 570. To the fore carriage are also secured the poles for the horses. The training gear for elevation is shown in the various figures. It consists of a toothed sector O, into which gears the teeth of a pinion belonging to a Canet differential (already described) and which is actuated by the handwheel *p*. The length of this sector is sufficient to enable the gun to be brought into a horizontal position when the swinging beams are lowered for travelling (see Fig. 508). The man training the gun stands on the platform P. The whole carriage is turned around on the baseplate, for lateral training, and the degree of displacement is indicated on a graduated scale by a needle. To get the gun into position a bar is passed between the spokes of the wheels under the swinging beam; cords are attached to other spokes at *e*, and by drawing on these cords with levers L, the winch *t* pulls round the wheels and raises the arms and the gun. The figures illustrate this arrangement. For lowering the

MODERN FRENCH ARTILLERY.

KEY PLAN TO FIG. 478. (*See Two-Page Engraving.*)



THE MANCHESTER SHIP CANAL WORKS.

(*For Description, see Page* 754.)

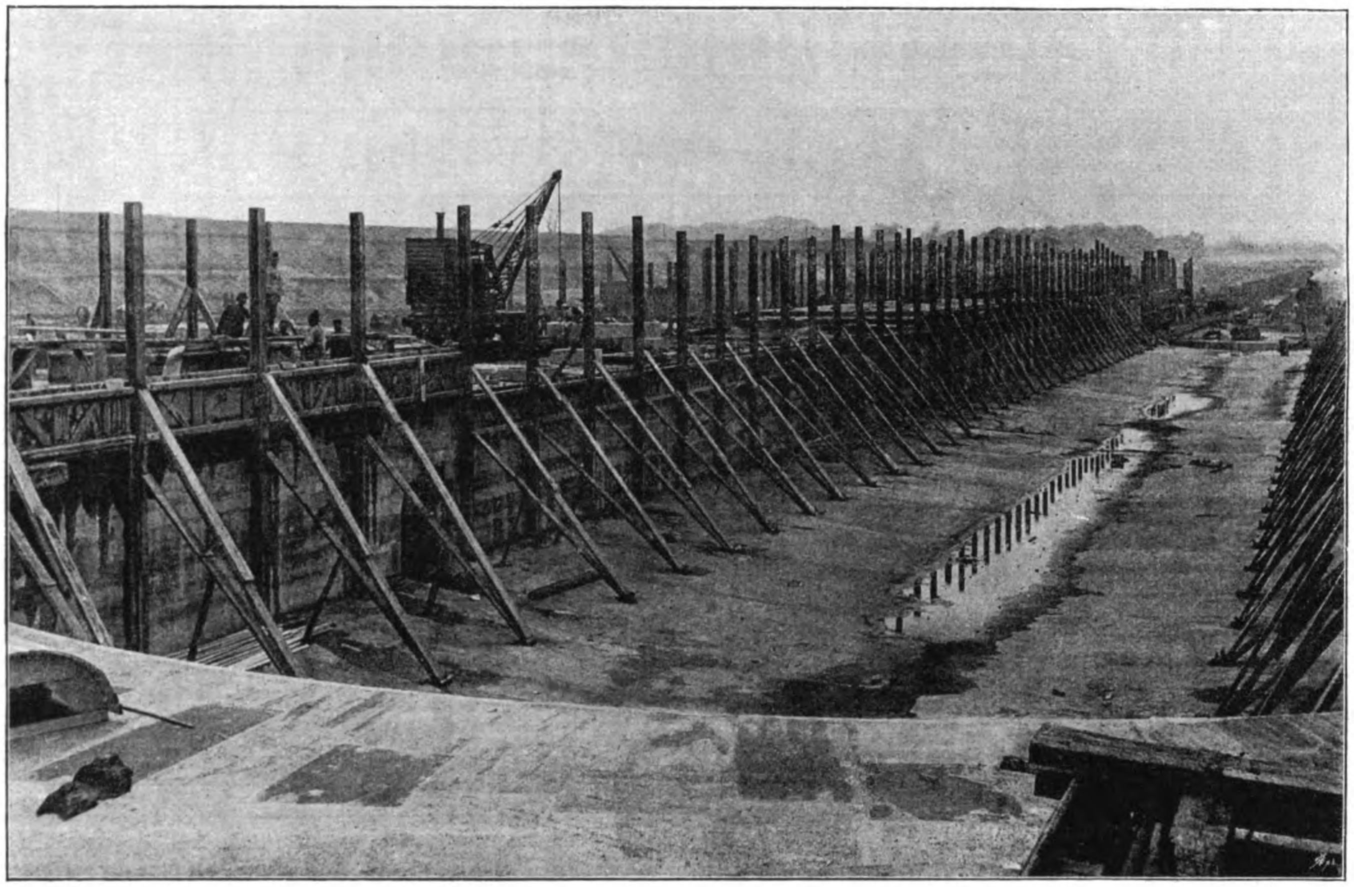


Fig. 4. The construction of the Eastham locks.

TABLE LXVII.—Particulars of Projectiles for 15-Cent. (5.90-In.) Canet Siege Gun.

Fig. 500.—Common Shell

	kilos.	lb.
Weight of cast iron ..	33.110	72.842
,, belt	.410	.902
,, fuze	.220	.484
,, bursting charge	1.260	2.772
Total weight ..	35.000	77.000

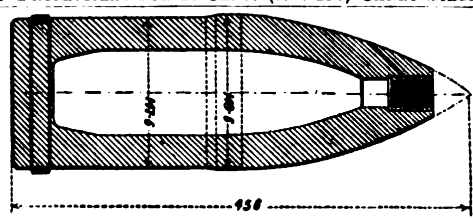


Fig. 501.—High Capacity Shell.

	kilos.	lb.
Weight of steel	28.990	63.778
,, belt	.410	902
,, fuze	.500	1.100
,, bursting charge	5.100	11.220
Total weight ..	35.000	77.000

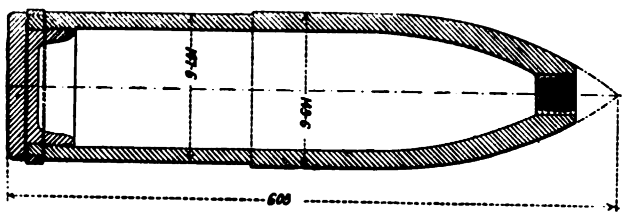


Fig. 502.—Shrapnel.

	kilos.	lb.
Weight of cast iron ..	27.020	59.444
,, balls	6.800	14.960
,, belt	.410	.902
,, fuze	.220	.484
,, bursting charge	.550	1.210
Total weight ..	35.000	77.000

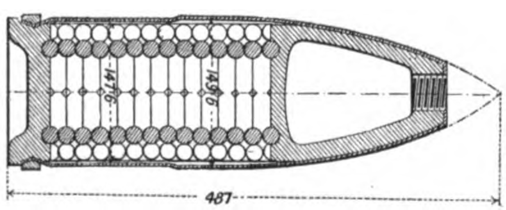


Fig. 503.—Mitraille Shell.

	kilos.	lb.
Weight of cast iron and steel	12.460	27.412
Weight of balls	4.650	10.230
,, belt	.180	.396
,, fuze	.500	1.100
,, bursting charge	.210	.462
Total weight ..	18.000	39.000

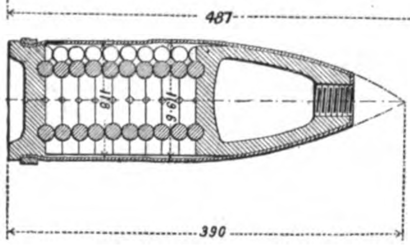
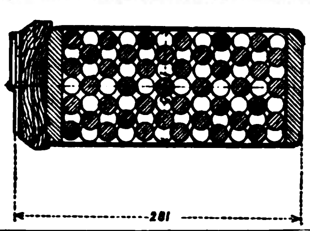


Fig. 504.—Case Shot.

	kilos.	lb.
Weight of box	4.640	10.208
,, balls	12.600	27.720
,, sulphur ..	.760	1.672
Total weight ..	18.000	39.000



gun a reverse process is followed, the cords in this case serving to retard the fall. Before firing, the large wheels resting on the bedplate are locked to the frame by pins, and the gun is then in the position shown in Fig. 507. The form of the bedplate, and its mode of attachment to the ground, are clearly seen in Fig. 506. The brake apparatus, which is detached from the swinging frame when travelling, is of the ordinary Canet type, with the central counter-rod of varying section; the effort of recoil is entirely absorbed by this brake, and but little shock is thrown upon the baseplate.

A number of mountings of this type have been constructed by the Forges et Chantiers, as they are very light and simple; they are especially adapted for general service, to defend entrenchments or permanent works, or in fact for any purpose which requires a frequent change of position. They are constructed for guns of 80 and 90 millimetres, 10, 12, and 15 centimetres (3.15 in., 3.54 in., 3.94 in., 4.72 in., and 5.90 in.).

THE NICARAGUA CANAL.

The idea of cutting a waterway through the isthmus connecting the two continents of North and South America has been revived every few years since the contour of the new world was definitely established. Cortez himself sought for a natural way along the rivers which flow in either direction to the sea in the neighbourhood of Tehuantepec, and finding none he purchased large tracts of land as an inheritance to his posterity, confident that in time the needs of the world and the advance of science would carry a highway over this spot. If Mr. James B. Eads had lived there is little doubt that Tehuantepec would have become the site of a ship railway; possibly it may still, but for the present that project is quiescent. No less than nineteen schemes for crossing the isthmus had been put before the world up to 1866, and since then there have been several others. The following is a list of the most practicable schemes, named geographically from north to south.

1. The Isthmus of Tehuantepec.
2. The Nicaragua route *viâ* Lake Nicaragua.
3. The Isthmus of Panama.
4. The San Blas and Chepo route.

MODERN FRENCH ARTILLERY. (*See page* 745.)

TABLE LXIX.—Forges et Chantiers de la Mediterranee. Quick-Firing Guns (Canet System) on Ship Mountings.

—			14 cm. Gun of 30 Calibres.		14-cm. Gun of 40 Calibres.		14-cm. Gun of 50 Calibres.	
			in.	mm.	in.	mm.	in.	mm.
Calibre			5.51	140	5.51	140	5.51	140
Total length of gun			165.4	4200	220.5	5600	275.6	7000
Length of bore			157.1	3990	212.3	5390	267.3	6790
			lb.	kilos.	lb.	kilos.	lb.	kilos.
Weight of gun			6724	3050	8907	4040	11,023	5000
„ armour-piercing shell			70.55	32	70.55	32	70.55	32
			ft.	metres	ft.	metres	ft.	metres
Muzzle velocity			1640	500	2165	660	2559	780
			lb.	kilos.	lb.	kilos.	lb.	kilos.
Weight of common shell			70.55	32	70.55	32	70.55	32
			foot-tons	metre tons	foot-tons	metre tons	foot-tons	metre tons
Energy at muzzle			1316.4	407.75	2294.0	710.46	3204	992.30
	yds.	m.	ft.	metres	ft.	metres.	ft.	metres
Remanent velocities at	547	500	1504	458	1977	603	2336	712
	1094	1000	1375	419	1806	551	2136	651
	1641	1500	1263	385	1653	504	1952	595
	2188	2000	1168	356	1509	460	1785	544
	2735	2500	1099	335	1381	421	1630	497
			foot-tons	metre tons	foot-tons	metre tons	foot-tons	metre tons
Striking energy at	547	500	1104.7	342.12	1914.9	593.04	2669.8	826.82
	1094	1000	924.5	286.34	1598.9	495.17	2232.0	691.22
	1641	1500	780.5	241.75	1337.8	414.30	1863.4	577.14
	2188	2000	667.3	206.70	1114.4	345.12	1558.3	482.67
	2735	2500	590.8	183.04	933.3	289.08	1300.8	402.87
Striking energy in foot and metric tons per inch and per cent. of circumference of projectile	At muzzle		77.10	9.4	134.35	16.38	187.72	22.89
	547	500	64.71	7.89	112.20	13.68	156.40	19.07
	1094	1000	54.13	6.60	93.66	11.42	130.71	15.94
	1641	1500	45.77	5.58	78.33	9.55	109.23	13.32
	2188	2000	39.12	4.77	65.29	7.96	91.28	11.13
	2735	2500	34.61	4.22	54.70	6.67	76.19	9.29
			in.	cm.	in.	cm.	in.	cm.
Thickness of wrought-iron plate penetrated	At muzzle		7.04	17.9	10.47	26.6	13.31	33.8
	547	500	6.21	15.8	9.21	23.4	11.69	29.7
	1094	1000	5.47	13.9	8.11	20.6	10.27	26.1
	1641	1500	4.84	12.3	7.12	18.1	9.05	23.0
	2188	2000	4.36	11.1	6.25	15.9	7.95	20.2
	2735	2500	3.97	10.1	5.51	14.0	7.00	17.8
	deg.		yards	metres	yards	metres	yards	metres
Range at different angles	3		2,118	2,000	3,221	2,945	3,931	3,595
	5		3,346	3,060	4,735	4,330	5,638	5,155
	7		4,358	3,985	6,015	5,500	7,048	6,445
	10		5,692	5,205	7,644	6,990	8,803	8,050
	15		7,546	6,900	9,810	8,970	11,104	10,155
	20		9,044	8,270	11,515	10,530	12,880	11,770
	25		10,293	9,330	12,832	11,735	14,229	13,010
	30		11,100	10,150	13,818	12,635	15,245	13,940
	35		11,734	10,730	14,493	13,255	15,944	14,580

TABLE LXXIII.—The Forges et Chantiers de la Mediterranee: Particulars of Cast-Iron Guns (Canet System)

—			15 cm. Short Gun.		15 cm. Long Gun.		10 cm. Short Gun.		19 cm. Long Gun.	
			in.	mm.	in.	mm.	in.	mm.	in.	mm.
Calibre			5.90	150	5.90	150	7.47	190	7.47	190
Total length of gun			165.4	4200	177.2	4500	209.5	5320	224.5	5700
			tons	kilos.	tons	kilos.	tons	kilos.	tons	kilos.
Weight of gun			3.987	4050	4.036	4100	8.122	8250	8.170	8300
			lb.		lb.		lb.		lb.	
„ shell			77.16	35	77.16	35	154.32	70	154.32	70
„ powder charge			19.84	9	26.45	12	39.68	18	55.11	25
			ft.	metres	ft.	metres	ft.	metres	ft.	metres
Initial velocity			1607	490	1870	570	1607	490	1870	570
			foot-tons	m. tons	foot-tons	metre tons	foot-tons	m. tons	foot-tons	m. tons
Striking energy			1382.8	428.4	1871.1	579.7	2794.5	8658	3742.0	1159.4
	yds.	m.	ft.	metres	ft.	metres	ft.	metres	ft.	metres
Remanent velocities at	547	500	1463	446	1699	518	1489	454	1732	528
	1094	1000	1332	406	1543	472	1381	421	1604	489
	1641	1500	1220	372	1407	429	1282	391	1489	454
	2188	2000	1135	346	1286	392	1200	366	1381	421
	2735	2500	1069	326	1184	361	1135	346	1282	391
			foot-tons	m. tons	foot-tons	metre tons	foot-tons	m. tons	foot-tons	m. tons
Striking energy at	547	500	1145.6	354.92	1545.3	478.76	2374.0	735.52	3211.1	994.84
	1094	1000	949.3	294.11	1283.1	397.51	2041.5	632.49	2754.1	853.31
	1641	1500	796.7	246.81	1060.0	328.38	1761.0	545.56	2374.0	735.52
	2188	2000	689.4	213.60	885.0	274.18	1543.0	478.02	2041.4	632.48
	2735	2500	612.1	193.63	750.5	232.53	1378.9	427.20	1761.0	545.56
Striking energy in foot and metric tons per inch and per cent. of circumference of projectile	At muzzle		75.36	9.19	101.92	12.43	118.98	14.51	160.97	19.63
	547	500	62.40	7.61	84.38	10.29	102.09	12.45	138.09	16.84
	1094	1000	51.74	6.31	69.94	8.53	87.82	10.71	118.49	14.45
	1641	1500	43.46	5.30	57.73	7.04	75.76	9.24	102.09	12.45
	2188	2000	37.55	4.58	48.21	5.88	66.34	8.09	87.82	10.71
	2735	2500	33.37	4.07	40.92	4.99	59.28	7.23	75.76	9.24
			in.	cm.	in.	cm.	in.	cm.	in.	cm.
Thickness of wrought-iron plate penetrated (Gâvre formula)	At muzzle		6.92	17.6	8.62	21.9	9.60	24.4	11.93	30.3
	547	500	6.06	15.4	7.51	19.1	8.62	21.9	10.72	27.2
	1094	1000	5.31	13.5	6.57	16.7	7.75	19.7	9.52	24.4
	1641	1500	4.68	11.9	5.74	14.6	6.96	17.7	8.62	21.9
	2188	2000	4.21	10.7	5.03	12.8	6.33	16.1	7.75	19.7
	2735	2500	3.93	9.9	4.48	11.4	5.86	14.9	6.96	17.7
	deg.		yards	metres	yards	metres	yards	metres	yards	metres
Range at different angles	3		2,078	1,900	2,575	2,355	2,116	1,935	2,635	2,410
	5		3,149	2,880	3,838	3,510	3,226	2,950	4,128	3,775
	7		4,112	3,760	4,926	4,505	4,226	3,865	5,096	4,660
	10		5,358	4,900	6,326	5,785	5,522	5,050	6,572	6,010
	15		7,080	6,475	8,218	7,515	7,316	6,690	8,557	7,825
	20		8,459	7,735	9,705	8,875	8,770	8,020	10,143	9,275
	25		9,552	8,725	10,859	9,930	9,940	9,090	11,379	10,405
	30		10,361	9,475	11,733	10,730	10,810	9,885	12,317	11,260
	35		10,940	10,005	12,340	11,285	11,420	10,445	12,959	11,850

5. The Caledonia Bay and Morti routes.
6. The Caledonia Bay and Sucubti route.
7. The so-called "Du Puydt" route.
8. The Cacarica and Tuyra route.
9. The Atrato and Fernando route.
10. The Atrato-Napipi route.

In 1879 an international congress sat in Paris to determine the best route for a canal connecting the two oceans. The various possible courses were discussed; the American delegates advocated the claims of the Nicaragua site, while the French preferred that of Panama. Eventually the supposed possibility of cutting a canal at the latter place entirely free from locks weighed so greatly in its favour that it was adopted. Every one knows what the result has been; first the straight cut without locks was abandoned, and now all work is suspended, with no probability of its being resumed.

The Panama Canal was never popular in the United States, the general feeling there being in favour of the Nicaragua route, and this was intensified when the development of the Pacific States rendered improved means of communication across the continent imperatively necessary. The transcontinental railways have not sensibly decreased the necessity for a shortened sea route since their charges are prohibitive for many classes of heavy goods. As early as 1849 the Government of the United States encouraged the formation of the Atlantic and Pacific Ship Canal Company, which obtained a concession from Nicaragua. The surveys were made by Colonel O. W. Childs, who determined the lowest point at which the range running down the isthmus could be crossed to be 152 ft. above sea level. He laid down a route for the canal from the mouth of the River Lajas, on the west shore of the lake, to the port of Brito on the Pacific, and although nothing further was done, the surveys have not only proved valuable, but also

MODERN FRENCH ARTILLERY. (*See page* 745.)

TABLE LXXI.—THE FORGES ET CHANTIERS DE LA MEDITERRANEE. PARTICULARS OF GUNS (CANET SYSTEM, MODEL 1889.)

—			Coast Defence Howitzer of 34 cm. Calibre.		Coast Defence Mortar of 34 cm. Calibre.	
			in.	mm.	in.	mm.
Calibre			13.39	340	13.39	340
Total length of gun			174.0	4420	107.1	2720
			tons	kilos.	tons	kilos.
Weight of gun			10.631	10,800	5.148	5230
			lb.		lb.	
„ shell			815.7	370	815.7	370
„ powder charge			77.16	35	37.48	17
			ft.	metres	ft.	metres
Initial velocity			984	300	656	200
			foot-tons	metre tons	foot-tons	metre tons
Striking energy			5479.1	1697.6	2435.3	754.49
	yds.	m.	ft.	metres	ft.	metres
Remanent velocities at	547	500	961	293	646	197
	1094	1000	941	287	633	193
	1641	1500	922	281	623	190
	2188	2000	902	275	613	187
	2735	2500	886	270	603	184
	3282	3000	869	265	549	181
			foot-tons	metre tons	foot-tons	metre tons
Striking energy at	547	500	5226.8	1619.3	2362.8	732.02
	1094	1000	5014.2	1553.6	2267.7	702 60
	1641	1500	4807.1	1489.5	2224.0	650.92
	2188	2000	4604.0	1426.4	2129.0	659.59
	2735	2500	4438.1	1375.1	2061.1	638.60
	3282	3000	4274.9	1324.6	1994.2	617.94
Striking energy in foot and metric tons per inch and per cent. of circumference of projectile	At muzzle		131.85	16.08	58.55	7.14
	547	500	125.78	15.34	56.82	6.93
	1094	1000	120.7	14.72	54.53	6.65
	1641	1500	115.7	14.11	52.80	6.44
	2188	2000	110.79	13.51	51.17	6.24
	2735	2500	106.77	13.02	49.52	6.04
	3282	3000	102.91	12.55	47.97	5.85
			in.	cm.	in.	cm.
Thickness of wrought-iron plate penetrated. (Gâvre formula)	At muzzle		10.35	26.3	5.78	14.7
	547	500	10.0	25.4	5.66	14.4
	1094	1000	9.72	24.7	5.51	14.0
	1641	1500	9.41	23.9	5.39	13.7
	2188	2000	9.13	23.2	5.27	13.4
	2735	2500	8.89	22.6	5.15	13.1
	3282	3000	8.66	22.0	5.03	12.8
	deg.		yards	metres	yards	metres
Range at different angles	5		1591	1455	831	760
	10		2969	2715	1542	1410
	15		4139	3785	2154	1970
	20		5118	4680	2663	2435
	25		5911	5405	3073	2810
	30		6529	5970	3395	3105
	35		6994	6395	3636	3325
	40		7409	6775	3855	3525
	Maximum		8147	7450	4238	3875

TABLE LXXII.—THE FORGES ET CHANTIERS DE LA MEDITERRANEE; PARTICULARS OF GUNS (CANET SYSTEM, MODEL 1889). MORTARS FOR COAST DEFENCE.

—			22 cm.		24 cm.		27 cm.		30 cm.		32 cm.	
			in.	mm.	in.	mm.	in.	mm.	in.	mm.	in.	mm.
Calibre			8.66	220	9.45	240	10.63	270	12.01	305	12.60	320
Total length of gun			69.2	1760	75.5	1920	85.0	2160	96.0	2440	100.8	2560
			tons	kilos	tons	kilos.	tons	kilos.	tons	kilos.	tons	kilos.
Weight of gun			1.396	1420	1.811	1840	2.579	2620	3.711	3770	4.292	4360
			lb.		lb.		lb.		lb.		lb.	
„ shell			220.5	100	286.6	130	410.0	186	595.2	270	683.4	310
„ powder charge			10.36	4.7	13.2	6	19.2	8.7	28.0	12.7	32 2	14.6
			ft.	metres	ft.	metres	ft.	metres	ft.	metres	ft.	metres
Initial velocity			656	200	656	200	656	200	656	200	656	200
			foot-tons	m. tons	foot-tons	m. tons	foot-tons	m. tons	foot-tons	m. tons	foot-tons	m.-tons
Striking energy			658.17	203.92	855.66	265.09	1224.25	379.29	1777.0	550.57	2040.5	632.14
	yds.	m.	ft.	metres	ft.	metres	ft.	metres	ft.	metres	ft.	metres
Remanent velocities at	547	500	636	194	640	195	640	195	643	196	643	196
	1094	1000	617	188	623	190	623	190	633	193	633	193
	1641	1500	603	184	610	186	613	187	620	189	620	189
	2188	2000	590	180	597	182	603	184	607	185	610	186
	2735	2500	577	176	584	178	590	180	597	182	600	183
	3282	3000	564	172	571	174	581	177	587	179	590	180
			foot-tons	m. tons	foot-tons	m. tons	foot-tons	m. tons	foot-tons	m. tons	foot-tons	m.-tons
Striking energy at	547	500	619.3	191.86	814.4	252.36	1164.0	360.60	1689.1	523.39	1939.3	600.93
	1094	1000	581.5	180.18	772.1	239.25	1117.0	346.07	1654.5	512.70	1899.8	588.66
	1641	1500	557.0	172.60	739.9	229.27	1070.1	331.58	1586.9	491.67	1821.9	564.52
	2188	2000	533.0	165.17	708.4	219.52	1036.0	321.02	1520.3	471.08	1764.6	546.73
	2735	2500	509.5	157.90	677.6	209.98	991.5	307.22	1471.5	455.93	1708.0	529.24
	3282	3000	486.8	150.82	647.5	200.65	958.7	297.06	1423.3	441.02	1652.4	512.03
Striking energy in foot and metric tons per inch and per cent. of circumference of projectile	At muzzle		24.57	2.996	29.11	3.55	37.31	4.55	47.64	5.81	52.07	6.35
	574	500	23.09	2.816	27.71	3.38	35.42	4.32	45.26	5.52	49.53	6.04
	1094	1000	21.68	2.644	26.32	3.21	34.03	4.15	44.36	5.41	43.54	5.92
	1641	1500	20.77	2.533	25.17	3.07	32.55	3.97	42.56	5.19	46.49	5.67
	2188	2000	19.88	2.424	24.11	2.94	31.57	3.85	40.75	4 97	45.10	5.50
	2735	2500	19.02	2.319	23.04	2.81	30.17	3.68	39.44	4.81	43.62	5.32
	3282	3000	18.15	2.213	22.06	2.69	29.19	3.56	38.46	4.69	42.23	5.15
			in.	cm.	in.	cm.	in.	cm.	in.	cm.	in.	cm.
Thickness of wrought-iron plate penetrated (Gâvre formula)	At muzzle		3.07	7.8	3.54	9.0	4.21	10.7	4.99	12.7	5.35	13.6
	574	500	2.99	7.6	3.39	8.6	4.05	10.3	4.84	12.3	5.15	13.1
	1094	1000	2.83	7.2	3.27	8.3	3.94	10.0	4.72	12.0	5.07	12.9
	1641	1500	2.75	7.0	3.15	8.0	3.82	9.7	4.60	11.7	4.91	12.5
	2188	2000	2.68	6.8	3.07	7.8	3.74	9.5	4.48	11.4	4.80	12.2
	2735	2500	2.60	6.6	2.99	7.6	3.62	9.2	4.36	11.1	4.68	11.9
	3282	3000	2.52	6.4	2.87	7.3	3.54	9.0	4.23	10.9	4.60	11.7
	deg.		yards	metres	yards	metres	yards	metres	yards	metres	yards	metres
Range at different angles	5		771	705	787	720	815	745	820	750	826	755
	10		1443	1320	1465	1340	1515	1385	1525	1395	1536	1405
	15		2012	1840	2045	1870	2116	1935	2127	1945	2138	1955
	20		2482	2270	2531	2315	2619	2395	2630	2405	2646	2420
	25		2871	2625	2925	2675	3024	2765	3040	2780	3051	2790
	30		3171	2900	3231	2955	3335	3050	3363	3075	3373	3085
	35		3390	3100	3456	3160	3576	3270	3596	3290	3614	3305
	40		3543	3240	3609	3300	3740	3420	3762	3440	3778	3455
	Maximum		3888	3555	3970	3630	4112	3760	4139	3785	4166	3810

exceedingly accurate. Further surveys were made between 1870 and 1876. In 1872 President Grant appointed a commission to report on the various plans submitted by the surveying parties, and in 1876 the commission reported that "the route known as the Nicaragua route possesses, both for the construction and maintenance of a canal, greater advantages, and offers fewer difficulties from an engineering, commercial, or economical point of view, than any other of the routes shown to be practicable by surveys sufficiently in detail to enable a judgment to be formed of their relative merits." The routes considered were the first, second, third, and tenth, given above.

The route selected was 181 miles in length, and involved four dams across the River San Juan, with 21 locks of 10 ft. lift, ten on the Atlantic, and eleven on the Pacific slope. The chief engineer of the Government surveys, Mr. A. G. Menocal, still considered that improvements might be made in the route by more detailed examination, and in 1880 he was able, in the western division, to effect a decrease in the length and in the amount of the excavation, and also to render the curves easier. In 1885 he attacked the eastern side, and was so successful, that soon afterwards a company was chartered for the building of the canal. The first work to be done was to supplement the early