THE MORRIS RIFLE MAGAZINE.

WE publish on page 191 illustrations of the Morris magazine as applied to the Lee or any other bolt rifle. There are, speaking broadly, advocates of two main classes of magazines for rifles, one declaring in favour of a magazine permanently built into the gun, of which the Schulhof and the Winchester are types; the other favouring a system of detachable or semi-detachable magazine, of which the Lee and Mannlicher are representatives. In the Lee system from five to seven cartridges are packed in a metal box or frame containing a spring and platform for pressing up the cartridges as they are pushed out of the box by the action of the bolt of the rifle. In the Mannlicher five or six cartridges are packed in a metal clip and inserted into the rifle; the act of inserting the cartridges thus packed compresses a spring permanently fitted in the rifle which forces up a cartridge at each stroke of the bolt. The magazine devised by Mr. Morris, whose name is so well known in connection with firing tubes and other gunnery devices, is a combination of the two systems of detachable and fixed magazines. It can be carried separately from the rifle, loaded with six or seven cartridges, and instantaneously inserted into the breech, and when its stock of cartridges has been expended, the magazine can be refilled in place with loose cartridges, as shown in Fig. 2, almost as quickly as if the cartridges were already packed in separate receptacles. From twenty-six to thirty shots can be fired in a minute with this magazine from a pouch of loose cartridges, thus saving the expense and weight of carrying the ammunition specially packed in a number of metal cases or clips.

There are only three working parts in the magazine, viz., the sliding door, the platform, and the spring (see Fig. 3), so that there is very little to get out of order, and it can be very easily cleaned, as by opening the slide free access is obtained to the interior.

As will be readily understood, the magazine has many advantages; it can be kept detached from the rifle when the officer in command does not want his men to expend much ammunition, and it is especially adapted for volley firing, as three or four cartridges can be placed in the magazine as quickly as one round can be inserted into an ordinary bolt rifle. Its principal advantages, however, lie in the fact that it combines an insignificant first cost with great simplicity and durability; that it can be re-charged very rapidly; and that if, from sand or other obstruction, it becomes jammed, it can be taken apart, cleaned, and put together again on the field in a few minutes.

We should add that the device has been approved by Lord Wolseley, Lord Charles Beresford, and others, and that a number have been ordered to be fitted to the new rifle for a practical trial. We predict a better success for the magazine than for the new rifle.

The magazine can be seen at the offices of the Morris Tube, Ammunition, and Safety Range Company, 11, Haymarket.

THE LATE MR. WILLIAM MUIR.

THE death of the late Mr. William Muir has removed another of the few remaining engineers who formed part of that early school of mechanics of which Whitworth and Nasmyth were prominent examples. If Mr. Muir did not occupy so important a place in public attention as did some of his contemporaries, it by no means follows that he was behind them in the knowledge of his art; his modest disposition rendered him incapable of pushing himself forward, while his attention was so fully concentrated upon his work that he had no time or thought to bestow upon gaining a widespread personal popularity. His tools carried his name all over the world, and wherever they went they testified to his integrity and ability.

Mr. Muir was born at Catrine, in Ayrshire, on January 17, 1806. He received the ordinary middle-class education of the time, and was then bound apprentice to Mr. Thomas Morton, of Kilmarnock, a mechanic of great and very varied skill. The work to which he was put included the ordinary jobs which find their way into a country shop, and in addition comprised the manufacture of carpet looms, bagpipes, and telescopes, his master having a great reputation for the two latter. On the completion of his apprenticeship, in 1824, he got work with the firm of Girdwood and Co., of Glasgow. In 1829 he was engaged with the Catrine Company, and in 1830 he was at Houldworth's, of Glasgow. In 1831 he went to London, and entered the shops of Messrs. Maudslay and Field, where he soon became a foreman. In these works he met Joseph Whitworth and James Nasmyth, and it is curious to note that all three eventually settled in Manchester. After being five years with Maudslay's, Mr. Muir went for a short time to Holtzappfel's, to whom he acted as traveller, and then he became foreman to Messrs. Bramah and Robinson. He stayed here until 1840, when Mr. (afterwards Sir Joseph) Whitworth induced him to go to Manchester and become manager in his works. It was while Mr. Muir was here that the celebrated Whitworth system of screw threads was brought out, and a great portion of the credit belongs to him. He was also engaged in the design and construction of the road-brushing machine, a new knitting machine, a radial die-box, a new boring bar, a bolt screwing machine, a planing machine for circular work, and the radial drill. But Mr. Muir and Mr. Whitworth were not congenial spirits, and it was not possible for them to work harmoniously. Consequently the connection ceased in 1842.

An opportunity now occurred for Mr. Muir to turn his inventive faculty and great mechanical skill to good account. Mr. Thomas Edmundson, the originator of the railway ticket, was in need of assistance in the production of machines for printing his tickets, and offered Mr. Muir an order for their manufacture. To execute this he took a shop in Berwick-street, Manchester, and set up for himself. The premises were soon outgrown, and he removed to Miller's-lane, Salford, and from thence to Strangeways, Manchester. Here the present business was developed. Among the many important orders which have been here executed we may mention one, in 1852, for new and special labour-saving machine tools and appliances for Woolwich Arsenal, and another, in 1854, for a large quantity of machinery for the Small Arms Factory. Mr. Muir's appropriate and expressive monument is to be seen in the Britannia Works; those who are acquainted with the productions of those works will be best able to appreciate the value, importance, and varied excellencies that characterise the inventions and improvements that he effected in machine tools.

Mr. Muir retired from active business some years ago, and settled at Brockley, London, where he died on June 15th of the present year. He married, in 1832, Miss Eliza W. Dickinson, of Drypool, and had five sons, of whom the eldest is the London representative of the firm, the fourth being the head of the works, and the fifth a civil engineer in Manchester.

LAUNCHES AND TRIAL TRIPS.

ON Wednesday the Spanish steamer Gracia, built and engined by Wigham, Richardson, and Co. for the Linea de Vapores Serra, was launched from the Neptune Works, Low Walker. The Gracia is a steamer 345 ft. between perpendiculars, 40 ft. beam, and 28 ft. depth, and is specially fitted up for the company's service. The model of the ship and all the arrangements, which show many points of originality, are entirely due to the designer, Mr. Gilbert S. Goodwin, of James-street, Liverpool.

The Abertay, a new screw steamer, built and engined by Messrs. William Simons and Co., Renfrew, to the order of Messrs. A. and A. Y. Mackay, Grangemouth, and under the superintendence of Mr. J. Donaldson, consulting engineer, after loading a cargo at Queen's Dock, Glasgow, proceeded down the Clyde on Monday last on its trial trip. It carried 1300 tons deadweight cargo on a light draught, and ran the measured mile at Skelmorlie, when a mean speed of 10$\frac{3}{4}$ miles was attained. The following are the principal dimensions: Length, 230 ft.; breadth, 33 ft.; depth, 15 ft. 3 in.; with cellular double bottom for water ballast. The engines are on the triple-expansion principle, and of 750 indicated horse-power, the diameter of the cylinders being 17 in., 27 in., and 44 in. respectively, with a stroke of 30 in. Steam is supplied by two mild steel boilers having Brown's patent furnaces and Kirkaldy's Compactum feed water heater. They work at a pressure of 160 lb. per square inch.

The patent hopper dredger Sode-ga-ura-Maru, recently constructed by Messrs. William Simons and Co., Renfrew, for the purpose of effecting harbour improvements in Japan, has completed her trials on the Clyde with very satisfactory results. The construction of the bow of this vessel is a novel arrangement of the builders, and is designed specially to enable the buckets to dredge close to quay walls, and also dredge from the water level to a depth of 30 ft. Its hopper has a capacity for 300 tons of dredgings, and the side shoots are so constructed as to be capable of filling hopper barges alongside as well as its own hopper cavity. The dredging gearing is adapted for working either in hard or soft material, and has a bucket lifting capacity of about 300 tons per hour. Steam mooring winches are fitted at bow and stern for head and side cutting, having treble barrels, each working independently. The engines are of the compound surface-condensing type of 250 indicated horse-power, the boiler being of steel constructed for a working pressure of 90 lb. per square inch.

A screw steamer, the Tangier, was successfully launched from the yard of Messrs. W. Doxford and Son, at Pallion, on Tuesday, August 21. Her principal dimensions are: Length between perpendiculars, 265 ft.; breadth, 37 ft.; depth, 18 ft. 6 in. The engines are triple-expansion with three cranks and all Messrs. Doxford's latest improvements, the cylinders being 21 in., 33 in., and 54 in. in diameter respectively, and the stroke 36 in. They are supplied with high-pressure steam from exceptionally large boilers.

AMERICAN RAILROAD BUILDING.—The aggregate length of new railroad completed in the United States in the first half of this year was 3320 miles. This total must be regarded as a close approximation only, as it is confined to thirty-six States. The largest construction effected in the first half of 1888 took place in California, in which 397 miles of line were completed. Kansas and Georgia each ranked second with a construction of 295 miles. Texas came third with a construction of 179 miles, and Kentucky fourth with a construction of 177 miles.

THE ITALIAN IRONCLAD "LEPANTO."

*Steam Trials of the Royal Italian Ironclad "Lepanto."**

By Major NABOR SOLIANI, Member.

THE Royal Italian ironclad Lepanto underwent recently a series of trials at sea which are interesting, both in themselves and with reference to the size and type of the ship and the power and type of her engines and boilers. It is, in fact, the first time that a power of 16,000 I.H.P. has been developed on board an ironclad, giving her a speed of over 18 knots, and that a large number of locomotive boilers, in connection also with boilers of a different kind, have been worked together with complete success.

I have got permission from His Excellency the Minister of Marine, Mr. B. Brin, the designer of the ship, to put before this Institution the results obtained, hoping that their record, enhanced in importance by the considerable amount of attention that this type of ship has attracted from the naval and engineering world, will be a useful addition to the knowledge already gained on the propulsion of modern warships.

A description of the Italia, the sister ship of the Lepanto, was given some time ago in scientific newspapers (ENGINEERING, February 17, 1888, page 158), and therefore I shall restrict myself here to the principal dimensions and data of the Lepanto that have a bearing on the subject.

The principal dimensions of the Lepanto are as follows:

Length between perpendiculars ...	400 ft. 6 in.
Breadth	72 „ 9 „
Depth, moulded...	46 „
Mean draught, normal...	28 „ 4 „
Area of midship section	1843 sq. ft.
Displacement	13,851 tons

The ship is entirely built of steel, and has no sheathing on her bottom, differing in this respect from the Italia, in which the steel bottom is sheathed with wood and zinc.

The internal divisions are pretty much the same in both ships, with the exception of the boiler-rooms, which are differently arranged on account of the different type of the boilers.

The Italia is fitted with twenty-six boilers of the Admiralty oval marine type, divided into six compartments, three forward the engine-rooms and three aft, each compartment having its own funnel.

On the Lepanto there are also six compartments of boilers, similarly situated, as shown on Fig. 1, but only the two near the engine-rooms have marine oval boilers, four in each, and the remaining four compartments have locomotive boilers, four in each, making a total number of eight oval marine boilers and sixteen locomotive boilers. Their arrangement is clearly shown on the engravings.

The locomotive boilers, which form, perhaps, the most interesting feature of the machinery, deserve special notice. There are two furnaces in each boiler, separated by a longitudinal water space, which, however, stops short of the tube-plate, leaving a passage between, above the bridge. The furnaces are just as long as the firegrate, but to prevent the fire damaging the tubes, and to insure a good combustion of the gases, a high hanging inclined baffle brick bridge is fitted, as usual in railway practice, in each furnace at the end of the firegrate. The bottoms of the ash-pits form water pans to keep the grates cool; the latter are made with longitudinal cast-iron rocking bars. The oval boilers have three furnaces, each discharging in one common combustion chamber. Their grates have ordinary firebars $\frac{3}{4}$ in. thick, with $\frac{5}{8}$ in. interstices. Their are four tunnels—two for the forward set of boilers, and two for the after one. In each set the oval and the locomotive boilers have each their own separate funnel. The boiler rooms are provided with twenty fans—four in each oval boiler room, and three in each locomotive room—capable of maintaining an air pressure of over 2$\frac{1}{2}$ in. of water in the former, and of 4 in. in the latter. The main engines, four in number and arranged in four separate compartments at the centre of the ship, are of the well-known type of Messrs. Penn, with three equal vertical cylinders, as applied on Her Majesty's ships Ajax and Agamemnon, working compound at moderate power, and direct at full power. The cylinders are steam-jacketted, and fitted with a double ported flat slide valve, having an expansion valve working on its back, which allows of any degree of cut-off being fairly obtained. The main engines work their own air and main feed pumps, the circulating pumps only being, as usual, moved by independent engines.

The following are the leading particulars of the engines and boilers:

PARTICULARS OF MACHINERY.

Oval Boilers.

Boilers:	
Number of boilers	8
Height	14 ft. 7 in.
Width..	11 „ 7 „
Length	10 „ 2 „
Furnaces and combustion chambers:	
Number of furnaces in one boiler ..	3
Diameter „	3 ft. 2 in.
Length „	7 „ 4 „
Width of combustion chamber.. ..	10 „ 2 „
Depth „ „	2 „ 2 „
Height „ „	6 „ 6 „
Capacity of furnaces and combustion chambers in one boiler above fire-grates	240 cubic feet
Grates:	
Length of grates	6 ft. 6 in.
Area of grates in one boiler	59 „ 8 „
Arrangement of firebars	Longitudinal
Type of firebars	Ordinary

* Paper read at the thirtieth session of the Institution of Naval Architects, at Glasgow, July 26, 1888.

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Material of firebars	Iron
Thickness of firebars	¾ in.
Interval between firebars	⅝ ,,
Tubes:	
Number of tubes in one boiler	306
Material	Brass
Length of tubes between tube-plates ..	7 ft. 3 in.
Diameter of tubes { internal	2¾ in.
Diameter of tubes { external	3 ,,
Area through tubes in one boiler ..	12.6 sq. ft.
Heating surface in one boiler { tubes	1744 ,,
Heating surface in one boiler { total ..	1920 ,,
Total for all eight oval boilers:	
Grate area	478.4 ,,
Heating surface { tubes	13,952 ,,
Heating surface { total	15,360 ,,
Area through tubes	100.8 ,,
Water surface	862 ,,
Capacity of furnaces and combustion chambers above firegrates	1920 cub. ft.
Capacity of steam chamber	2560 ,,
Weight of water	124 tons
Funnels:	
Number of funnels..	2
Size (oval)	5 ft. 6 in. × 7 ft. 4 in.
Height above firegrate	76 ft.
Area	80.6 sq. ft.

Ratio of	
Tube heating surface / Grate area	27
Total heating surface / Grate area	32.1
Area through tubes / Grate area	0.211
Area of funnels / Grate area	0.168
Water surface / Grate area	1.8
Capacity of steam chamber / Grate area	5.35
Capacity of furnace and combustion chambers / Grate area	4
Load on safety valves	60 lb.
Fans:	
Number of fans	8
Diameter of fans { four	4 ft. 6 in.
Diameter of fans { four	6 ft.
Type of engines	Brotherhood

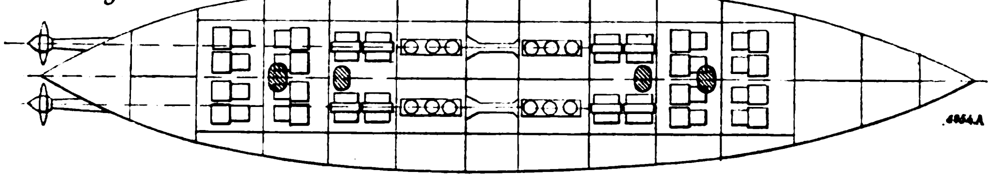
Locomotive Boilers.

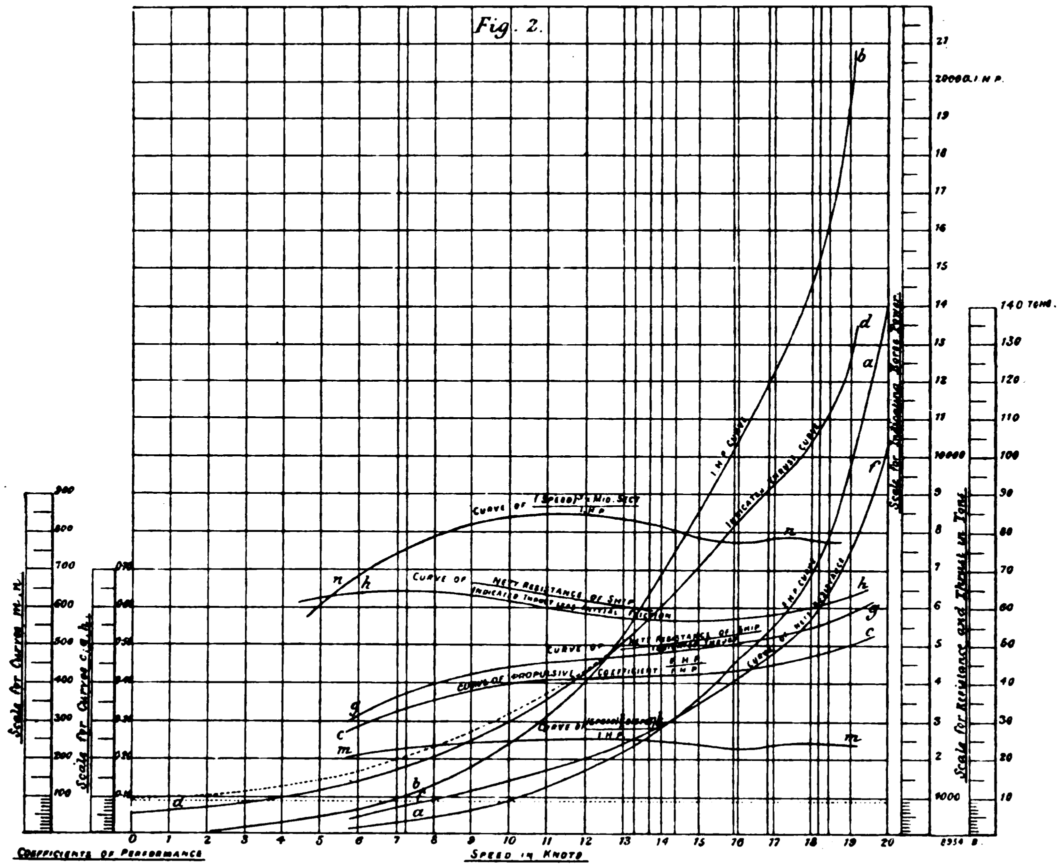
Boilers:	
Number of boilers	16
Height ,, ...	9 ft. 6 in.
Width ,, in front	7 ,, 11 ,,
Length ,, ...	14 ,, 5 ,,
Diameter of barrel	6 ,, 7 ,,
Furnaces:	
Number of furnaces in one boiler ..	2
Width ,, ...	3 ft. 3 in.
Length of furnaces	6 ft. 8 in.
Height of crown above firegrate ..	6 ft.
Capacity of furnaces in one boiler ..	260 cub. ft.
Grates:	
Length of grates	6 ft. 6 in.
Grate area in one boiler	42.2 sq. ft.
Arrangement of firebars	{ Longitudinal rocking.
Material	Cast iron
Type	{ Having side inclined combed air grooves
Tubes:	
Number of tubes in one boiler	376
Material	Brass
Length of tubes between tube-plates ..	7 ft. 7 in.
Diameter of tubes { internal	1¾ in.
Diameter of tubes { external	2 ,,
Area through tubes in one boiler ..	6.27 sq. ft.
Heating surface in one boiler { tubes	1490
Heating surface in one boiler { total	1670
Total for all sixteen locomotive boilers:	
Grate area	675.2 sq. ft.
Heating surface { tubes	23,840 ,,
Heating surface { total	26,720 ,,
Area through tubes	100.3 ,,
Water surface	1,412 ,,
Capacity of furnaces and combustion chambers above firegrates	4160 cub. ft.
Capacity of steam chamber	3360 ,,
Weight of water	105.6 tons
Funnels:	
Number of funnels..	2
Size (oval)	6 ft. 4 in. × 8 ft. 2 in
Height above firegrate	72 ft.
Area	94 sq. ft.
Ratio of	
Tube heating surface / Grate area	35.3
Total heating surface / Grate area	39.6
Area through tubes / Grate area	0.15
Area of funnels / Grate area	0.14
Water surface / Grate area	2.09
Ratio of	
Capacity of steam chambers / Grate area	4.98
Capacity of furnaces and combustion chambers / Grate area	6.16
Load on safety valves	60 lb.
Fans:	
Number of fans	12
Diameter ,, { four	4 ft. 6 in.
Diameter ,, { eight	6 ft.
Type of engines	Brotherhood

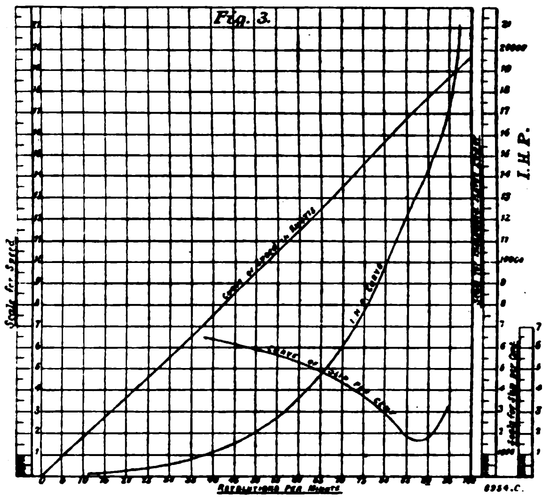
Engines.

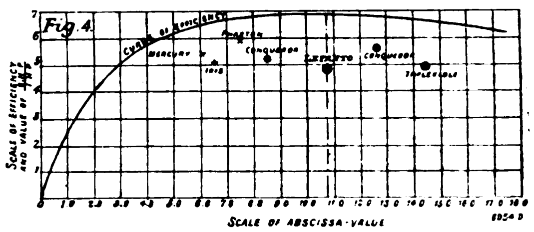
Description of engines	{ Three equal vertical cylinders, Penn's type.
Main engines:	
Number of engines	4
,, cylinders in one engine ..	3
Diameter of cylinders	54 in.
Stroke	39 ,,
Number of cranks in one engine.. ..	3
Angle of cranks	120 deg.
Collective indicated horse-power ..	18,000
Revolutions	96
Condensers:	
Number of condensers	8
Collective cooling surface	31,300 sq. ft.
Propellers:	
Number of propellers	2
Description	Admiralty
Diameter	20 ft. 6 in.
Number of blades	3
Pitch	20 ft. 6 in.
Pitch ratio	1
Surface of blades in one propeller ..	80 sq. ft.

Fig. 1.









PARTICULARS OF TRIALS.

The trials were to be made in accordance with the following programme, proposed by Messrs. John Penn and Sons, and accepted by the Ministry of Marine:

1. A trial with only two oval boilers lighted, and the after engines only at work on the compound system, to ascertain the most economical steaming of the ship.
2. A trial with the eight oval boilers lighted, the four engines working compound.
3. Ditto, with the four engines working direct expansion.
4. A forced draught trial with only the after set of engines and boilers at work, the engines working direct.
5. A forced draught trial with all eight oval boilers and eight locomotive boilers lighted, the four engines working direct.
6. A full-power forced draught trial or trials, with all the engines and boilers at work, the engines working direct.

This programme was not completely carried out, on account of the ship having been put in commission, which prevented the final 18,000 I.H.P. trial being made. It went, however, far enough to show what can be expected from the engines when working at their fullest power.

The trials were made along the eastern coast of the Gulf of Genoa, from Spezia to Genoa and back, the two runs being altogether of over 80 nautical miles. A portion of the forward run from Spezia to Genoa was taken in each trial, to bring up the engines to the desired speed. The speed of the ship was ascertained by means of bearings on well-known points on shore in both runs. The bottom of the ship was fairly clean, the ship having been docked on March 1, viz., about one month before the trials. The ship was fully laden in all the trials, with very slight differences of draught. The indicated horse-power developed was ascertained from the indicator cards of the main engines, without taking any account of the steam used for auxiliary purposes. The trials were carried out under the direction of Mr. J. W. Fairley and Mr. May, who represented the firm, and of Mr. Holland, the engineer in charge.

All the results obtained and the conditions of trials are figured on the Table on the next page, and to them the following remarks will serve as an illustration.

One of these remarks is of great importance, as it refers to the behaviour of the locomotive boilers, which was perfect. After the rather discouraging experience with locomotive boilers working in sets on board some ships, as the Flavio Gioja of the Royal Italian Navy, and the

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PARTICULARS OF TRIALS.

	Trials. 1 April 4.	2 April 7.	3 April 11.	4 April 14	5 April 28.	6 April 28.	7 May 5.	8 May 12.
Sea	Calm	Calm	Rather rough	Calm	Heavy cross	Calm	Rather rough	Calm
Wind	Light N.O.	Light N.O.	Fresh N.O.	Light N.O.	Light S.W.	Light N.	Fresh N.	Light N.
Mean draught .. ft.	30 ft. 4 in.	30 ft. 4 in.	30 ft. 3 in.	30 ft. 3 in.	30 ft. 1½ in.	30 ft. ½ in.	30 ft. 3 in.	30 ft. 4 in.
Area of midship section .. sq. ft.	1,999	1,999	1,993	1,993	1,984	1,978	1,993	1,999
Displacement .. tons	14,860	14,860	14,810	14,810	14,740	14,690	14,810	14,860
Wetted surface .. sq. ft.	36,500	36,500	36,430	36,430	36,325	36,255	36,430	36,500
Mean speed of ship .. knots	7.25	13.7	13.3	14.4	15.89	16.78	18.18	18.38
Indicated horse-power	1,004	6,230	5,714	7,385	10,330	12,010	15,260	16,150
Number of boilers used	2 oval	8 oval	8 oval	4 oval 8 locom.	8 oval 8 locom.	8 oval 8 locom.	8 oval 16 locom.	8 oval 16 locom.
„ engines „	2	4	4	2	4	4	4	4
Mode of action of engines	Compound	Compound	Direct	Direct	Direct	Direct	Direct	Direct
Area of firegrate used .. sq. ft.	94.1	478.4	478.4	Oval 239.2 Locom. 337.6.	Oval 478.4 Locom. 337.6	Oval 478.4 Locom. 337.6	Oval 478.4 Locom. 675.2	Oval 478.4 Locom. 675.2
Heating surface used: Tubes	3,488	13,952	13,952	18,896	25,872	25,872	37,792	37,792
Heating surface used: Total	3,840	15,360	15,360	21,040	28,720	28,720	42,080	42,080
Mean steam pressure in pounds per sq. in.: Oval boilers	50	54	37	52	48	51	53.5	54.2
Mean steam pressure in pounds per sq. in.: Locomotive boilers	..	..	..	58	52	56	58 5	60.
Mean steam pressure in pounds per sq. in.: Engine-room	48	51	34	47	44	47	49	49
Mean air pressure in inches of water: Oval boiler stokeholes	Natural	0.65 in.	0.94 in.	1 in.	1 in.	1.5 in.	1 in.	1.6 in.
Mean air pressure in inches of water: Locomotive boiler stokeholes	..	..	..	1.9 „	1.2 in.	2.5 „	2 „	1.9 „
Cut-off: In H.P. cylinders	0.1	0.5	0.1	0.45	0.175	0.175	0.3	0.3
Cut-off: „ L.P. „	0.6	0.6						
Ratio of expansion	11.1	3.5	5 56	1.89	3.93	3 93	2.63	2.63
Mean pressure in pounds per sq. in.: H.P. cylinders	15.3	23	15.4	36.62	23.5	26.1	30.65	31.9
Mean pressure in pounds per sq. in.: L.P. „	6.8	13						
„ vacuum in condensers .. in.	28.6	28.7	23.6	27.	27.5	27.5	27	27
Revolutions per minute	38.8	70.58	68.73	74.25	80.95	85	92.05	93.5
Apparent mean slip per cent.	6.4	4.25	4.6	3.8	2.7	1.8	2.34	2.72
Mean speed of piston per minute .. ft.	252.2	458.25	446.25	484.27	526.5	552.5	598	607.75
I.H.P. per sq. ft. of grate	10.7	13	11.9	12.8	12.6	14.6	13.1	14
Heating surface per I.H.P. in sq. ft.: Tubes	3.48	2.24	2.45	2.55	2.5	2.17	2.46	2.34
Heating surface per I.H.P. in sq. ft.: Total	3.82	2.47	2.69	2.84	2.78	2.41	2.74	2.61
Coal used per hour, in tons	0.9	6.4	6.9	11.4	13.7	16.8	21.8	23.5
„ I.H.P. per hour, in pounds	2.02	2.27	2.75	3.45	2.97	3.14	3.2	3.3
Coal burnt per sq. ft. of grate per hour: Oval boiler .. lb.	21.3	29.9	32.3	34	35	38	33	38
Coal burnt per sq. ft. of grate per hour: Locomotive boiler „	..	..	..	51	41	58	49	51
Steam used per I.H.P. per hour as shown by indicator cards	16.1	15	18.2	22.2	18.4	18.2	21.1	20.7

Polyphemus of the Royal English Navy, some fear was entertained that similar troubles might be experienced with the Lepanto, in which the difficulty appeared to be still greater, considering the larger number of boilers to be worked together in so many different separate compartments. But nothing of the kind happened, nay, everything went to prove the contrary. From the very beginning of the preliminary trials which took place towards the end of last year, the locomotive boilers gave evidence of their good working, which went on increasing trial after trial, so as to be now an established fact. They never primed or gave any trouble whatever. The feeding was occasionally uncertain, but the fault was due to air that collected in the main feed pipe. This imperfection was removed, and on the last two trials the feeding was quite satisfactory. After each one of the last three forced draught trials the locomotive boilers had tubes leaking, but in small number, and not more, comparatively, than the oval boilers, which, even in this respect, did not behave better. Moreover, there were discrepancies between the different compartments of boilers, locomotive as well as oval, which shows that the management of the fires has a good deal to do in this matter.

The ventilation of the locomotive stokehold is excellent. The fans being fitted on top of the boilers, no current of air strikes the floor, and a thorough cool ventilation and forced draught are obtained without any inconvenience whatever from coal-dust. The same may be said of the oval boiler stokeholds, where the fans are fitted on the wings behind the boilers, but although the supply of air is ample, the temperature does not during forced draught fall so low, probably on account of the boilers facing each other. The mean temperature of the oval boiler stokeholds was about 106 deg. against 88 deg. in the locomotive boiler stokeholds, while the atmospheric temperature oscillated about 58 deg.

The engines worked very satisfactorily all through the trials, without the slightest hitch occurring in any part of the whole machinery. This circumstance helped, no doubt to some extent, the good performance of the boilers, which had never to be checked or hampered when in full swing.

The power of 16,150 I.H.P. on the last trial was developed by the engines with a mean air pressure of 1.9 in. of water in the locomotive boiler stokehold, and of 1.6 in. in the oval boiler stokehold, the coal burnt per square foot of grate per hour being 51 lb. in the former and 38 lb. in the latter. But as at the preliminary partial trials mentioned above, the oval boilers were worked up to 2½ in. of pressure and the locomotive boilers up to 3½ in. with perfect success, burning 45 lb. and 68 lb. of coal respectively per square foot of grate per hour, there is evidently room left for more power. The gain in speed which would follow such increase of power is, however, not very great, as is clearly apparent from the results of the last two trials, and still more from the I.H.P. curve, shown on Fig. 2, of which something will be said hereafter.

A very good performance was that obtained on the sixth trial (April 28), when, with only two-thirds of the boilers at work, the engines developed over 12,000 I.H.P. (two-thirds of the total power), driving the ship at nearly 17 knots. The cut-off being at 0.175 of the stroke, the steam worked with a ratio of expansion 4.35, which, from the consumption of water shown by the indicator cards, appears to give the most efficient performance of the engines at great power.

A circumstance deserving notice is that all these trials were carried out with the ship's stokers, who for the greater part were not yet trained for forced draught stoking.

Regarding the efficiency of the engines, although the consumption of coal was the lowest on the first trial, when the two after engines were acting compound at very low power with a great ratio of expansion (about 11), this condition of working does not appear to be the most efficient, as the consumption of water shown by the indicator cards was greater on this trial than on the next when the ratio of expansion was reduced to 3.5 only. The same thing happens, although in a less marked degree, when the engines act on direct expansion, as there is no material difference in the consumption of steam over four expansions. Below this ratio the consumption increases, as may be seen from the results of the last two trials.

To have more complete data of the ship and engines' performance, besides the trials above mentioned, runs were made on the measured mile to ascertain the speed of the ship corresponding to the lowest possible speed and power of the engines; also the power and speed of the engines for a speed of about 10 knots of the ship. The results are as follows:

	Knots.	Knots.
Speed of ship	2.7	10
Revolutions	15	55
Indicated horse-power	158.6	2403

Now I beg to call attention to Fig. 2, in which the results relating to the ship's performance are graphically recorded, in connection with the E.H.P. curve, as was determined by experiments on the model of the Italia made for the Royal Italian Government by Mr. R. E. Froude at Torquay, by the kind permission of the Admiralty. The E.H.P. curve *a a* corresponds to a displacement of 14,784 tons, which is approximately the mean displacement of the Lepanto at the various trials. The Lepanto being a finer ship than the Italia for the same displacement, the ordinates of curve *a a* should be lowered a little, but, considering that the bottom of the Lepanto was not perfectly clean, curve *a a* may be accepted as sufficiently correct; *b b* is the I.H.P. curve; *d d* is the "indicated thrust curve," as it results from the I.H.P. curve. The dotted line at the bottom of curve *d d* is to show the increase of thrust due to the friction of the forward set of engines if they were acting at low powers with the after set.

According to this curve the initial friction of the engine would be about 7.5 per cent. of the load at full power; *f f* is the "curve of the net resistance of the ship" as it results from the E.H.P. curve.

It will be noticed that the undulation characteristic of the E.H.P. curve *a a* and of the net resistance curve *f f* at about 16.5 knots, is faithfully reproduced on the I.H.P. curve *b b*, and on the indicated thrust curve *d d*, giving strong evidence of the correctness and importance of the method of investigation devised by the late Mr. Froude.

Curve *c c* gives the ratio $\frac{\text{E.H.P.}}{\text{I.H.P.}} = p$, viz., the propulsive coefficient or the "net total efficiency of propulsion," which slightly increases at the higher speeds when it approaches to the standard value 0.50. Curves *m m* and *n n* give the "coefficient of performance" for displacement and midship section. Curve *g g* gives the ratio between the net resistance of the ship and the indicated thrust. Curve *h h* gives a similar ratio when the initial friction of the engines is taken off from the indicated thrust. All these coefficient curves *c c*, *m m*, *n n*, *g g*, *h h*, show more or less an undulation at about the same speed at which there is a marked change on the curve of E.H.P. Curve *r r* in Fig. 3 gives the I.H.P. in function of revolutions.

By following the method of investigation devised by Mr. R. E. Froude, and illustrated in his paper "On the Determination of Dimensions for Screw Propellers," read at the Institution of Naval Architects, 1886, I have approximately determined for the maximum speed of 18.38 knots the efficiency of the Lepanto's screw propellers, which would have an abscissa value, 10.75, very close to maximum efficiency. This abscissa value and the corresponding net total efficiency of propulsion are plotted on Fig. 4, which is the reproduction of Mr. Froude's standard curve for the efficiency of screw propellers, as illustrated in his paper above mentioned. With this abscissa value the true slip of the Lepanto's screw propellers at the speed of 18.38 knots would be about 20 per cent., while the apparent slip is only 2½ per cent., leaving 17.28 per cent. for the speed of the wake that follows the ship.

Iron Ore in Wisconsin.—A large deposit has been opened up near Wausau, in the central part of Wisconsin. The ore is reported to contain 67 per cent. of metallic ore, and to be low in sulphur and phosphorus.

Another Great American Observatory.—Denver is about to have an astronomical observatory. The dome of the Denver Observatory will rise from a plain and will have a great elevation. The building and instruments have been provided through the liberality of Mr. W. B. Chamberlain, of Denver. The covering of the dome is of galvanised iron. The weight of the dome will be about 12 tons; the devices for making it revolve easily are ingenious, it being sought to substitute rolling for sliding friction. The telescope, which is now being completed, will be a valuable instrument. The diameter of the object glass will be 20 in., and the length of the tube about 26 ft., of the best hard rolled steel.

Queensland Rivers and Harbours.—Mr. Nisbet, chief engineer of the Queensland harbours and rivers department, is making his annual visit of inspection to the northern ports of the colony. Sir J. Coode's report on the means advisable for the improvement of Normanton harbour is now to hand. It points out the necessity of a considerable amount of dredging on the bar. The Hydra, which is the latest dredge built in Brisbane, will leave in a short time to undertake this work. Tenders of Messrs. Brand and Dyborough, of Townsville, for the stonework, and of Mr. Porter, of Brisbane, for the pilework in connection with Thursday Island jetty, have been accepted. In the Burnet, a dredge is busily at work on the upper flats clearing out the cuttings which were originally deepened to 9 ft. at low water, but have since silted up slightly. The dredge Maryborough has completed a cutting in the Sandy Island Straits at a place which is known as Snout's Point, and will continue the dredging between Wide Bay and the mouth of the Mary. The dredge Hydra has lately been at work deepening the Bulimba Reach to 20 ft. at low water, and the Groper has been employed in the Brisbane Reach dredging in front of the wharves, where the bottom has silted up a little. The dredge Bremer is at the Nerang Creek, endeavouring to form a better channel for the trading boats which run up to Nerang.

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