MACHINERY OF BRITISH FIRST-CLASS CRUISERS "EDGAR" AND "HAWKE."

CONSTRUCTED BY THE FAIRFIELD SHIPBUILDING AND ENGINEERING COMPANY, LIMITED, GOVAN, GLASGOW.

(*For Description, see opposite Page.*)

Fig. 19.

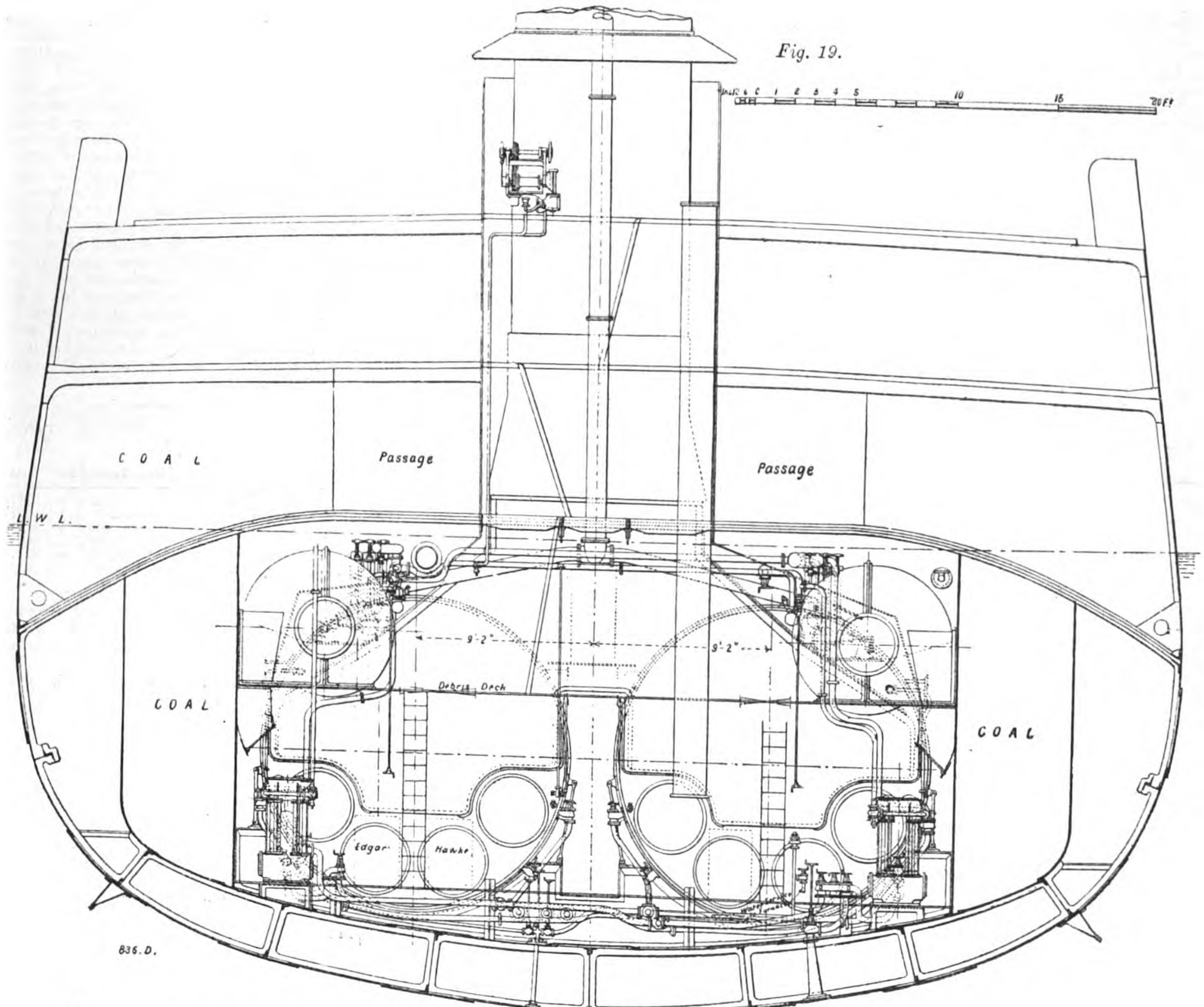
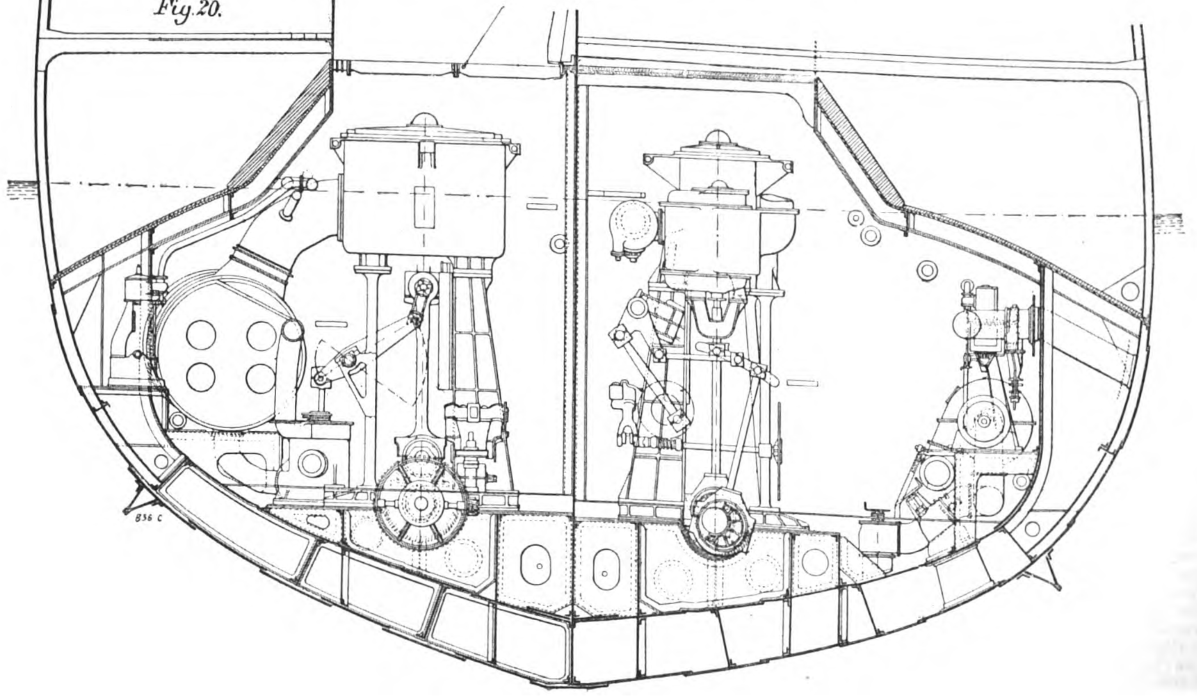


Fig. 20.



THE BRITISH FIRST-CLASS CRUISERS "EDGAR" AND "HAWKE."

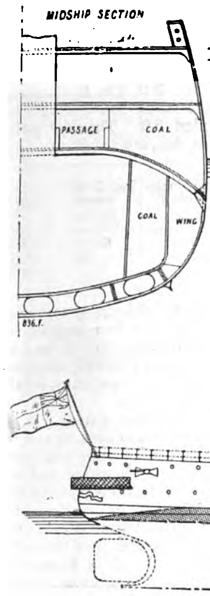


FIG. 23.

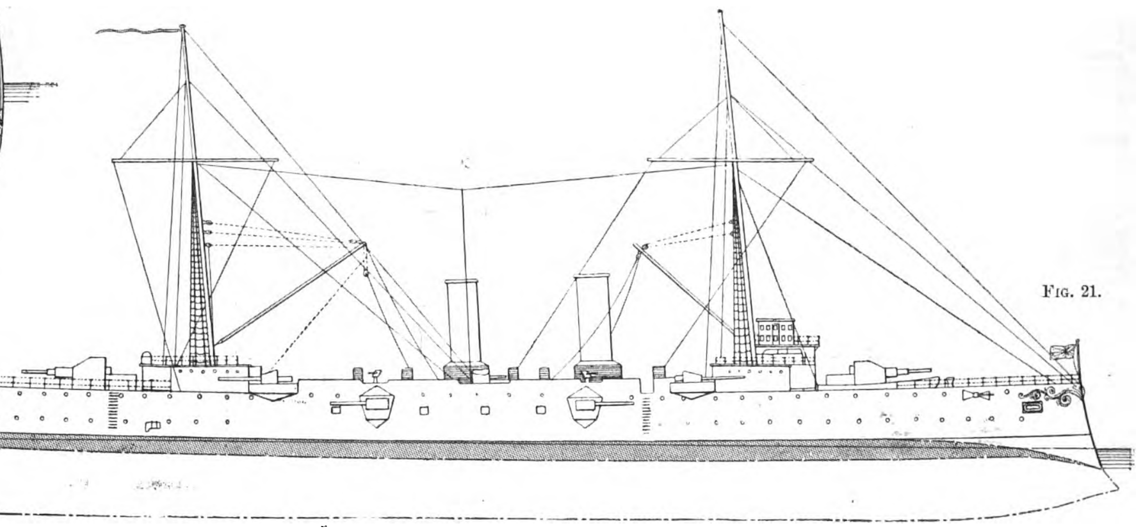
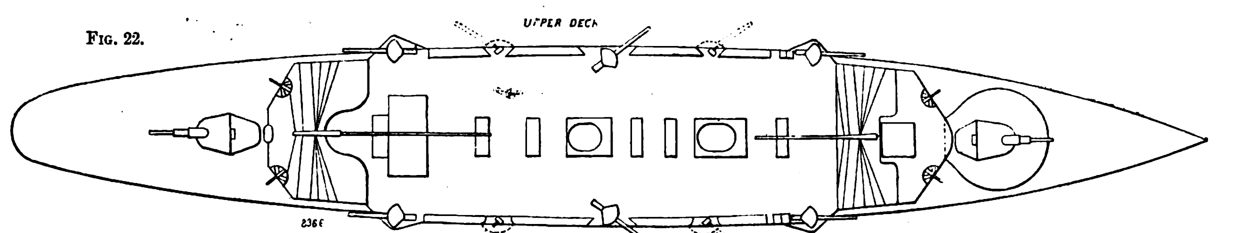


FIG. 21.

FIG. 22.



—	1891.		1890.		1889.
	No.	Tons.	No.	Tons.	Tons.
Sir Raylton Dixon and Co.	28	38,597	20	43,665	40,689
Ropner and Son	13	37,977	12	32,662	29,441
Richardson, Duck, and Co...	15	27,264	14	24,861	21,585
Craig, Taylor, and Co. ..	4	9,364	8	15,398	10,451
R. Craggs and Sons	9	4,030	5	5,553	5,561
W. Harkess and Son	2	2,900	9	5,600	2,700

The engine production was 73,480 indicated horse-power, against 60,000 indicated horse-power, a satisfactory increase.

WEST HARTLEPOOL.

As in other parts there is a falling off in this port; but it is probably larger than it would have been had not a fire greatly hindered production in one of the three yards, Messrs. Irvine's. The total output is 41 vessels of 96,993 tons, all steel screw steamers of about 2000 tons, only one being 760 tons. The largest was of 4069, by Messrs. Gray, and the average was 2360 tons, the highest average probably of any port. The following gives the number of vessels built and the aggregate average gross tonnage since 1882:

Year.	No.	Tons.	Average.	Year.	No.	Tons.	Average.
1882	39	67,367	1787	1887	22	55,451	2429
1883	32	67,062	1719	1888	33	73,849	2237
1884	21	30,963	1475	1889	40	84,109	2103
1885	18	33,626	1838	1890	43	29,846	2322
1886	9	15,293	1699	1891	41	96,993	2365

Of the vessels launched 11,445 tons, or 11.8 per cent., were for foreign clients, while local owned craft were rather fewer. Messrs. Gray launched 26 vessels of 59,033 tons, nine of the larger vessels being for London, and ten for north-east coast firms. In 1890 the total was 27 vessels of 64,253 tons, so that there is a decrease of 5220 tons on this, the largest total reached by the firm. With this exception the year's work beats all previous years. These vessels were all engined at the Central Marine Engine Works at West Hartlepool, and also two other vessels. All the 28 sets of engines were of the triple-expansion type with one exception. The total indicated horse-power is 32,550. In the previous year 30 sets of 37,100 indicated horse-power were constructed; but owing to a strike the production in the past year was affected. These works have now been in full operation six years, and up to the end of 1891, 122 sets of machinery have been turned out aggregating 142,000 indicated horse-power. Messrs. Furness, Withy, and Co. completed ten steamers of 25,592 tons, the nominal horse-power of the engines being 2305, a decrease only of one vessel and 432 tons on 1890, when the total was the greatest on record. Messrs. Irvine's total is five vessels of 12,368 tons against the same number of vessels, aggregating 9570 tons, so that the total is by a long way the largest in history of the firm.

BLYTH AND WHITBY.

The two shipbuilding establishments in Blyth launched during the year five steamers of 6903 tons and 3894 indicated horse-power, and a hopper barge of 102 tons; total, 7005 tons, against 7377 tons in 1890, and over 10,000 tons in 1889. The Blyth Shipbuilding Company launched four steamers of 6871 tons, and a hopper barge of 102 tons; and the Union Co-operative Company one steamer of 32 tons and 10 horse-power. In addition, steamers and ships aggregating 100,000 tons received extensive overhauls from the Blyth Company. The new graving dock being constructed will be opened during the current year. At Whitby Messrs. Turnbull and Son launched two steel screw steamers for local owners, the aggregate being 4781 tons, while in the preceding year they completed four steamers of 8682 tons, three of which were for Whitby owners. The production is very much below the average of the past few years.

(*To be continued.*)

THE FIRST-CLASS CRUISERS "EDGAR" AND "HAWKE."

(*Concluded from page 12.*)

WE conclude to-day our illustrations of the engines of this cruiser and of her sister ship, the Hawke, from photographs and drawings kindly supplied to us by the constructors, and we give also illustrations of the vessel. In our previous article we gave engravings of the engines and boilers, and a general description. We now propose to deal with some details, and with the type of ship. (See two-page plate and pp. 74 and 75.)

The Edgar is the first completed of nine cruisers ordered under the Naval Defence Act of 1889. Five were ordered from private yards and four from the dockyards. The vessels differ from many other high-speed cruisers in the Navy in that they have no armoured belt, as in the Australia class. For protection the vessels depend on a protective deck just below the water line, on a judicious arrangement of coal bunkers, and on minute subdivision. As will be seen from the profile of the Edgar (Fig. 21), for which we are indebted to "Brassey's Annual," this deck extends from stem to stern, sloping downwards at the bow and slightly at the stern. It is arched on section (Fig. 23). The maximum thickness is 5 in., and the minimum 2 in. The deck is associated with cellular subdivision and coal-bunker protection. These separate both engines and boilers from the outer skin of the ship, and, as will be seen from the cross-sections through the boiler spaces (Fig. 19), the boilers are completely under the protective deck, the communication being by hatches with cofferdams. The engines, however, rise above the level of the protective deck, and the method of protecting them is indicated on the other cross-section (Fig. 20). The curve of the deck is broken by a sloped coaming, on which is a glacis armour plating, 6 in. thick (compound), protecting the cylinders. Over the top, again, is the armoured deck with cofferdams. The conning tower is of 12-in. compound armour, with armoured communication tubes 7 in. thick. Between the protective and main decks ready-use magazines of 3-in. steel are fitted for supplying the casement guns and 6-in. guns on the upper deck. The double bottom in the machinery space is divided into twenty-seven water-tight compartments, but the double bottom is virtually extended nearly throughout the length of the ship by means of the flats to magazines, &c.

The Edgar, which was built at Devonport, it may be stated, is an enlarged Mersey or a smaller Blake, but she has been proved more efficient as regards the important matter of speed even than the latter. She is for isolated service, has fair coal capacity, large crew accommodation, great powers of offence and defence against all comers. She was made rather longer than some other cruisers to insure greater speed. On the next page we tabulate the dimensions, and with them give for comparison the details of some other vessels.

It is well to state that the New York and Commerce Destroyer of the United States have not been tried, and the speeds stated are those estimated or contracted for. The Australia's speed is that contracted for; it was exceeded on trial. Some further points of comparison may be found in Mr. Biles' paper read before the Institute of Naval Architects,* while the full

* See ENGINEERING, vol. li., pages 365, 382, 413.

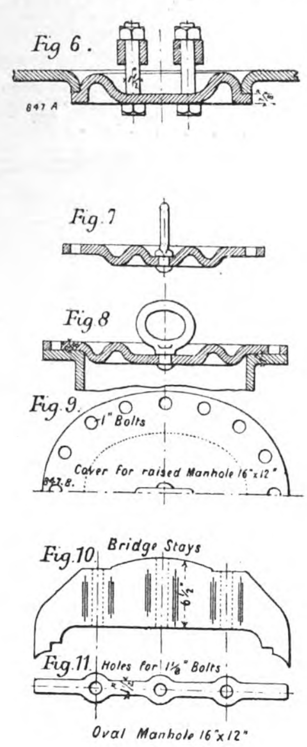
DIMENSIONS, &c., OF SEVERAL FAST CRUISERS.

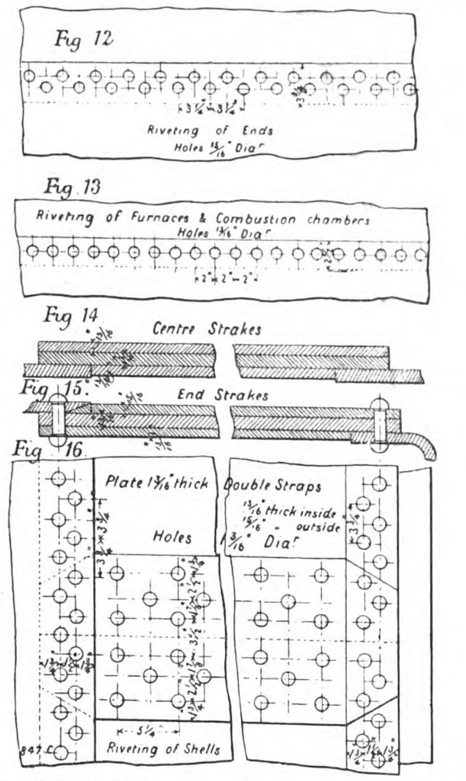
—	H.M.S. "Edgar."	H.M.S. "Blake."	H.M.S. "Australia."	U.S. "New York."	"Commerce Destroyer" (U.S.)	French "Cécille."
Length	360 ft.	375 ft.	300 ft.	380 ft.	412 ft.	378 ft.
Breadth	60 ,,	65 ,,	56 ,,	64 ft. 10 in.	58 ,,	49 ft. 3 in.
Draught (mean)	23 ft. 9 in.	25 ft. 9 in.	22 ft. 6 in.	23 ,, 3½ ,,	24 ,,	19 ,, 9 ,,
Displacement	7350	9000	5600	8150	7475	5766
Indicated horse-power (mean)	12,463	14,535	8500	16,500	21,000	9600
Speed (knots)	20.97	19.3	18.5	20	22	19
Coal on designed draught (tons)	850	1500	900	—	750	—
Endurance at 10 knots ..	10,000	15,000	8000	—	9800	—
Protective deck slopes ..	5 in. and 2 in.	6 in. and 4½ in.	Belt	6 in. and 3 in.	4 in.	—
Flats	2½ in.	3 in.	..	3 in.	2½ ,,	—
Armament ..	2 9.2 in. B.L.; 10 6-in. R.F.; 16 6-pdrs; 3 3-pdrs.; 8 machine	2 9.2 in. B.L.; 10 6-in. R.F.; 16 3-pdr.	2 9.2 in. B.L.; 10 6-in.; 16 R.F.; 7 machine	6 8-in. B.L.; 12 4-in. R.F.; 8 6-pdrs; 4 1-pdrs.; 4 Gatlings	4 6 in. B.L.; 12 4-in. R.F.; 16 6-pdrs.; 8 1-pdrs.; 4 Gatlings	6 6.3-in. 5-ton B.L.R.; 10 5.49 in. 3-ton B.L.R.; 3 Q.F. 10 machine.

results of the Blake's trial may be found in a previous issue.* It is scarcely necessary to state that the Edgar is built of steel, with a formidable ram. The double bottom which runs throughout the ship is constructed on the usual cellular bracket system, and is sub-divided by longitudinal and transverse framing as shown in cross-sections (Figs. 19 and 20), for protection against under-water attack. The strengthening of the framing of the ship is shown also on the sections.

The two 9.2-in. breechloading guns, the principal guns in the armament, will give the cruiser great offensive power, as with a fair chance she will be able to engage a heavily weighted armoured ship to some advantage. These 22-ton guns, which can penetrate 10 in. of armour at 500 yards, are on centre pivot mountings, fitted on the upper deck, one forward and one aft (Fig. 22). There will be ten 6-in. quick-firing guns on centre pivot mountings—six fitted on upper deck and protected by 3-in. shields, and four fitted in casements on main deck and protected by 6-in. compound armour in the front and 2-in. steel plating at rear. The gunner really stands with armour surrounding him, and ammunition is served by means of tubes through the deck. Twelve 6-pounder quick-firing guns will be distributed as follow: Two on forward deck shelter, two on after deck shelter, four on upper deck, two on main deck forward, two on main deck aft. In addition there will be four 3-pounder quick-firing guns, seven five-barrel Nordenfelts; two torpedo tubes above and two below water broadside, and eighteen 8-in. Whitehead torpedoes. The ship is lighted by electricity and has four search lights. She is ventilated by artificial as well as by natural means, and fresh water is provided by one of Weir's evaporators (25-tube) capable of producing 170 gallons per hour. There are steam hoists for working the boats. These hoists were constructed by Messrs. Muir and Caldwell.

* See ENGINEERING, vol. lii., page 603.





The machiney we have already described at some length. It is exactly the same in both cruisers, but the Hawke has not yet made her trials. One distinct feature is its compactness. The platforms being in the wings of the ship, as shown on section (Fig. 20), lend themselves to the protection of the cylinders by the coaming. The general arrangements illustrated on the two-page plate show that the steam pipes are so arranged that the steam from either set of boilers can be used independently of the other, and for either engine. As to the machinery, it may be stated generally that weight was minimised, consistent only with efficiency and safety. The engines and boilers are well designed; that was to be expected, coming as they do from the works at Fairfield under the management of Mr. Andrew Laing, and they indicate the best practice of to-day in high-power machinery. In our previous article we gave general views of the boilers; this week we give details which will be of interest (Figs. 6 to 15). These show the riveting at the junction of the longitudinal butt strakes and the circumferential joints. Figs. 10 and 11 show the bridge stays of the combustion chamber, which are of forged steel. The manhole covers (Figs. 6 to 9) have double corrugations. The boilers, as we have already stated, are the largest yet made for the Navy, being 16 ft. in diameter by 18 ft. long. The furnaces are 3 ft. 6 in. in diameter, the grate bar in the double-ended boiler being 7 ft. long, and in the single-ended 6 ft. The chief particulars of the heating surface, &c., are as follows:

—	One Single-Ended Boiler.	Four Double-Ended Boilers.	Total.
Heating surface (sq. ft.) ..	1727	23,684	25,411
Grate area	56 25	812	868.25
Ratio of heating to grate ..	..	..	29.26

The forced draught is on the Admiralty system of closed stokehold, the fans having been supplied by Messrs. W. H. Allen and Co., London. It may be stated also that Messrs. Muir and Caldwell, Glasgow, supplied the feed, bilge, and fire pumps, which are all independent of the propelling engines.

We have already given the results of trials. In an article on another page of the present issue we analyse these; but here it may not be uninteresting to give the results according to weights. In the paper read recently before the Institution of Naval Architects, Mr. Durston, in his "Table of Weights, &c., for Engines of War Ships from 1838-91," gives the weights for the designed power. We do not know that these are absolutely correct, but they may be given as approximately right. The vessel, however, far exceeded contract power, the mean on the four-hours forced draught run being 13,101 indicated horse-power, and on the natural draught run being 10,179 indicated horse-power, so that we give the results for the actual results, as well as for the contract power.

—	Forced Draught.		Natural Draught.	
	Contract.	Actual Mean Result.*	Contract.	Actual Mean Result.
Power	12,000	13,101	10,000	10,170
Air pressure .. .. in.	1	.712	.5	.3
Piston speed	850	888	..	841
Indicated horse-power per ton of engine	26.67	29.12	22.22	22.61
Indicated horse-power per ton of boilers	27.52	30.05	22.94	23.35
Indicated horse-power per ton of water boilers	69.77	76.18	58.14	59.18
Indicated horse-power per ton of machinery	10.4	11.35	8.66	8.81
Indicated horse-power per square feet of grate	14.04	15.33	11.7	11.91
Capacity of boilers per indicated horse-power cub. ft.	1.33	1 217	1.06	1 041
Heating surface per indicated horse-power .. cub. ft.	2.07	1.895	2.48	2.437

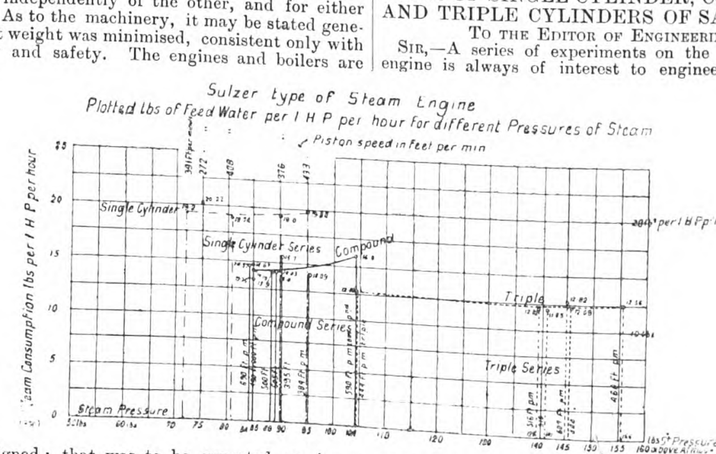
* Mean on measured mile.

The results are certainly good, and it is to be noted that the boilers were subjected to over 1 in. air pressure for a short time and gave no trouble, nor did they on subsequent examination disclose any weakness.

TESTS OF SINGLE CYLINDER, COMPOUND, AND TRIPLE CYLINDERS OF SAME TYPE.

To THE EDITOR OF ENGINEERING.

SIR,—A series of experiments on the same type of engine is always of interest to engineers, and more particularly if the tests have been carefully carried out. I have taken some trouble lately to collect from reliable sources the inclosed series of twenty-three experiments, all on the same type of condensing engine; the only



SUMMARY OF TWENTY-THREE EXPERIMENTS ON THE "SULZER" TYPE OF STEAM ENGINE.

Single Cylinder, Compound, and Triple-Expansion, Steam Jacketed, Condensing.

Experiment. Number.	Date.	Duration in Hours.	Particulars of Engine.	Cylinders. Diameters. High-Pressure.	Intermediate Pressure.	Low-Pressure.	Strokes for all Cylinders.	Steam Pressure.	Speed. Revolutions per Minute.	Piston Speed.	Indicated Horse-Power.	Steam Consumption, including Jacket Water. Pounds per Indicated Horse-Power per Hour. Including Condensation in Steam Pipes.	Excluding Condensation in Steam Pipes.	Jacket Water in Per Cent. of Feed.	Remarks and Authorit
				in.	in.	in.	ft. in.	lb. per sq. in.	revs.	ft. per min.	I.H.P.	lb.	lb.		
								Single Cylinder Series.							
1s	..	11.1 hours	At Société trois Fontaines, by M. Vinçotte	22.6	..	..	3 5.3	95	62.9	433	157.5	19.84	19.25	6.75	From *L'Ingénieur-Conseil*, 1884, Nos 20 and 21
2s	1879	12 days of 9 hours each	At Aselmeyer, Pfister, and Co., near Naples, on high-pressure cylinder of compound engine	21.7	..	..	4 11	..	54.1	532	183.2 both engines	17.24	..	..	Same engine non-condensing, used 21.4 lb. steam per indicated horse-power per hour, including pipe water. From Sulzer.
3s	1872	4 days	Two engines at Augsburg (spinning mill), by Professor Linde	17.7	..	..	3 5.4	75	39.5	272	395	20.22	19.66	7.0	From "Trial of 400 Horse-Power Sulzer Engines," by Professor Linde. See ENGINEERING, January 10, 1873.
4s	1878	6 days of 11 hours each	At Ochtrup, Westphalia, by L. Grabau	26.6	..	..	4 5.1	81	45.1	408	196	18.74	17 94	8.6	From printed report issued by Ludwig Grabau.
5s	1875	2 days of 10.7 and 11.7 hrs.	Two engines at Augsburg, by Professor Linde	26.7	..	..	4 11	90	38.2	376	291.5	19.0	..	..	Mean of two experiments } From printed report issued by Professor Linde. See ENGINEERING, Feb. 21, 1879.
6s	1875	2 days of 10.4 and 11.5 hrs.						72	39.7	391	403 2	19.2	..	..	Ditto
								Compound Series.							
1c	1886	3 days of 4 hours each	At Messrs. Pietro and Sons, Coggiola, Italy	17.7	27.6	..	2 11.4	95	65	384	176.2	14.00	..	..	Mean of three experiments. From W. Zuppinger's report.
2c	1882	10 hours	At M. Vandersmissen Brothers, Alost, by M. Vinçotte	19.7	29.5	..	2 11.5	90	66.5	395	133	15.7	15.4	10.5	From *L'Ingénieur-Conseil*, 1884. Nos. 20 and 21
3c	1887	8.7 ,,	In Belgium, by M. Vinçotte	22.7	35.4	..	4 11	85	50.1	493	247	13.35	..	10.6	From Carels Frères.
4c	1888	2 days of 5 hours each	At Milan for Messrs. Borghi Brothers, by Professor Soldini (cylinders side by side)	20.1	31 9	..	4 7.1	84 85	75 74.9	689 688	259.4 268.5	14.57 14.67	14.16 14.24	9.0 9.7	From copy of certificate received from Messrs. Borghi Brothers.
5c	1887	5 hours	At Milan, by Professor Soldini (cylinders side by side)	18.7	28.5	..	4 5.1	104	60	590	268 6	16.0	15.5	6.3	From *L'Industria Rivista Tecnica* of February 12, 1888, page 102
6c	1883	10 days of 9½ hrs. each	Two engines at Aselmeyer, Pfister and Co., near Naples (cylinders tandem) No. 1	21.7	39.5	..	4 11	..	55.8	549	335.5	14.3	..	..	From Messrs. Sulzer Frères.
7c			No. 2	24.6	39.4	..	4 11	..	55.4	545	363.8	13.9	..	..	
8c	1891	8 hours	At Van Hoegaerden, Court St. Etienne, experiment by M. Vinçotte	26.6	39.4	..	4 11	88	50.7	500	509	13.0	13.55	10.7	From Messrs. Carels Frères.
9c	..	16.7 hours	At Roubaix, by Messrs. Dejace and Dubrieul	23.6	35.4	..	4 11	85	59.6	587	351	14.15	..	..	,, ,, ,,
10c	1890	7½ hours	At Société des Moulins à Merxem. Experiment by M. Vinçotte	26.6	39.8	..	4 11	89	61.5	605	431	14.0	13.86	9.9	,, ,, ,,
11c	1891	9 hours	At Compagnie de Floreffe. Experiment by M. Vinçotte	31.5	49.4	..	5 10.9	89	51.7	610	524	14.03	13.4	10.5	
								Triple Series.							
1t	1889	5 hours	At Augsburg, by Professor Schröter. See ENGINEERING, December 5, 1890.	11.1	17.7	27.6	3 3 4	156	70.2	460	198	12.56	12.2	20	Mean of three experiments at ¼ cut-off in high-pressure cylinder = 12.57 lb. steam deducting pipe water. Mean of two experiments at 0.3 cut-off in high-pressure cylinder = 12 83 lb. steam deducting pipe water. } See *Zeitschrift Deutscher Ingenieure*, vol. xxxiv., page 7, 1889. From "Trials of Triple Expansion Engine," by Professor Schröter.
2t	1888	2 days of 9 & 5 hrs. each	At Gross-kikinda, Dampfmühl, Actien-Gesellshaft, Hungary	18.7	29.5	43.3	3 5.3	146	61.5	444	379	12.09	11.95	..	Mean of two experiments with 22 per cent. cut-off in high-pressure cylinder. } From Messrs. Sulzer.
3t	1888	2 days of 5 & 4½ hrs. each						104	64.5	444	327	12 86	12.73	..	Mean of two experiments with 25 and 22½ per cent. cut-off in high-pressure cylinder.
4t	1889	1.6 hours	At Heinrich-Haggenmacher, Budapest	21.7	33.5	40.2	3 11.2	139	65.5	516	585	12.02	11.87	..	Preliminary experiment } From Messrs. Sulzer.
5t	1889	4.5 ,,						141	65.5	516	615	11 85	11 7	..	.. ..
6t	..	10.9 hours	At Augsburg, by Professor Schröter	19.7	29.6	47.3	4 7.2	145	66	607	601 3	12.82	12.65	15.9	Mean of three other experiments = 12.63 lb. steam per indicated horse-power per hour, excluding pipe water. From Professor Schröter's Report on Trial.

SUMMARY AND AVERAGES OF TWENTY-ONE PUBLISHED EXPERIMENTS ON THE SULZER TYPE OF STEAM ENGINE. ALL HORIZONTAL, CONDENSING, AND STEAM JACKETED. FROM 1872 TO 1891.

Type of Engine. Sulzer.	Steam Pressure (above Atmosphere).	Piston Speed.	Indicated Horse-Power.	Steam Consumption, Pounds per Indicated Horse-Power per Hour, including Steam Pipe Water and Jacket Water.	Steam Consumption, Pounds per Indicated Horse-Power per Hour, excluding Steam Pipe Water, but including Jacket Water.	Remarks, &c.
	lb.	ft. per min.		lb.	lb.	
Single cylinder ..	72 to 95	272 to 433	157 to 400	18.7 to 19.8 mean 19.4	17.9 to 19.2 mean 18.95	Five experiments, 1872 to 1878.
Compound ..	84 to 104	384 ,, 689	133 ,, 524	13.35 to 16.0 mean 14.44	13.4 to 15.5 mean 14.3	Ten experiments, 1882 to 1891.
Triple	104 to 156	444 ,, 607	198 ,, 615	11.85 to 12.86 mean 12.36	11.7 to 12.7 mean 12.18	Six experiments, 1888 to 1889.

difference being the number of cylinders, single, compound, and triple. The engines naturally differ in diameters and strokes, and indicated horse-power varies from about 300 to 700.

Your readers may like to have these figures all relating to the well-known Sulzer horizontal type. If a similar collection of experiments could be got together on other types it would, I think, be very instructive. Nearly all these tests have been made by trained experimenters and some by distinguished men, such as Professor Linde, Professor Schröter, and Monsieur Vinçotte, and have been executed with great care.

As these experiments extend over a good many years, from 1872 to 1891, they have necessarily been made with very different pressures of steam, revolutions, piston speeds, and expansions.

The inclosed curves show at a glance the plotted results in pounds of steam per indicated horse-power per hour for the engines, with one, two, or three cylinders, according to various pressures of steam. I also inclose a short summary of the experiments.

The steam per indicated horse-power with the single cylinder engine is about 19 lb. with steam pressures from 70 lb. to 90 lb. With the compound it is about 14½ lb., with steam pressures of 85 lb. to 100 lb. With the triple it is about 12¼ lb., with pressures of 100 lb. to 155 lb. These number include, of course, the jacket water. The piston speeds are also added.

Those who have made many experiments on the same engine know well that the results vary a good deal, and there is always a most economic rate of expansion, giving the minimum consumption of steam per indicated horse-power per hour for any engine with the same pressure of steam.

This is no doubt partly the reason why some of the results in these experiments do not quite agree or come out rather different to what one would expect. Another is that the quality of the steam was not probably the same, but contained more or less moisture in the different cases.

Yours truly,
BRYAN DONKIN, JUN.

Bermondsey, January 9, 1892.

CAPITAINE'S OIL AND GAS ENGINES.

TO THE EDITOR OF ENGINEERING.

SIR,—In reply to the letter of "Engineer," published in your last week's issue, I beg to say that "Engineer" does not seem to be aware that no maker or seller of gas or oil engines includes the requirements of the Bunsen or the vaporiser in his statements about consumption of gas or oil, unless he *expressly* mentions that they *are* added on.

The figures of the Capitaine engines you published in your issue of the 1st inst. are not only *my* results but the main figures of a large number of tests (both in practical work and on the brake); and if "Engineer" doubts them, he is welcome to ascertain them.

I am, Sir, yours very truly,
LEOP TOLCH.

Liverpool, January 11, 1892.

ANOTHER NILE BRIDGE.—A contract is about to be let for a great bridge to be thrown over the Nile at Benha.

COMPOUND ENGINES OF THE FERRY-BOAT "CINCINNATI."

CONSTRUCTED BY THE PENNSYLVANIA RAILROAD COMPANY.

(*For Description, see Page* 69.)

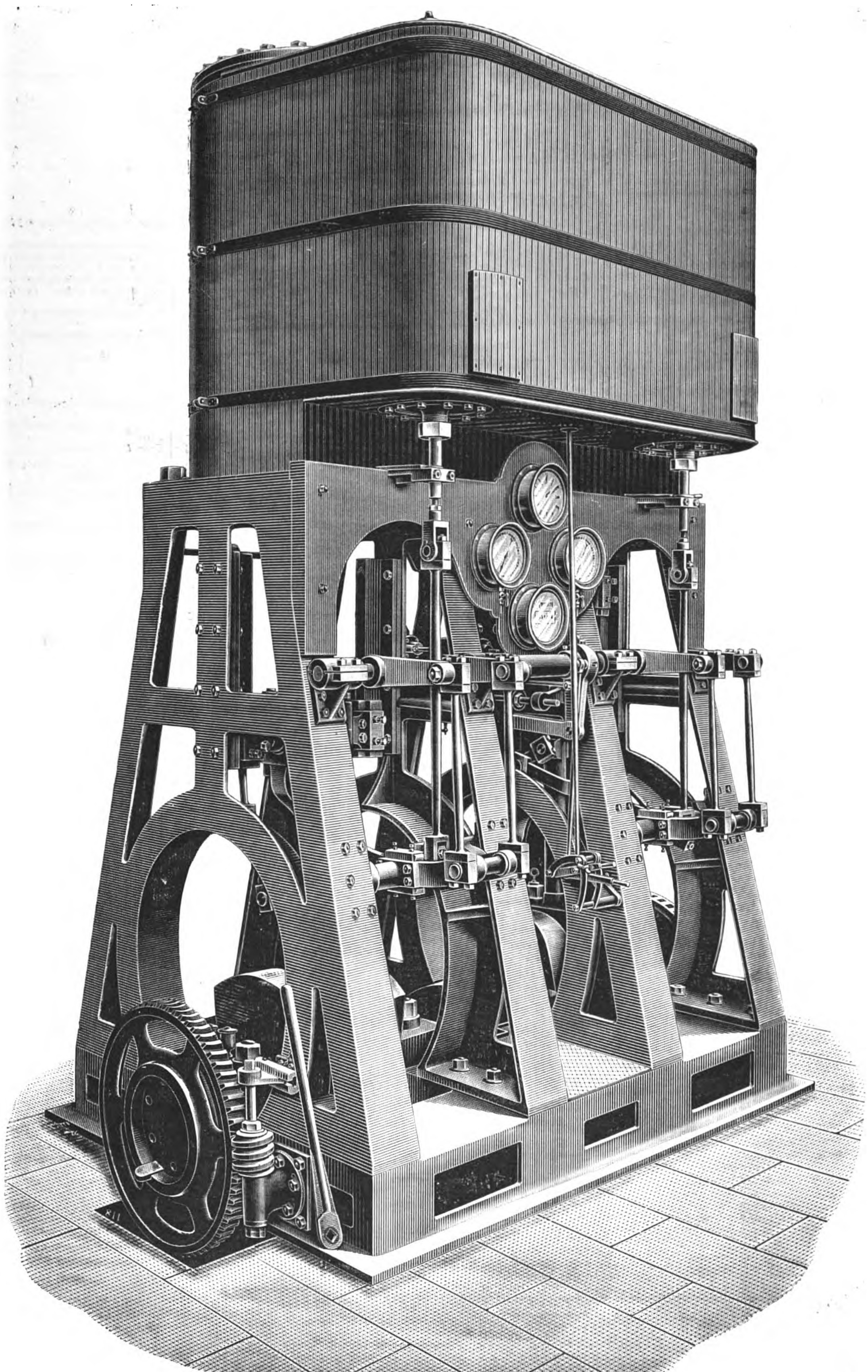
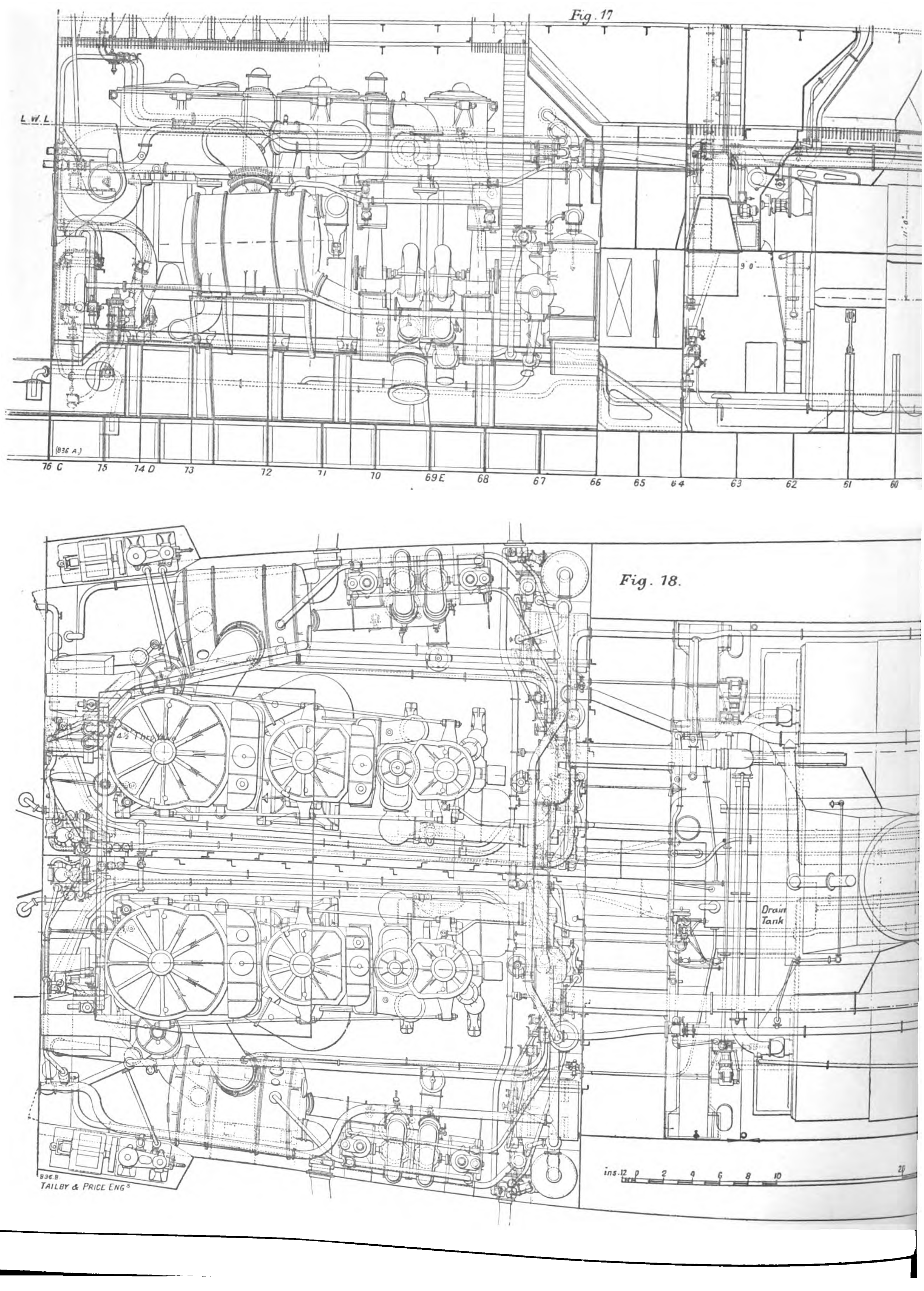


FIG. 10.

GENERAL ARRANGEMENT OF BOILERS AND MACHIN

CONSTRUCTED BY THE FAIRFIELD SHIPBUILDIN

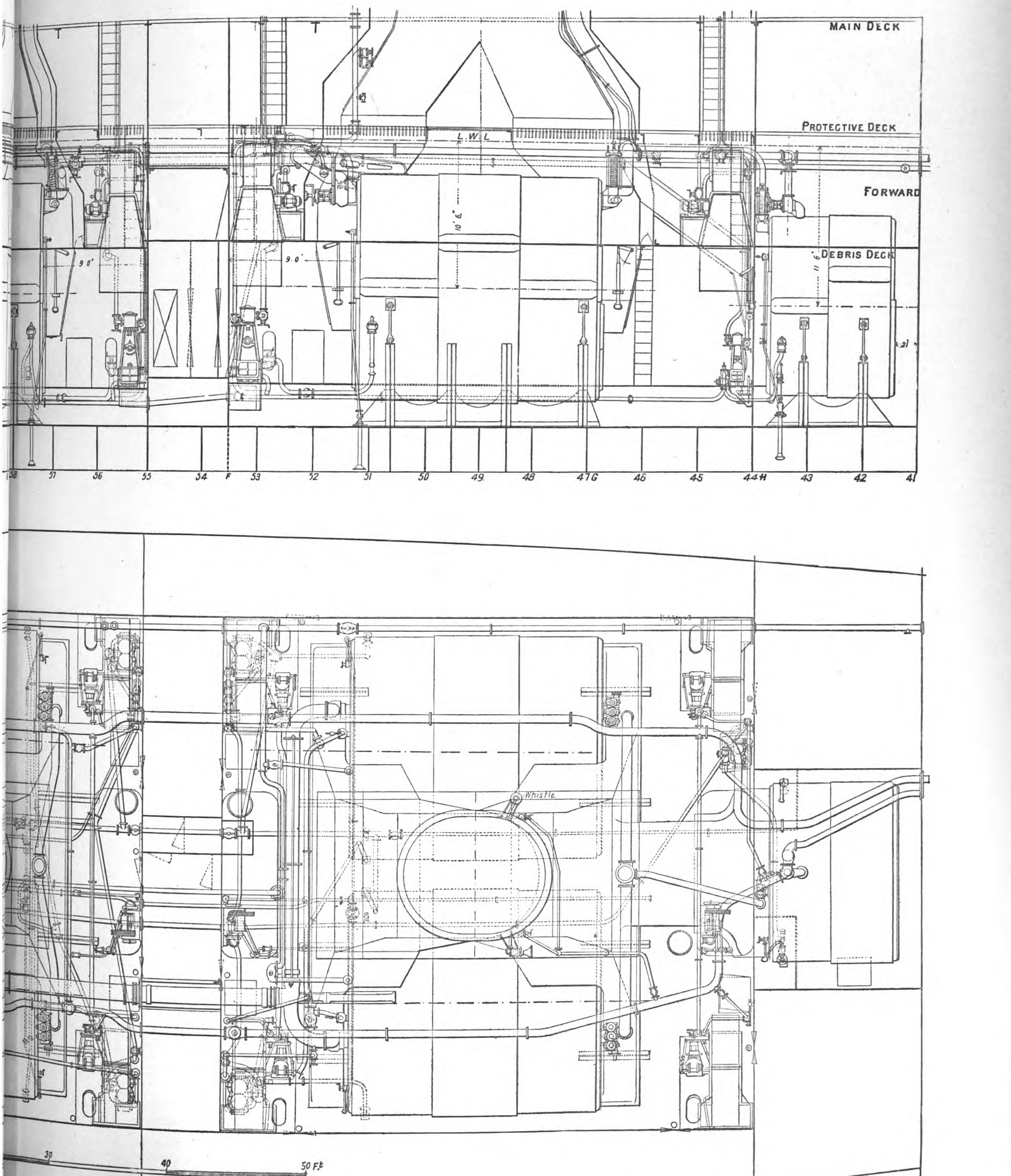
(For I



OF H.M. FIRST-CLASS CRUISERS "EDGAR" AND "HAWKE."

ENGINEERING COMPANY, LIMITED, GOVAN, GLASGOW.

(Page 75.)



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NOTICE.—Immediately following the Index to our last volume, which is published with the current issue, will be found the Classified Directory of Current Advertisements in ENGINEERING, together with a List of the Telegraphic Addresses of the Advertisers and Key. This Directory and List are also published in a separate book form for handy references, which may be had gratuitously on application to the Publisher. This Directory is sent at regular intervals to the principal purchasers of machinery throughout the world.

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With a Two-Page Engraving of the GENERAL ARRANGEMENT OF BOILERS AND MACHINERY OF H.M. FIRST-CLASS CRUISERS "EDGAR" AND "HAWKE."

Re THE "INDIAN ENGINEER."

IMPORTANT NOTICE.

1891. E. No. 1428.

IN THE HIGH COURT OF JUSTICE.
CHANCERY DIVISION.
MR. JUSTICE NORTH.

Mr. BEAL } Friday, the 4th day of December, 1891,
Regr. } *between*
"ENGINEERING," LTD.,
Fo. 96. Plaintiffs.
W. H. BOYD,
Defendant.

Upon Motion for an Injunction this day made unto this Court by Counsel for the Plaintiffs and upon hearing Counsel for the Defendant and upon reading the Writ of Summons issued in this action on the 25th November, 1891, an Affidavit of JAMES DENNINGTON an Affidavit of JOHN DYER and an Affidavit of ALEXANDER THOMAS HOLLINGSWORTH all filed the 27th November, 1891, and the several Exhibits therein referred to **and the Plaintiffs and Defendant** by their Counsel **consenting to the following order** and the Plaintiffs by their Counsel not insisting on any enquiry as to damages caused by the Defendant's Circular and **the Defendant by his Counsel expressing his regret for the erroneous Statements therein contained and consenting that this Order shall be advertised** without further comment in the Plaintiff's Newspaper "ENGINEERING" and also undertaking that he the **Defendant will not either by himself his servants travellers and representatives issue or distribute in England or permit to be issued or distributed in England a Circular addressed "To Advertisers seeking an Eastern Trade"** and containing a statement in the words following "The whole of the Engineering Journals printed and published in England have not a combined weekly circulation of sixty copies in India so that it will at once be seen that for advertising purposes in the East they are practically valueless" **or any other Circular or Advertisement containing any UNTRUE statements as to the circulation of the Newspaper called "ENGINEERING"** the property of the Plaintiff Company **or otherwise slander or libel the Plaintiff Company** in their Trade. **This Court doth not** think fit to make any **Order** upon the said Motion except **that the Defendant W. H. Boyd do pay to the Plaintiffs "ENGINEERING," Ltd., their Costs of this Action as between Solicitor and Client** such Costs to be taxed by the Taxing Master C. B.

NOTICES OF MEETINGS.

THE INSTITUTION OF CIVIL ENGINEERS.—IN CONSEQUENCE OF THE DEATH OF H.R.H. THE DUKE OF CLARENCE, HON. M.INST.C.E., THERE WILL BE NO MEETING ON TUESDAY, THE 19TH INST.—Students' meeting, Friday, January 15th, at 7.30 p.m. "Testing and Inspecting for Commercial Purposes," by Mr. J. Roxburgh Sharman, Stud. Inst. C.E. Professor Alex. B. W. Kennedy, F.R.S., M. Inst. C.E., in the chair.—Students' visit, Thursday, January 21st, at 3 p.m., to inspect the electrically-driven machinery at the works of Messrs. Willans and Robinson, Thames Ditton. Train leaves Waterloo (south station) 1.50 p.m., or Vauxhall 1.54 p.m.

CHEMICAL SOCIETY.—Thursday, January 21st, at 8 p.m. Papers to be read: "The Estimation of Oxygen in Water," by Mr. M. A. Adams. "A Pure Fermentation of Manitol and Dulcitol," by Mr. P. F. Frankland and W. Frew. "The Luminosity of Coal-Gas Flames," by Mr. V. B. Lewes. "The Magnetic Rotation of Dissolved Salts," by Mr. W. Ostwald. "On the Dissociation of Liquid Nitrogen Peroxide, by Mr. W. Ostwald.

THE CHARTERED INSTITUTE OF PATENT AGENTS.—Wednesday, the 20th instant, in the Arbitration-Room, 55 and 56, Chancery-lane, at 7.15 p.m. precisely. 1. To resume the discussion on Mr. Abel's and Mr. Loubier's papers. 2. To read and discuss a paper by Mr. A. V. Newton "On Patent Agency, its Origin and Uses." 3. And if time permit, to read and discuss a paper by Mr. G. B. Ellis, Assoc. C.I.P.A., "On Compulsory Licenses."

PHYSICAL SOCIETY.—January 22nd. "On the Driving of Electro-Magnetic Vibrations by Electro-Magnetic and Electro-Static Engines," by Professor G. F. Fitzgerald, F.R.S. "On Supplementary Colours," by Professor S. P. Thompson, F.R.S.

THE SURVEYORS' INSTITUTION.—Monday, January 18th, at 12, Great George-street, Westminster, when a paper will be read by Mr. E. H. Morris (Fellow), entitled "The Four-Course System, with Desirable Variations." The chair to be taken at 8 o'clock.

SOCIETY OF ARTS.—Wednesday, January 20th, at 8 p.m. Ordinary meeting. "Spontaneous Ignition of Coal and its Prevention," by Professor Vivian B. Lewes. Sir Frederick Bramwell, Bart., D.C.L., F.R.S., will preside.—Thursday, January 21st, at 4.30 p.m., Indian Section. "From Tien-Shan to the Pamirs—Experiences on the Russo-Chinese Frontier," by Herbert Jones. Sir William W. Hunter, K.C.S.I., C.I.E., LL.D., will preside. The paper will be illustrated by lantern slides.

ENGINEERING.

FRIDAY, JANUARY 15, 1892.

THE PARLIAMENTARY COSTS OF ENGLISH RAILWAYS.

IT will not probably surprise the general public, or that section of it which has a special interest in railway development, to learn that the number of Bills coming before Parliament during the ensuing session is much less than usual, and that it is proposed to construct a shorter mileage of new railway lines, through those Bills, than has been proposed for several years. This is not, of course, quite satisfactory, in view of the reduced expenditure of railway capital that must be looked for, and the consequently reduced employment of engineering and industrial resources. But it is only what might be expected under the circumstances. The principal railway companies have had their hands full for the last two or three years in attending to parliamentary measures that seriously threatened their statutory powers and their financial position, and now that the end of the long process of inquiry and negotiation attending this matter appears to be in view, the railway companies are naturally anxious to have time to survey their position and prospects before taking up new enterprises. Such enterprises are costly enough at any time in their parliamentary aspects, but the ordinarily large expenditure attendant upon new Bills has been largely augmented during recent years by legislative proposals that the companies have had to combat.

It is not, however, to be supposed that railway enterprise has reached its final limit, as measured in terms of railway mileage, either in the United Kingdom or in any other important manufacturing and industrial country. It is quite true that there are few countries that have so large a mileage of railways relatively to area as our own, the only country that is superior to Great Britain in this respect being Belgium. But the archives of most of the administrative departments of the great companies, and, in many cases, of the smaller companies as well, contain proposals for further extensions of the existing system, which, although put on one side for a season, will be certain to see the light when the fulness of the time has come. Railways, indeed, will only cease to be built in this country when the trade and traffic of the country has ceased to advance, and we appear to be as yet a very long way from that undesirable position. The engrossing work and anxiety that have been demanded from all the principal officials of our great railways in the recent adjustment of rates, charges, and powers, is, of itself, a sufficient explanation of the comparative stagnation that has now occurred in the projection of new lines; and it is easy to conceive that the less promising industrial outlook has also had something to do with the fact in question.

One of the most remarkable features of the railway development of the United Kingdom is the very large number of schemes for extension that never come to anything, even after Bills have been submitted to Parliament for their sanction, and a considerable amount of capital has been expended in financing, promoting, and preliminary expenses generally. During the thirty-five years ending 1890 there were no fewer than 5704 Bills deposited by new and existing companies for railway extensions, that represented a total proposed length of 42,983 miles, or more than twice the present railway mileage of the United Kingdom. It need hardly be said that the greater part of these new schemes were either withdrawn or rejected by Parliament, since the total extent of railway mileage actually built during the same period was 11,793 miles. Not less striking is the large capital proposed to be raised for these general schemes. The Bills deposited between 1865 and 1890, both years included, made proposals for raising upwards of 1090 millions of new capital, or 648 millions more than the amount that has actually been raised in the interval for railway purposes generally, and if we take the last twenty years alone, we find that the mileage proposed to be added to the existing railway system was 17,544 miles, and the capital proposed to be raised in respect of that mileage was no less than 794 millions.

A still further peculiarity of the railway history of the last thirty years is that the majority of the Bills introduced into Parliament for railway extension, and the great part of the capital proposed to be raised in respect of such additions, have been originated, not by new, but by existing companies. This, perhaps, is only what might, after all, be expected, for the existing companies naturally desire to retain the railway business of the country, as far as possible, in their own hands, and to exclude the competition of outsiders. In this they have, on the whole, been very successful, for during recent years, unless we except the case of the Hull and Barnsley Railway, few entirely new lines have been constructed unconnected with the already existing system. At one time there was a strong tendency in certain quarters to promote new railway enterprises, in the hope that the existing companies could be cajoled or persuaded into acquiring them at a premium on their original cost, in order to avoid the diversion of the traffic otherwise threatened. That, however, has not generally been a successful bit of speculation, and of late years it has seldom been attempted. The railway companies already established have naturally a prescriptive prestige and opportunity that outsiders can rarely command, and, besides this, they have a very formidable financial and legal position, found to be almost unassailable.

The total expenditure represented by the applications to Parliament for powers to construct new or extend existing railways must, during the last thirty years, have amounted to almost fabulous sums, but the items are so difficult to trace in the railway companies' accounts, and so impossible to compute for new companies, who do not, perhaps, publish any accounts at all if their schemes do not succeed, that it is only a very rough calculation that can be offered as to their aggregate. A return presented to the House of Commons in 1883 showed that during the ten years ending with 1882 the then existing companies had expended on the promoting and opposing of Bills in Parliament a total sum of 3,925,000*l.*, or 392,500*l.* per annum. This amount was equal to an average of 2970*l.* for each Bill introduced, and if this average were taken for the whole of the 5704 Bills introduced since the year 1855, it would give a grand total of 16,929,000*l.* But the actual amount was probably a great deal larger even than this, for the expenditure shown for the ten years ending 1882 was that incurred by existing railway companies only, and does not include the undoubtedly large sums expended by outsiders. That those sums must have been very considerable is clear from the fact that, of the 5704 new Bills introduced into Parliament in the period 1855-90, only 3766 were promoted by existing companies, so that 1938 Bills were put forward by new companies, who did not often survive the ordeal of the rejection of their measures, and with reference to whose expenditure, as already indicated, we are without details. It is probable, taking the expenditure as a whole over this period, that it was not much, if any, under 25,000,000*l.* sterling, which is about 2.8 per cent. of the total paid-up capital of the United Kingdom at the end of 1890, and over 4 per cent. of the total sum actually added to the paid-up capital of British railways for the same period.

The fact that between 1855 and 1890 proposals were made for the construction of 42,983 additional miles of railway in the United Kingdom, against 11,793 miles actually constructed, may be taken as a proof that in the opinion of those who promoted the Bills seeking powers for this additional mileage, there is still scope for considerable extension of the railways of this country. No doubt a certain proportion of these Bills were duplicates of Bills introduced in previous sessions, but even after a liberal deduction has been made for such duplication, the difference between the mileage proposed and the mileage completed is remarkable. The fertility and activity of promoters in bringing forward new schemes would no doubt be more apparent than it is, were it not that the penalty to be paid for defeat is so serious. Parliament, in its wisdom, has demanded that parties promoting railway Bills in Parliament shall prove their good faith by making substantial deposits of capital in advance of a hearing, and after the powers asked for have been granted. All this has been against the promotion of lines that might have been useful and even necessary, but which it does not suit the existing companies to construct, and which outsiders are either afraid or unable to face. The Metropolitan Outer Circle Railway recently proposed is a case in point. It was admitted by Parliament that this line was necessary, for two different Acts were obtained for its construction; but the existing railway companies did not encourage it, and were not prepared to take it up themselves, so that the parties who had it in hand have not hitherto seen their way to proceed with a system that may hereafter be placed at the mercy of other, and possibly rival and hostile systems. It is well that Parliament should discourage frivolous and vexatious schemes, and should to that extent protect the existing railway companies from a large expenditure in opposing enterprises that are probably not always seriously meant; but it is fairly open to doubt whether this principle, good up to a certain point, is not carried too far. Nor is it too much to assume that with the restraints already referred to as placed by Parliament on impracticable or unnecessary schemes, few new enterprises are brought forward, unless there is reason to suppose that they would be useful, and supply a felt want. So that it is fair to suppose that Parliament may have applied the drag too far in withholding consent from so very considerable a proportion of the enterprises actually submitted for its consideration.

Notwithstanding the discouragements and difficulties already referred to as standing in the way of new railway enterprises in the United Kingdom, and in spite of the comparatively low range of remuneration on invested capital earned by existing companies, there appears to be very little slackening of the activity of both new and old companies in the promotion of new lines. In the period 1865-90 the most marked development of new enterprises took place during the five years ending 1869, when Bills were introduced for powers to construct 8824 new miles of railway, and to raise for that purpose 296 millions of capital. In the next five years there was a pause, the capital involved being only 214 millions, and in the five years ending 1874 there was a further drop to an average annual proposed capital of 143 millions. The first drop is all the more remarkable in that it covered the most prosperous period of British commercial history; the second is not at all surprising, considering that it was coincident with the collapse of credit and trade that followed the previous inflation. But in the five years ending 1884 there was a revival of home railway enterprise, and applications were made to Parliament to sanction the construction of 5707 miles of new railway, involving a proposed capital expenditure of 276 millions. The inevitable reaction followed the further spurt, until at the end of 1889 it was found that the number of new railway Bills promoted had fallen to 500, proposing 2167 miles of new line, and a consequent capital outlay of 125½ millions. The year 1890 witnessed an improvement on this state of comparative stagnation, the number of Bills promoted being 114, the mileage of proposed new lines being 775, and the proposed capital required for their construction being 35¼ millions.

It would be difficult at any time to determine whether the mileage of railway lines laid down in the country was sufficient for its requirements, and it is obvious that up to a certain point the greater the mileage of railways available the better for the interests of the country generally. It will be seen, however, that the mileage constructed in Great Britain does not compare unfavourably with that laid down in other European countries, the figures for the years 1870, 1880, and 1890 being as stated below:

Mileage of Railways Open in Different European Countries in 1870, 1880, and 1890.

—	1870.	1880.	1890.
	miles	miles	miles
United Kingdom	15,537	17,933	20,073
Germany	11,729	20,693	24,845
France	11,142	15,275	21,899
Russia	7,098	14,026	17,594
Austria-Hungary	5,947	10,494	16,093
Italy	3,325	5,340	7,830
Belgium	1,799	2,399	2,676
Holland	874	1,143	1,632
Switzerland	885	1,596	1,869
Norway	224	652	972
Sweden	1,089	3,654	4,879
Denmark	470	975	1,211
Spain	3,400	4,550	5,951
Portugal	444	710	1,188
Roumania	152	859	1,537
Turkey	392	727	1,024
Totals	65,007	101,026	131,276

The figures given under the year 1890 are not in all cases applicable to that year, but to the nearest year thereto that can be given. Both totals and details are, however, sufficiently approximate to serve the intended purpose of showing that the railway mileage of the United Kingdom has been steadily progressive, in spite of the drawbacks referred to, although not so much so as that of Germany and France, where, however, the areas are much greater. Of course, as regards both capital expenditure and railway income, the United Kingdom is much further in advance of the other countries of Europe than mere railway mileage would seem to indicate.

THE FIRST-CLASS CRUISER "EDGAR."

We have completed our description of the cruiser Edgar and of her machinery, and have given the general results of speed trials; but these are worthy of more careful consideration, both on account of their interest and also of their rarity. For it must be noticed that, while private firms can systematically carry out elaborate speed trials of all their ships, or test the performance as to consumption of steam, &c., of all their engines, and find this to pay; while also thousands of pounds and months of time can be given to try torpedoes, nets, &c.; while we can afford to send torpedo boats full tilt at floating fortresses; yet we are, we believe, correct in saying that not one thorough speed trial has ever yet been carried out in the Navy, and we are perfectly sure that the consumption of steam of not one engine of a ship of war is known. It may be, of course, that the trials of the Greyhound in 1873 finally settled all questions regarding the resistance of ships, and that we now need nothing but model experiments, though we should be sorry to state that this is so; but they certainly settled nothing about the engines. However, no doubt the efforts of private firms will in time supply us with facts sufficient to complete, so far as such a thing is possible, our knowledge of the steam engine; and meantime the highly educated young engineer officers, on whose training the Admiralty spend a fair amount of money, can go on as usual settling the exact dimensions of a stoker's blue collar, or seeing that he spills no drops of oil to mar the purity of the first lieutenant's clean decks.

We give in tabular form the results of seven trials on the measured mile at Stokes Bay, and for comparison the two contractors' trials for acceptance of the machinery at Plymouth. In order to show the results clearly, they are plotted graphically on a diagram accompanying this article, the horizontal scale being of knots, and the vertical the corresponding indicated horse-power, the curve A B C E F G is then drawn through the spots obtained. Before, however, the curve can be drawn, a correction must be made, because as will be seen from Table I., the trial is marred by a change of draught. The trials were to be at or about 10, 12, 14, 16, 18 knots and full speed, and the 10, 12, and 14 knots trials being made on one day, the draught was for some reason or other altered before continuing, then a trial at about 13 knots was made, in order, we presume, to bring the two sets of results into comparison, before proceeding with the 16 knots, &c. This change of draught is unfortunate, but we can only endeavour to allow for it by estimating its probable effect. We calculate thus:

	ft.	in.
Mean draught on 24th	23	2½
" " 27th	23	9
Change of draught, or 2.27 per cent.	0	6½

This change will mean an increase of about 4½ per cent. on the wetted surface, and hence also on the indicated horse-power.

We add then 4½ per cent. to the 10, 12, and 14 knots indicated horse-powers; and we also apply a similar correction to the two trials at Plymouth, adding 4 per cent. to the full-power trial indicated horse-power, and subtracting 1 per cent. from the natural draught trial indicated horse-power. Doing this we obtain the numbers in the second column of Table II., and plotting these in the diagram, obtain in order the points K G L F E D C B A; we should then draw a fair curve through these points, except K and L, but it will be found that we cannot bring the point D into a fair curve, so we are obliged to leave this point out and conclude that probably some inaccuracy occurred in that particular result. There will also be noticed a slight flatness at B, appearing to indicate that the indicated horse-power given for this speed is somewhat large; but still, the want of fairness is small; and remembering that C is for the same day and conditions as E, F, and G, we should not attempt to draw a curve including D, but decide that the results for D are in some way inaccurate as just stated.

In order to separate, if possible, the engine efficiency or a part of it, we next draw the curve of indicated thrust. In column 4, Table II., we have the speeds of the screw calculated; and, dividing the energy exerted per minute by the engine by these, we obtain column 5 of indicated thrusts. These values are plotted in the diagram at *k g l f e d c b* and *a*, and the curve of indicated thrust for the progressive trials should pass through *g f e d c b a*. But we now find that not only is *d* out of the fair as we should expect, but also the slight want of fairness at B is on this curve accentuated, so that *b* lies above the straight line joining *a* and *c*. This shows us that the results for B and A are not consistent with those at C E F and G; either B and *b* are too high or A and *a* are too low, or both. Thus altogether it appears that we cannot attach much value to the lower results; and it is therefore of no use

TABLE I.—DETAILS OF TRIALS OF H.M.S. "EDGAR."

—	Trials off Plymouth.		Progressive Trials on Measured Mile at Stokes Bay.						
	Natural Draught.	Full Power.	10 Knots.	12 Knots.	13 Knots.	14 Knots.	16 Knots.	18 Knots.	Full Speed.
	Nov. 4, 1891.	Nov. 19, 1891.	Nov. 24, 1891.	Nov. 24, 1891.	Nov. 27, 1891.	Nov. 24, 1891.	Nov. 27, 1891.	Nov. 27, 1891.	Nov. 27, 1891.
Draught of water { Forward ..	23 ft. 3 in.	22 ft. 9 in.	22 ft. 8 in.	22 ft. 8 in.	23 ft. 0 in.	22 ft. 8 in.	23 ft. 0 in.	23 ft. 0 in.	23 ft. 0 in.
Draught of water { Aft	24 ,, 6 ,,	23 ,, 10 ,,	23 ,, 9 ,,	23 ,, 9 ,,	24 ,, 6 ,,	23 ,, 9 ,,	24 ,, 6 ,,	24 ,, 6 ,,	24 ,, 6 ,,
Revolutions	99.2	104.5	45.3	55.9	63.1	65.9	79.3	92.8	106.2
Pitch of screws	23 ft. 4 in.	24 ft. 4 in.	24 ft. 4 in.	24 ft. 4 in.	24 ft. 4 in.	24 ft. 4 in.	24 ft. 4 in.	24 ft. 4 in.	24 ft. 4 in.
Speed	19.25	20.97	9.647	11.87	13.4	14.015	16.512	18.836	20.488
Indicated horse-power	10,179	12,463	880	1690	2461	2997	5102	8401	13,101

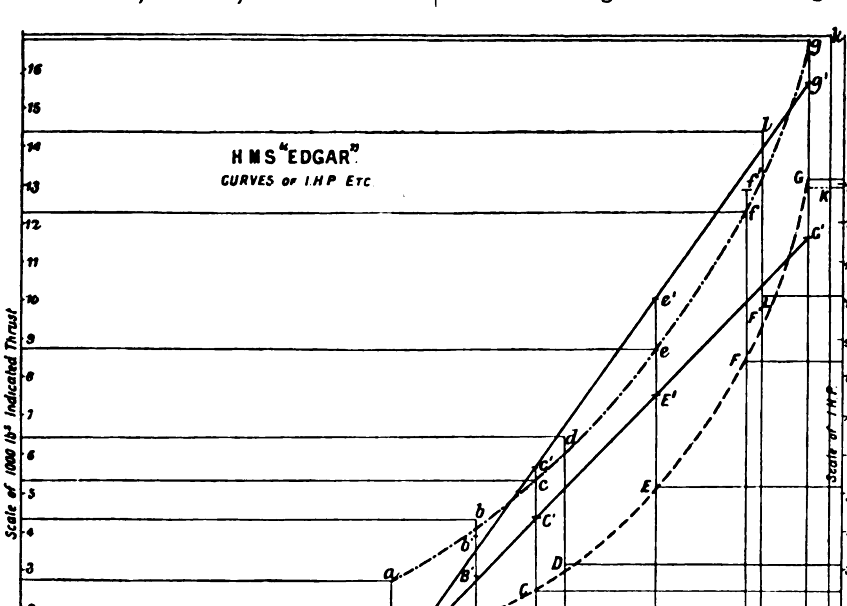
TABLE II.—ANALYSIS OF RESULTS OF TRIALS AT PROGRESSIVE SPEED OF H.M.S. "EDGAR."

Speed. Knots.	Indicated Horse-Power.	Revolutions.	Speed of Screw.	Indicated Thrust.	Speed of Ship.	Slip per Cent.	Log Speed.	Difference	Log Indicated Horse-Power.	Difference	Power of Speed which Indicated Horse-Power varies as
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
			ft. per min.	lb.	ft. per min.						
20.97	12,961	104.5	2542.8	16,821	2124.96	16.4					
20.488	13,101	106.2	2584.2	16,730	2076.117	19.7	1.3114996		4.1173044		
19.25	10,077	99.2	2314.7*	14,366	1950.67	15.7		.0365109		.1929734	5.3
18.836	8,401	92.8	2258.1	12,277	1908.715	15.5	1.2749887		3.9243310		
								.0571890		.2165905	3.78
16.512	5,102	79.3	1929.6	8725.4	1673.216	13.3	1.2177997		3.7077405		
14.015	3,132	65.9	1603.6	6445.2	1420.187	11.4		.0906949		.3160998	3.48
13.4	2,464	63.1	1535.4	5296.8	1357.87	11 5	1.1271048		3.3916407		
								.0526541		.1446500	2.74
11.87	1,766	55.9	1360.2	4284.5	1202.83	11.5	1.0744507		3.2469907		
								.0900584		.2832029	3.14
9.647	920	45 3	1102 3	2754.2	977.563	11.3	.9843923		2.9637878		

* Pitch 23 ft. 4 in. for this trial.

to attempt to determine the constant engine friction, by prolonging the thrust curve to cut the vertical axis, even supposing the lowest speed determined, viz., 9.647 knots, had not been too great to use for this purpose.

One point, however, is very clearly shown by the true—*i.e.*, upper—part of the curve, viz., the loss of speed due to the drag of the bottom in the comparatively shallow water of the measured mile. It will be noticed that the points K *k* lie below the fair curves, while L *l* for the natural draught trials lie above. The latter, however, need not be considered since there was in that case no special need for great accuracy in the determination of the speed. But on the full-power trial the speed was determined with considerable accuracy; and it will be found that, drawing through K a parallel to the base, this cuts the indicated horse-power curve just half a knot to the left of K. We conclude then that at Stokes Bay, with the same indicated horse-power and draught as at Plymouth, the speed obtained would have been half a knot less; this half-knot then must be the loss due to the bottom drag.



The third set of points on the diagram A[1] B[1] C[1] E[1] F[1] is plotted by drawing ordinates representing log indicated horse-power, the base line being taken such a distance below O A that the spot corresponding to the lowest speed may fall on A[1], or, which is the same thing, the ordinates from the base line in the figure represent the difference of the log of each indicated horse-power from the log of the smallest one, viz., 920. If the relation between indicated horse-power and speed were

$$\text{Log I.H.P.} = a + b\,\text{V},$$

where *a* and *b* are constants, then the spots would all lie on a straight line. In the figure a straight line is drawn through C[1] and G[1] which passes very near to E[1] and B[1]; but F[1] lies considerably below it, a result we should hardly have expected, since neither in the curve of indicated horse-power nor of thrust is there any sign that the results of this trial are low. Of course we should not expect B[1] or A[1] to come in fairly, but we see that B[1] does very nearly; so that the probability is that the unfairness at B and *b* is due to a too small value of the indicated horse-power at A.

A law which is sometimes assumed to represent the facts very closely is

$$\text{Log}\ \frac{\text{I.H.P.}}{\text{revolutions}} = a + b\,\text{V},$$

or as we term it

$$\text{Log (indicated thrust)} = a + b\,\text{V}.$$

To test the correctness of this law the points $a^1\ b^1\ c^1\ e^1\ f^1\ g^1$ are plotted in a similar way to A[1] B[1], &c., a^1 and A[1] coinciding to start with. But there being room on the diagram, the scale is double that of A[1] B[1], &c., which accounts for the greater slope of *a b c*. So far as can be seen this law is no closer than the preceding, the only difference perceptible being that the line $a^1\ c^1$ lies closer to or more evenly between a^1 and b^1, thus tending to divide the inaccuracy between the two trials; f^1 again is below, and e^1 practically on the line.

The remaining columns in Table II. show: The slip per cent., where it will be seen the 14-knot trial again is anomalous; and also the very great increase of slip at the maximum power, shows that the ship is reaching the limit of speed for her size and form: and the calculation of the power of the speed according to which the indicated horse-power varies between the different speeds; the results in column 12 are obtained by dividing those of column 11 by the corresponding figures in column 9. The 14-knot trial is omitted, and the numbers found point to the unfairness at B, and also, seeing the sudden increase from 3.78 to 5.3, to a possible understatement of the indicated horse-power at 18.836 knots.

THE CRYSTAL PALACE ELECTRICAL EXHIBITION.—No. I.

THE common reproach against exhibitions of not being ready on the opening day may be cast against the show at the Crystal Palace with some force; still the importance of the exhibits which are now ready, or in an advanced state of progress, is such as to give the Exhibition a real importance at the present moment, with excellent promise of becoming in a few weeks an exhibition so representative, and so comprehensive, as shall well illustrate the present state of electric technology, and do credit to the management and to the enterprise of the British, Continental, and American firms that take part. Those who intend to make several or numerous visits to the Palace may well commence at once, as not only is there abundance of completed material, but for such there will also be the advantage of seeing several important installations in various stages of progress.

The catalogue, which was on sale in the building the first thing on Saturday morning, is something more than a bare list of the 228 exhibition spaces allotted, as it contains a useful series of introductory articles by Mr. H. J. Dowsing, each of these articles being prefatory to a special section of the Exhibition. Thus we have, for example, a 2½-page essay on the general phenomena of electricity, in which such sources as the thunderstorm, the frictional machine, the voltaic battery, and the magnetic machine are touched on. The hydraulic analogue serves to introduce the ideas of potential and quantity, after which the most important units are briefly dealt with. This essay is prefatory to those exhibits relating to the scientific or demonstrative side of the subject, general educational apparatus being principally shown by Bishop, of Croydon, and Bowron, of Praed-street. Messrs. Crompton and Co. exhibit special contrivances for the demonstration of such phenomena as bear on losses in the dynamo. On the scientific side there are also the experimental devices of Professor Elihu Thomson for illustrating phenomena in connection with the alternating current, devices which created so much interest in connection with the Paris Exhibition of 1889, and which were explained by Professor Fleming in a lecture before the Society of Arts in May, 1890.

The next sectional introductory essay in the catalogue is on electrical measurements, and, like the previous and following essays of Mr. Dowsing, is popularly written, so as to give fundamental notions to those who have had but little scientific training. It must be remembered that, in setting out with such an aim, it is impracticable to altogether avoid some few things which the scientific critic will regard—or, perhaps, condemn—as crudities, or as general expressions rather than absolute truths. Still, we take it that by far the larger number of the users of the catalogue will appreciate Mr. Dowsing's short and intelligible introductions, and will find them useful. The section of measuring instruments includes contributions, among which may be specially mentioned those from White of