THE INSTITUTION OF NAVAL ARCHITECTS.

The Meeting of the Institution of Naval Architects was resumed on Thursday morning, the 15th inst. Two papers were read upon mild steel chiefly as used in shipbuilding. The first, by Mr. B. Martell, was entitled, "A Brief Review of the Progress of Mild Steel, and the Results of Eight Years' Experience of its Use for Shipbuilding Purposes." The second was by Mr. J. Ward, "On the Present Aspect of Mild Steel for Shipbuilding." There was nothing new in either of these papers. Mr. Martell's was historic; first, very much of himself; secondly, of Lloyd's; and thirdly, dimly structural. The paper had or seemed to have an object not apparent to many, that object being to explain his own views on a subject which had evidently been elsewhere one of contention, and thus to walk publicly into the enemy's camp with mystic "references to special subjects," perfectly plain to those behind the scenes, but who were precluded from a reply because, as Mr. Martell seemed to be careful to remark, "the Institution is not a place where questions of a personal nature should be discussed." The structural points referred to were chiefly those that relate to the relative strengths, as against strains such as those that result from collision or grounding, of steel and iron ships, supposing the ships to be built of regulation scantling. As against such strains, the inference from the paper is that the lighter section of steel employed removes the claim to superiority over iron ships. Another point was to the effect that a vessel may be strained at the butts without its being possible to detect it in the ordinary way in dry dock; that is to say, that the ship may be so resting as to close butts that would be open in the water, and that refitting butt straps and re-rivetting may be necessary when a ship's plater thinks not. A few words were said on basic steel and certain failures, and the refusal of Lloyd's to accept basic steel for ships for the present.

The gist of Mr. Ward's paper was to the effect that mild steel ships were, under every consideration, better than iron; that Messrs. Denny had made ships in which they had used 51,000 tons of steel; that steel in their works was treated without any special precautions; that out of about 400,000 pieces — plates and angles — only eleven plates and three angle bars have failed; and that local heating was not attended with such serious results as was commonly supposed. Any detrimental effect of working at blue heat was of the rarest occurrence, pieces of all kinds and shapes being constantly finished in their (Messrs. Denny's) works without any losses. The author then gave the results of a large number of experiments to test these and other questions, the figures obtained being all in his favour, and showing that mild still was structurally superior to iron, and its manipulation in every respect equally easy. The paper contained no less than fifty-seven quarto pages, most of them occupied with the results of experimental tests by machine and by dynamite.

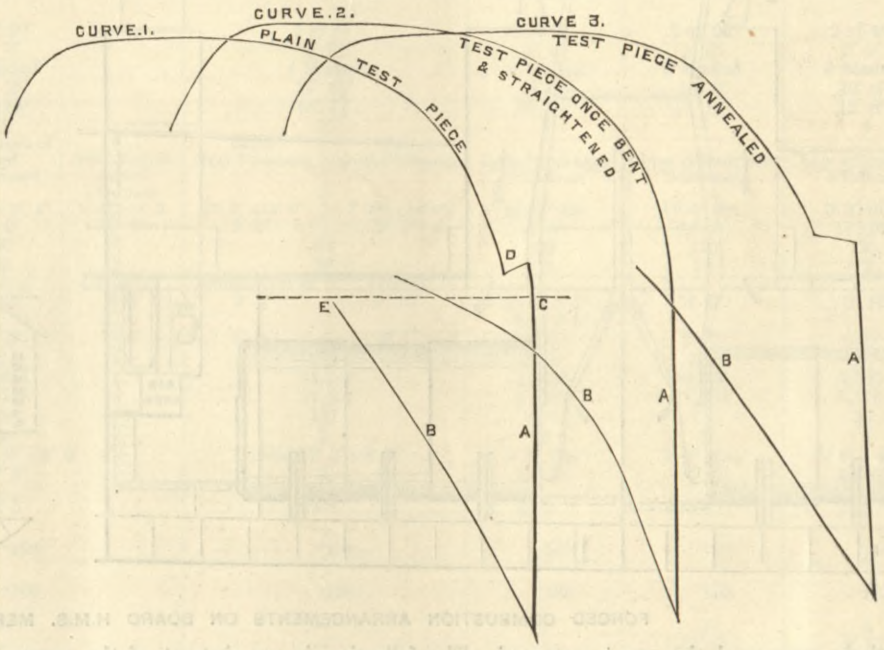
In the discussion on these papers Sir Nathaniel Barnaby urged the necessity, in spite of Mr. Ward's figures, of testing and examination, and for refusing to trust any steel on account of its brand; but Mr. Kirk agreed with Mr. Ward as to giving the men no special instructions as to the methods of manipulation.

The Hon. George Duncan, of Messrs. Maudslay, Sons, and Field, said that the results of his experience, especially in the construction of boilers, was quite opposed to Mr. Ward's. He had found that plates and rivets were both to be distrusted, and the greatest care was necessary to avoid the effects of local heating and working at an insufficient temperature. He had made arrangements for producing boilers with hardly any of the customary local heating, having devised a set of machinery for the purpose, including the thinning or tapering-down of corners cold by cutting away instead of hammering out. Messrs. Maudslay, we may remark, are paying special attention to boiler construction, and have entirely departed from the usual boiler-shop practice. Plates, and even difficult forms, are now completely set out in the drawing-office, and "trying-up" has been almost wholly avoided. The firm intends working large engines and boilers at 180 lb., and, believing in the importance of the boiler as a chief element on board a steamship, they have taken up the matter as one requiring much more special attention than has customarily been paid to it.

Respecting corrosion, one speaker said he had found it occur very severely at first, but that with care as to cleaning and painting, it seemed to cease entirely. Admiral Sir John Hay referred to the necessity for applying the facts which had been ascertained concerning the evil effects of vibration long continued on the material of steel ships, and he suggested that the compass changes on board steel ships might be to some extent due to molecular change of the steel caused by vibration—changes such as he considered were to be inferred from facts obtained by experiments on the magnetic changes in metals, as a result of crystalline change.

Mr. Gilchrist explained that basic steel of the lower tensile strengths was entirely devoid of the imperfections which had been the cause of complaint, and that these complaints had not been made with respect to the enormous quantities of basic steel that had been made in Germany, and, moreover, that some of the plates which had been most complained of in this country had not really been basic but were acid plates. Mr. James Riley said he had been trying hard to destroy plates by local heating, and could not, but had found some ill effects of working at blue heat. Heating to a high temperature without subsequent working was more harmful. He predicted that basic steel would be successful, but would be made by the open hearth.

Mr. W. Parker remarked that experiments might be pointed to that showed that steel plates were not injured by punching; but inquiry proved that these were only thin plates, the thicker the plate the greater the damage, and the same of a sheared off strip until annealed. Basic steel he thought would be good if its tensile strength were kept low. Mr. Parker, however, showed some remarkable curves illustrating the effect on steel of mechanical work done under different conditions. The curves were obtained by Wicksteed's autographic recorder, and by Stromeyer's indicator, and are of great importance. We reproduce some of them annexed. They are all from similar test pieces of the same mild steel. Curve 1 was obtained from a test piece of plate as taken from the mill, 1·14 square inch sectional area. The breaking load of this was 31·23 tons, or 27·4 per square inch, and the extension in 10in. 2·77in. In this curve will be seen the peculiar drop—or rather sudden extension—at D, which has recently been particularly observed by autographic means, and taken as indicating the period of loss of elastic resistance. Above this the curve rises in no peculiar manner as the load and extensions increase until rupture occurs. Mr. Parker has, however, supplemented the curve by one from a Stromeyer indicator, which we described in our last impression, and this is shown by the line B, which magnifies the elongation 100 times. By means of this indicator the moment of ductile extension is instantly shown by the rapid movement of the pointer, and the instant of loss of elastic resistance is thus determined. By projecting the point E in this curve or line by which this instant is recorded, we have on the ordinary curve the point C, at which the elastic limit of the material is really reached, the vertical distance between C and D indicating the period and intensity of a semi-elastic resistance, which suddenly fails and becomes one either of plastic resistance or of what we might provisionally assume to be a mechanical re-arrangement of the molecules which are under an approach to equilibrium as to stress when the external load is sufficient to constitute incipiently effective resistance to the forces by which they are attracted to each other. The re-arrangement for a period adds to the resistance to further deformation, but from D this is gradually overpowered and destructive extension is recorded by the curve. Curve 2 is taken from an exactly similar test piece, the sectional area of which was 1·132 square inch, but the piece had been bent to a radius of about 3in., and then straightened, thus putting upon the material strains of alternate sign which must cause some alternate re-arrangements. Whatever the nature of the physical changes, it is clear that the cause of the sudden extension shown at D in curve 1 is wholly absent in curve 2; but the limit of elastic resistance is very much lessened, this being reached near B, the Stromeyer curve ceasing to be straight hereabout. Further, it will be seen from curve 3 for an exactly similar specimen, bent once and straightened and then annealed, that the original conditions are restored; but the specimen shows rather less ultimate strength. These and other experiments described by Mr. Parker show that steel cannot be worked without changes in molecular arrangement and mechanical properties.



GRAPHIC HISTORY OF THREE TEST PIECES OF STEEL.

Contrary to expectations Mr. W. Denny said but little, and that little was, of course, in support of Mr. Ward's paper. Mr. W. H. White stated that the Admiralty intended making experiments on basic steel, and in reply to some remarks concerning the use of steel of higher strength so as to utilise the properties of that metal, he remarked that the Admiralty had made no difficulty about accepting high strength steel if it had high ductility. Mr. E. A. Cowper spoke on the subject generally, and the readers of the papers replied.

A paper was afterwards read by Mr. E. C. Warren, "On the Use of Steel Castings in lieu of Iron Forgings and Brass Castings in Building and Fitting Ships, &c." His paper gave some information on the progress that had been made in the production of heavy and complex steel castings for very various purposes, and the experimental test figures which accompanied the paper showed that excellent results had been obtained. The paper was illustrated with a large number of engravings of steel castings, made to replace wrought iron and to do work which could not possibly be done by or with iron.

There was no discussion on Mr. Warren's paper, but some remarks were made upon it. The numbers of makers of good steel castings in England, it was said, could be counted on one hand. It was agreed that the tests imposed were sometimes unnecessarily severe, and were such as no welded iron forgings would stand. To withstand these tests the steel castings became costly in production. Mr. Hall mentioned that two or three firms, including his own, had been very much pestered by the Admiralty on steel castings, and then when orders were given out they were sent to some makers totally unable to produce what was wanted, and from whom, after six weeks of failures, they had to go to a well-known firm of high repute. In explanation of this strange behaviour on the part of the Admiralty, it was stated by Mr. W. H. White that one department of the Admiralty made the tests and inquiries, and another department gave the orders. Why the order-giving department should act as though the other were not in existence was not explained. One speaker stated that with every wish to obtain his steel castings from English makers he had not been able to do so at less than about 45s. per cwt. for castings at all satisfactory, but had easily obtained clean and good castings from Germany at 33s. per cwt. They were not so strong, and the contraction in area of samples under test was about 6 per cent. less, but this was of no importance.

On Thursday evening the first paper read was by Mr. Richard Sennett. The following is an abstract of the paper, which was on

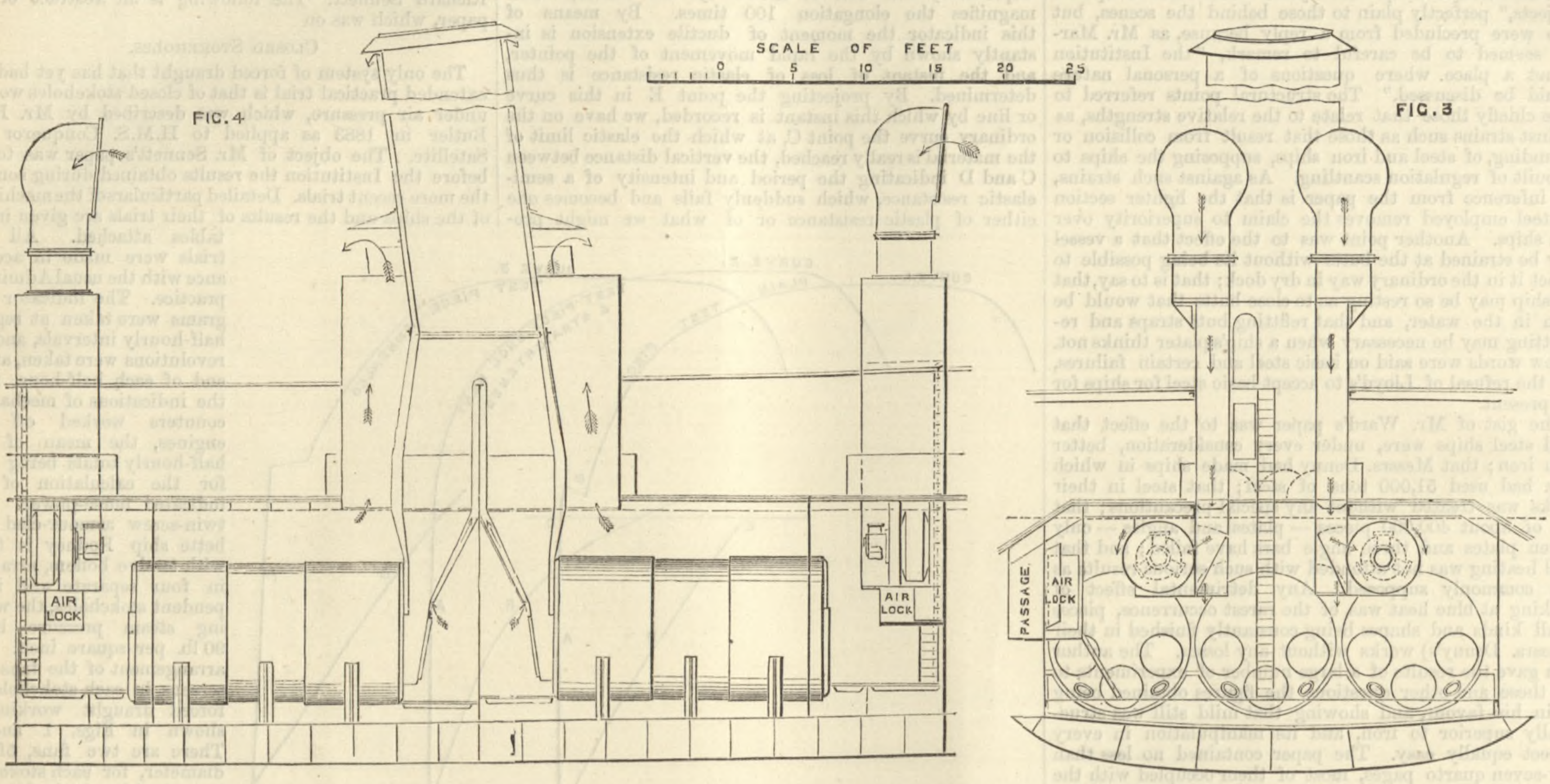
CLOSED STOKEHOLES.

The only system of forced draught that has yet had any extended practical trial is that of closed stokeholes worked under air pressure, which was described by Mr. R. J. Butler in 1883 as applied to H.M.S. Conqueror and Satellite. The object of Mr. Sennett's paper was to lay before the Institution the results obtained during some of the more recent trials. Detailed particulars of the machinery of the ships and the results of their trials are given in the tables attached. All the trials were made in accordance with the usual Admiralty practice. The indicator diagrams were taken at regular half-hourly intervals, and the revolutions were taken, at the end of each half-hour, from the indications of mechanical counters worked off the engines, the mean of the half-hourly totals being used for the calculation of the indicated horse-power. The twin-screw armour-clad barbette ship Rodney is fitted with twelve boilers, arranged in four separate and independent stokeholes, the working steam pressure being 90 lb. per square inch. The arrangement of the fans and screens in each stokehole for forced draught working is shown in Figs. 1 and 2. There are two fans, 5ft. in diameter, for each stokehole, one at either end, fixed on the *débris* deck that forms the air-tight ceiling of the stokehole. The engines of the Rodney are vertical three-cylinder compound, each set having one high and two low-pressure cylinders, the ratio of the volume of the high to that of the two low-pressure cylinders being 1 to 4·05. The proportions of the boilers and engines are such that with natural draught alone an indicated horse-power of from 7500 to 8000 would be developed. A four hours' trial with forced draught was made on the 13th June, 1885, all twelve boilers being used. The mean indicated horse-power developed was 11,158, with an average air pressure in the stokeholes equal to 1·4in. of water. This gives a mean of 14·75 indicated horse power per square foot of fire-grate, and of 18·5 indicated horse-power per ton of boiler, including water, uptakes, fittings, &c. The boiler power was in excess of the capacity of the engines, and a subsequent trial was, therefore, made on the 16th June, 1885, with nine boilers only in use. The air pressure during this trial was gradually raised from 1½in. to 2in. of water, and the average indicated horse-power developed was 9544, which is equal to 16·83 indicated horse-power per square foot of fire-grate. During the last hour of this trial, when the air pressure was kept equal to 2in. of water, the mean indicated horse-power developed was 9760, or 17·2 indicated horse-power per square foot of fire-grate. The boilers generated an ample quantity of steam, the safety valves blowing freely throughout the trial. The forced draught trial of the Howe, a sister-ship to the Rodney, was made on the 14th January, 1886; the maximum indicated horse-power developed was 12,118, and the average for the four hours 11,725, or at the rate of 15·5 indicated horse-power per square foot of fire-grate. The official forced draught steam trial of the fast twin-screw cruiser Mersey was made off the Nore on the 24th September, 1885. The Mersey is fitted with six boilers of the low cylindrical marine type, arranged in two stokeholes, and with natural draught alone would be equal to about 4000 indicated horse-power. The working steam pressure is 110 lb. per square inch. The general features of the stokehole arrangements are shown in Figs. 3 and 4. In the Mersey, the supply to the fans is through air trunks carried direct to the upper deck. Two 5ft. fans are fitted for each stokehole. The engines of the Mersey are horizontal compound, each set having one high and one low-pressure cylinder, the ratio of the high to the low being 1 to 2·84. The average indicated horse-power developed during the trial was 6628, with an air pressure in the stokeholes equal to 2in. of water. This represents 16·61 indicated horse-power per square foot of fire-grate, and 21·7 indicated horse-power per ton of boiler, including water, uptakes, fittings, &c. The results of trial of the torpedo cruiser Scout were practically the same as those of the Mersey. The machinery and boilers are of similar type but smaller. The Scout has four boilers, two in each stokehole, and the working pressure is 120 lb. per square inch. The average indicated horse-power developed on the forced draught trial made at Spithead, on the 23rd September, 1885, was 3370, which is equal to 16·28 indicated horse-power per square foot of fire-grate, and 19·3 indicated horse-power per ton of boiler. In no case yet, on a full power trial, have the boilers been worked to the full extent of their capabilities, and the reserve of power in the fans has kept the steam supply always fully under command. In some trials made by using a portion only of the boilers, so that all the steam generated could be readily utilised by the engines, the results obtained have been higher than those quoted from the full-power trials. Several trials of the machinery of the sloop Caroline were made in the basin at Sheerness in March, 1885, with only one-half of the boilers in use. The results of one of these trials, of six hours' duration, are given in table attached, from which it will be seen that, with an air pressure equal to not more than 1½in. of water, 18 indicated horse-power was developed per square foot of fire-grate. The Caroline is a sister ship to the Satellite, referred to in Mr. Butler's paper, and the particulars and arrangements of the machinery and boilers are practically the same as in that ship. The following table affords a comparison of the performances of similar ships, some with ordinary open stokeholes, and others with closed stokeholes and forced draught:—

	1	2	3	4	5	6	7	8
							I.H.P. per	
	Ship.	Date.	Load on safety valves.	I.H.P.	Weight of boilers.	Area of fire-grate.	sq. ft. of fire-grate.	ton of boiler.
			lb.		tons			
Open Stokeholes	Inflexible	1878	60	8,483	756	829	10·21	11·22
	Colossus	1883	64	7,492	594	645	11·62	12·61
	Phæton	1884	90	5,588	462	546	10·23	12·1
Forced draught.	Howe	1885	90	11,725	632	756	15·54	18·5
	Rodney (9 boilers)...	1885	90	9,544	474	567	16·83	20·1
	Mersey	1885	110	6,628	306	399	16·61	21·7
	Scout	1885	120	3,370	174	207	16·28	19·3
	Trafalgar (estimated)	—	135	12,000	514	609	20·00	23·3

Note.—The weight of boiler given includes weight of water, funrel, uptakes, fittings, spare gear, &c.

In the ships with natural draught only, about 10¼ indicated horse-power was developed per square foot of fire-grate, between 16 and 17 indicated horse-power was obtained with moderate forced draught, the boilers being practically the same in the two cases. The steam blast was used throughout the trial of the Colossus. Grate area can only be used as a fair basis of comparison for boilers similar in design and construction. The indicated horse-power developed per ton weight of boiler is the more important feature, so far as the naval architect is concerned, and we see from column 8 that the effect of the application of forced draught has been to increase the power obtained from a given weight of boilers in the proportion roughly of 20 to 12, the engines and boilers being of practically the same description in both cases. In the Nile and Trafalgar, and other warships now building, triple expansion engines will be fitted, worked with steam of 130 lb. to 140 lb. pressure per square inch. From the experience they had now gained respecting the steam-generating powers of boilers in closed stokeholes kept under moderate air pressure, and the well-known economical employment of steam in triple expansion engines, they are satisfied that on the full power trials of these vessels, at least 20 indicated horse-power per square foot of grate and between 23 and 24 indicated horse-power per ton of boiler will be realised, and this condition has been readily accepted by the engine contractors, who have had experience of the working of the system. The maximum limit of the air pressure allowed on the Admiralty trials was equal to 2in. of water, or about one-thirteenth of a pound per square inch, and the boilers have in no way suffered from the work. It is probable that, with further experience, the pressure may be safely somewhat higher, with a corresponding increase in the steaming powers of the boilers. The closed stokehole system tends to promote economy of fuel, in consequence of the better supply of air and the higher temperatures at which the fires are worked. It is true that on some full power forced draught trials of ships in the Royal Navy the consumption of coal per indicated horse-power has been somewhat in excess of the expenditure required for natural draught alone. This, however, is not due to the method in which the coal is burnt, but simply results from the waste heat that passes up the funnel in consequence of the comparatively small proportion of heating surface to the coal burnt.

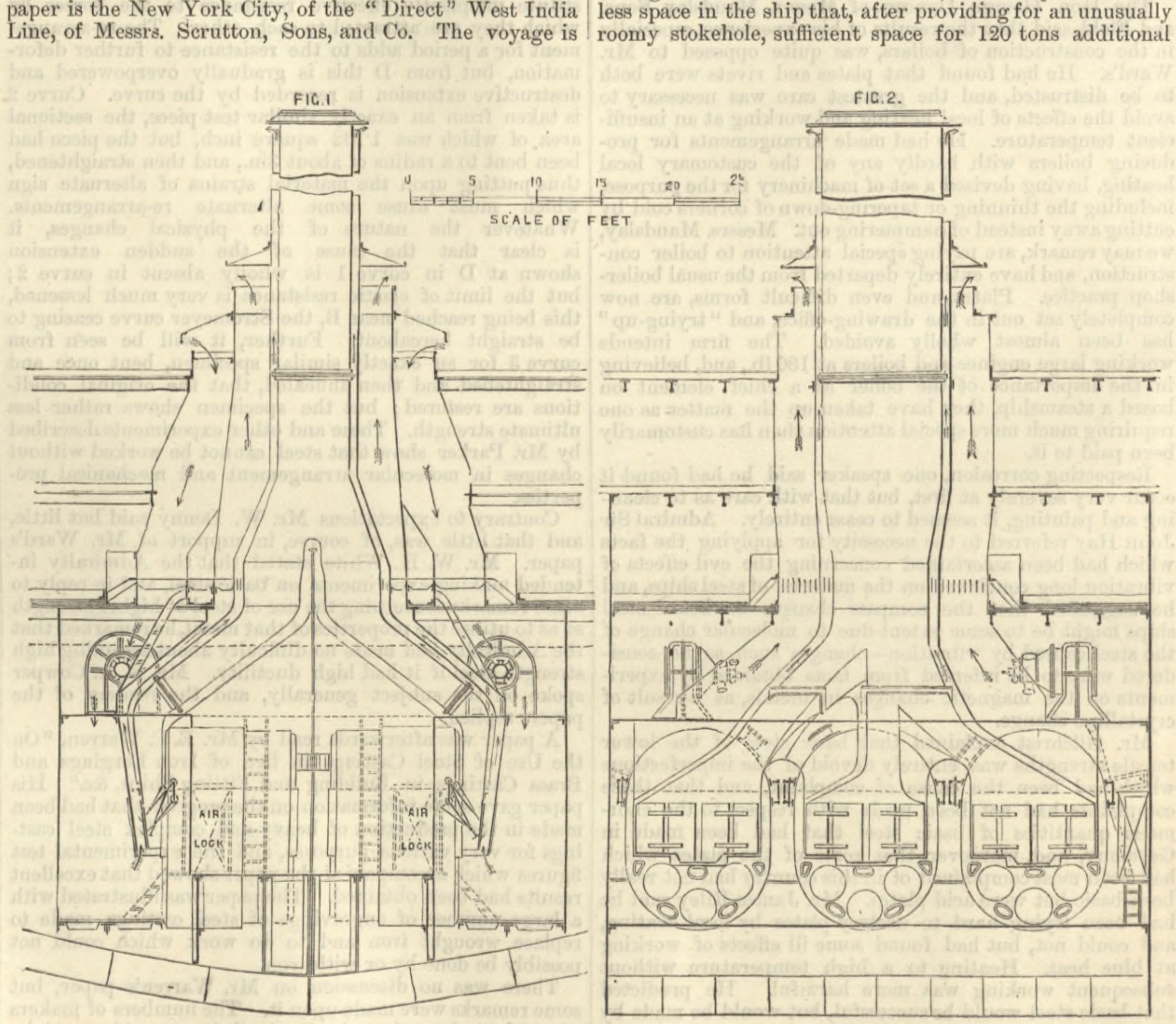


FORCED COMBUSTION ARRANGEMENTS ON BOARD H.M.S. MERSEY.

A paper on the subject by Mr. James Howden was next read. The following is an abstract of the paper, which was entitled, on

Forced Combustion in Furnaces of Steam Boilers.

The ship which chiefly supplies the facts stated in this paper is the New York City, of the "Direct" West India Line, of Messrs. Scrutton, Sons, and Co. The voyage is from London direct to the West India Islands, and through the Archipelago there, extending at intervals to Demerara and Honduras, the round voyage occupying, according to circumstances, from 3 to 4½ months. The opportunities on the voyage for obtaining fresh water for the boiler are so limited that, as a rule, salt water only is used. The boiler I proposed, to replace the one in use, was to be considerably less in size and in furnace and heating surface measurements, and therefore insufficient for natural draught working. The route in which the steamer makes her long voyages is not favoured with repairing shops, failure or injury to the boiler would have meant disaster. The New York City is a steamer built in 1879 on full load lines for large dead-weight carrying, her dimensions being 260ft. × 34½ft. × 22½ft., gross tonnage 1724, and displacement, on full load draught of 20ft., 3700 tons nearly. The engines are ordinary compounds, having cylinders 33in. and 61in. diameter by 33in. stroke, and without an expansion valve on the high-pressure cylinder. The original boiler, though worked as one double-ended boiler with two furnaces at each end, consisted of two separate cylindrical parts, each 12ft. 6in. diameter by 6ft. 4½in. in length with large steam domes. These cylindrical parts were tied together at the distance apart of 4ft. 3in., this space forming a dry combustion chamber, being closed in with an iron casing lined with fire brick. The new boiler, Figs. 1 and 2, supplied to the steamer to work with forced combustion, is single-ended with three furnaces, and occupies so much less space in the ship that, after providing for an unusually roomy stokehole, sufficient space for 120 tons additional coal could have been got in former boiler room. On next page will be found the principal particulars of the two boilers.



FORCED COMBUSTION ARRANGEMENTS ON BOARD H.M.S. RODNEY.

The diameter of the new boiler is somewhat greater than is required for the size of furnaces or number of tubes. The air-heating tubes for each furnace are forty in number, 2ft. 3in. in length, and 3¼in. external diameter, they also being proportioned, so far, in view of the boiler being worked with natural draught. The air space in the fire grates was reduced in width by side pieces to rather less than 2ft. 11in. across, so that each fire grate was, with 4ft. 1½in. length of bars, 12 square feet in area. A twofold

Particulars of New York City Trials.

	Original boiler.	New boiler.
Length without uptake ..	17ft. 0in.	11ft. 0in.
Diameter	12ft. 6in.	14ft. 0in.
Steam domes	two	None.
Number and dia. of furnaces	Four 3ft. 5in.	Three 3ft. 4in.
Number, length, and diameter of tubes	372 - 6ft. 4½in. × 3¼in.	210 - 8ft. 0in. × 3in.
Tube surface	2173 sq. ft.	1319 sq. ft.
Length of fire-bars, over all	5ft. 6in.	4ft. 1½in.
Aggregate fire-grate	75 sq. ft.	36 sq. ft.

object was sought in using these side pieces, one being to prevent the too rapid combustion of the fuel at the sides of the furnaces, and the other to reduce the heat somewhat at a part where the plating is unfavourably placed for throwing off the steam evaporated, being below the centre line of the furnace. The average revolutions of the engines with the natural draught boiler were 56, and the indicated horse-power 564. With the new boiler and forced draught it was found on the first trial that 64 revolutions could be easily maintained with the Scotch coal then used. The indicator on board being out of order no diagrams were then taken, but from diagrams taken on a subsequent voyage, it was found that, with the same load draught, 760 indicated horse-power were required to give 64 revolutions. The steamer put to sea immediately after trial, and made a good run to Trinidad without stoppage. The average revolutions on the voyage were 57, and the consumption 11 tons per 24 hours. The average speed would have been higher but for the formation of clinker, and inexperienced firemen. It was attempted on the voyage to run the fires twelve hours without cleaning, but the Scotch coal, which was of inferior quality, contained too large a proportion of clinker to permit this, and eventually it was found to be necessary to clean fires every six hours to keep them in good working order.

It may be noticed here that with the Welsh coal of fair quality, which has been used in the steamer for the last twelve months, the fires can be kept in good order by cleaning every twelve hours. After more than seven months continuous working, Messrs. Scrutton had a report prepared by their superintendent engineer, Mr. Nicolson, of the results of the working of the new boiler under forced draught up to the date of the report, 11th June, 1885, with a comparison of results from the natural draught boiler under same conditions. In this report the following particulars are given of four voyages made under similar conditions and affording a fair comparison, two being made with the natural draught boiler and two with the forced draught boiler. These are: With natural draught boiler (1) the homeward run from Barbadoes, arriving in London, January 1st, 1882; (2) the outward run from London to Barbadoes, leaving 20th May, 1884. With forced draught boiler (1) the outward run from the Clyde to Trinidad, leaving 13th October, 1884; (2) the homeward run from Barbadoes, arriving in London, 18th May, 1885.

Voyage.		Draught. Aft.	Draught. Forward.	Average Revolutions.	Average I.H.P.	Coal.	Consumption per 24 hours	Weather.
		ft. in	ft. in.				Tons	
1 Homewards	Natural draught	20 3	19 3	56	564	Welsh	13½	Fair
2 Outwards	Natural draught	20 4	18 10	59	Not taken	Ryhope	15	"
1 Outwards	Forced draught	20 4	18 10	57	Not taken	Scotch	11	Fair
2 Homewards	Forced draught	20 3	19 6	60	623	Welsh	9½	Fair, and head wind

Mr. Nicolson's report in regard to (2) voyage with forced draught boiler and Welsh coal, is as follows:—"Comparing this run with (1) voyage of original boiler, also with Welsh coal, it is evident that to have maintained on that voyage 60 revolutions and 623 indicated horse-power with that boiler the consumption could not well have been less than 15 tons per day, so that it appears to be a fair conclusion that the smaller boiler, with this system of forced combustion, has not only maintained a higher power than the larger natural draught boiler, but has at same time reduced the consumption of coal with the same engines from 2·24 lb. to 1·42 lb. per hour, without taking into account the power for working the fan engine, which, being supplied from the boiler, should correctly be added to the indicated horse-power of main engines." On the next voyage out and homewards after the report referred to was made, a still higher result was obtained, as given in the following extract of a letter from Messrs. Scrutton to my firm of 22nd August last:—"The New York City having completed on 7th August another voyage to the West India Islands and back to London, we have pleasure in informing you that the results obtained from your boiler with forced combustion show continued improvement. The average indicated horse-power of the outward and homeward voyages, ascertained by our superintending engineer, is 628, including 6 indicated horse-power for the fan engine. The consumption of Welsh coal has been throughout the voyage 9 tons per 24 hours. The boiler continues in perfect order. The results altogether are most satisfactory." This consumption at sea is at the rate of 1·337 lb. per indicated horse-power per hour, with a rate of combustion giving 17·4 indicated horse-power per square foot of fire-grate. On the last completed voyage a still higher rate of combustion was got by a new engineer, who, without any previous experience in forced draught, ran the engines for some days on the passage to Barbadoes at 62 revolutions, with an indicated horse-power of 706, including fan power, the coal consumption rising to 11 tons per day, this rate of combustion giving 19·6 indicated horse-power per square foot of fire-grate, with a coal consumption 1·454 indicated horse-power per hour, the coal being reported as "small and inferior." In the New York City the recovery of the heat from the escaping gases has not been effected to the extent it could have been, so much having been sacrificed by the adoption of proportions, as already explained, to ensure certain results by chimney draught. That a still higher economy in fuel could be obtained from the boiler of the New York City by utilising a greater proportion of this heat is therefore absolutely certain. The air of combustion in this steamer is heated directly by the waste gases in the heating chamber from 180 deg. to 200 deg. above temperature of stokehole. This is further increased by its passage through the furnace front plate and interior air boxes, which are preserved by the air carrying off their heat into the furnace, which it enters at a temperature probably averaging about 450 deg.

The discussion on these two papers was ably opened by Mr. Jas. Wright, C.B. He remarked upon the reluctance there seemed to be to taking diagrams in the City of New York; but said that, taking the figures given, when the City of New York was burning 9½ tons of coal per day and developing an indicated horse-power of 623, the rate of combustion was only 24½ lb. per square foot of fire-grate per hour. The greatest indicated horse-power said to be developed was 760, and the coal given for this was 11 tons. This gives a rate of 28½ lb. per square foot of fire-grate per hour. In the Navy the ordinary full power rate of combustion in similar boilers with much larger fire-grate, is with natural draught from 21 lb. to 22 lb. of coal per square foot per hour; with the steam jet in use this rate was commonly from 28 lb. to 30 lb., and in the Howe on the recent trial with the stokehole closed it was 34½ lb. But the fire-grate of the City of New York is much smaller than usual in proportion to the heating surface of the boiler. In naval boilers, and in many boilers of merchant ships, the total heating surface per square foot of fire-grate is from 27 to 30 square feet; but in the boiler of the City of New York the total heating surface is forty-two to forty-three times the area of the fire-grate, or about 45 per cent. more than the usual practice, and so the boiler ought to be very economical. Besides, the rate of steaming for the size of the boiler is

TABLE I.—*Particulars of Machinery (Mr. Sennett's paper).*

Particulars.	Inflexible.			Colossus.		Phaeton.	Mersey.	Scout.	Rodney and Howe.	Trafalgar proposed.
Description of Engines	3 cylinder vertical compound.			3 cylinder vertical compound		Horizontal compound.	Horizontal compound	Horizontal compound	3 cylinder vertical compound	Vertical triple expansion
Diameters of cylinders in inches. High pressure...	2 of 70″			2 of 58″		2 of 42″	2 of 38″	2 of 26″	2 of 52″	2 of 43″; 2 intermediate of 62″
Diameters of cylinders in inches. Low pressure ...	4 of 90″			4 of 74″		2 of 78″	2 of 64″	2 of 46″	4 of 74″	2 of 96″
Length of stroke ... ... ft. in.	4′ 0″			3′ 3″		4′ 0″	3′ 3″	2′ 6″	3′ 9″	4′ 3″
Propeller: Description	2 bladed			4 bladed		4 bladed	3 bladed	3 bladed	4 bladed	not yet decided
Propeller: Diameter... ... ... ft. in.	20′ 2½″			17′ 8½″		14′ 0½″	13′ 0″	10′ 6″	15′ 6″	
Propeller: Pitch. ... ... ft. in.	23′ 0½″			18′ 7½″		20′ 1¾″	18′ 5⅞″	12′ 6″	19′ 6″	
Boilers: Number	12			10		8	6	4	12	6
Boilers: Description	Oval 3 furnace	Four each of Oval 2 furnace	Oval Double ended 4 furnace	Eight Oval 3 furnace	Two Oval 2 furnace	Cylindrical high 3 furnace	Low cylindrical 3 furnace	Low cylindrical 3 furnace	Oval 3 furnace	High cylindrical 4 furnace
Boilers: Transverse dimensions	13′ 7″×15′ 6″	11′ 1″×13′ 4″	9′ 4″×14′ 3	12′ 9″×15′ 3″	7′ 10″×14′ 0″	13′ 5″ dia.	10′ 0″ dia.	9′ 3″ dia.	11′ 0″×15′ 0″	16′ 2″ dia.
Boilers: Length	9′ 0″	9′ 0″	17′ 0″	9′ 9″	9′ 9″	9′ 8″	18′ 9″	17′ 10″	9′ 8″	10′ 3″
Load on safety valves... ... ... lbs.	60			64		90	110	120	90	135
Furnaces: Number	36			28		24	18	12	36	24
Furnaces: Diameter	twelve of 3′ 6″	eight of 3′ 3″	sixteen of 3′ 6″	Twenty-four of 3′ 5″	Four of 2′ 10″	18 of 3′ 3″; 6 of 3′ 0″	3′ 2″	2′ 10″	3′ 0″	3′ 7½″
Furnaces: Length	6′ 0″	6′ 0″	6′ 6″	6′ 9″	6′ 9″	7′ 0″	7′ 0″	6′ 0″	7′ 0″	7′ 4″
Furnaces: Grate area in sq. ft. ...	829			645		546	399	207	756	609
Heating surface of boilers in sq. ft. Tubes	18,654			14,747		12,456	10,367	5,500	17,174	17,040
Heating surface of boilers in sq. ft. Total	22,288			17,507		14,562	11,700	6,170	20,294	19,390
Area through tubes in sq. ft.	158			117		87·5	61	32	102	96
Funnels: Number	2			1		2	1	1	2	2
Funnels: Size	Oval 10′ 0″×8′ 0″			Oval 12′ 0″×8′ 0″		8′ 0″ dia.	7′ 2″ dia.	6′ 6″+4′ 9″	9′ 0″×5′ 6″	7′ 0″ dia.
Funnels: Height above fire bars ...	77′ 3″			1		61′ 8″	52′ 6″	55′ 0″	75′ 0″	65′ 0″
Ratios of: Tube heating surface / Grate area	22·5			22·8		23·3	25·9	26·5	22·7	28
Ratios of: Area through tubes / Grate area	·190			·181		·160	·152	·154	·134	·158
Ratios of: Area of funnels / Grate area	·160			·128		·183	·100	·125	·114	·126
Forced draught fans: Number	—			—		—	4	4	8	6
Forced draught fans: Diameter ... ft. in.	—			—		—	5′ 0″	3′ 6″	5′ 0″	5′ 6″

TABLE II.—*Abstract of Steam Trials (Mr. Sennett's paper).*

	Open stokeholes.			Forced draught.					
	Inflexible.	Colossus.	Phaeton.	Mersey.	Scout.	Rodney.	Rodney.	Howe.	Caroline.
Date of trial	Nov. 14, 1878.	Jan. 10, 1884.	Feb. 12, 1884.	Sept. 24, 1885.	Sept. 23, 1885.	June 13, 1885.	June 16, 1885.	Jan. 14, 1886.	March 4, 1885.
Duration of trial in hours.	6	5	5	3	4	4	3	4	6
Number of boilers used ...	12	10	8	6	4	12	9	12	2
Mean steam pressure in boilers ... ... lbs.	61·06	61·52	85·35	107·8	113·09	93·06	92·74	89·21	84·52
Mean air pressure in boiler-rooms, inches of water..	—	—	—	2·02	1·52	1·4	1·89	2·05	1·5
Mean pressure in cylinders in lbs. per square inch. High-pressure ...	29·55	40·66	43·56	56·53	61·42	59·92	49·73	59·51	43·9
Mean pressure in cylinders in lbs. per square inch. Low-pressure ...	9·833	12·09	11·43	22·82	24·31	12·8	12·1	13·43	12·79
Mean revolutions per min.	73·26	89·96	100·26	122·34	152·33	103·42	100·13	106·63	77·8
Mean speed of piston, in feet per min.	586	585	802	795	762	776	751	800	389
Indicated horse-power ...	8483	7492	5588	6628	3370	11,158	9544	11,725	983
Area of fire-grate used in square feet	829	645	546	399	207	756	567	756	54·5
I.H.P. per square foot of fire-grate	10·21	11·62	10·23	16·61	16·28	14·75	16·83	15·51	18·02
Heating surface per I.H.P. in square feet ... Tubes ...	2·20	1·97	2·23	1·56	1·63	1·54	1·35	1·46	1·24
Heating surface per I.H.P. in square feet ... Total ...	2·63	2·33	2·61	1·77	1·83	1·82	1·6	1·73	1·43
Coal used per I.H.P. per hour, in lbs.	2·06	2·55	2·39	2·48	2·6	2·2	—	2·16	2·54
Coal used per hour, in tons	7·80	8·53	5·96	7·33	3·92	11	—	11·30	1·11
Remarks	Blast used last ½ hour only.	Blast used throughout the trial.	Natural draught only.						

NOTE.—The indicated H.P. recorded is that developed by the main engines only, and does not include the I.H.P. expended in working the feed and circulating pumps, blowing fans, and other auxiliary machinery.

really very low, as will be shown by a comparison with the results of recent trials of two ships—the Amphion and the Howe having similar boilers. The cubic capacity of the City of New York's boiler is 1693 cubic feet, of one boiler of the Amphion 1331 cubic feet, and of one boiler of the Howe 1344 cubic feet. The indicated horse-power given in the table on page 315 for the City of New York is 623, the indicated horse-power given by one boiler of the Amphion with natural draught was 706, the indicated horse-power given by one boiler of the Howe with natural draught was 644, and with forced draught 977. The indicated horse-power in each case per cubic foot of boiler is as follows:—City of New York, 0·368; Amphion, with natural draught, 0·53; Howe, with natural draught, 0·479; and Howe, with forced draught, 0·727. That is to say, the Amphion's boiler, with natural draught, gave 44 per cent. more power per cubic foot of boiler than the City of New York's boiler with Mr. Howden's system of forced combustion; the Howe's boiler, with natural draught, gave 30 per cent. more; and the Howe's boiler, forced with the stokehole closed, 97½ per cent. more. Taking, however, the highest indicated horse-power with which the City of New York is credited —760, or at the rate of 0·449 indicated horse-power per cubic foot of boiler, the Amphion's boiler with natural draught gave a higher power by 18 per cent.; the Howe's boiler with natural draught a higher power by 6·7 per cent.; and the Howe's boiler with the stokehole closed a higher power per cubic foot of boiler by 62 per cent.

Mr. Yarrow and Mr. Thornycroft both gave figures from their experience with boilers of the locomotive class in large torpedo boats which greatly exceeded those obtained by Mr. Howden. Mr. Milton remarked that the object of the latter was to gain high economy, while the system adopted by the Navy was intended to gain high evaporation, and to effect his object Mr. Howden had made the parts of his boiler much less accessible than those of the Navy, which really were economical boilers, capable, when necessary, of giving very great evaporation for special purposes, though with less economy. He much doubted the accuracy of the temperature of the air entering the furnace as given by Mr. Howden, for the attendant had told him that the hand could at any time be held on one part, which, according to Mr. Howden, would have air at about 400 deg. in contact with one side of it. He thought that where only one boiler was used a closed ash-pit had some advantages, but where several boilers were used a closed stokehole was much best. Mr. Boyd thought Mr. Howden had obtained some good results, and he knew that economical evaporation had been the result of the use of his arrangement, which, moreover, secured easy control over the rate of combustion.

Mr. F. C. Marshall added most materially to the value of the discussion, and gave the following results of a series of trials with boilers of a modified locomotive type, built for the Italian navy. The table below very clearly explains these trials.

Summary given by Mr. F. C. Marshall of Results of Evaporative Tests with two Boilers of Modified Locomotive Type for Torpedo Chasers.

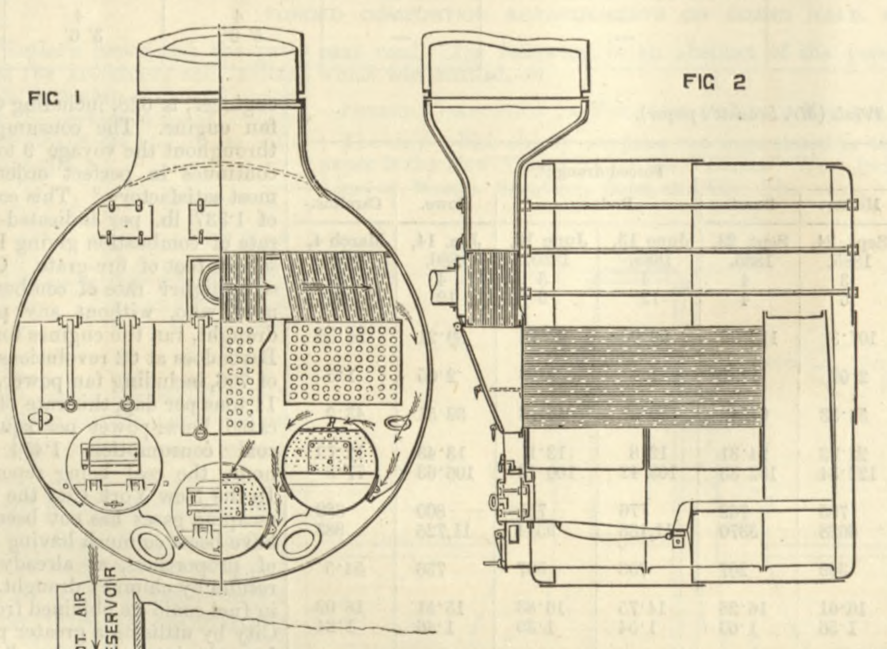
No. of trial.	Date.	Duration of trial.		Surfaces.		Mean steam pressure.	Water.		Water evaporated. From and at 212 deg. per hour.				Coals.				Air pressure.			Revolutions of fans.		Temperature.			
				Heating.	Grate.		Total.	Per hour.	Per hour.	Per lb. of coal.	Per sq. ft. grate.	Per sq. ft. heating surface.	Total.	Per hour.	Per sq. ft. grate.	Sq. ft. of heating surface p. lb. coal	In stokehole.	In ash-pit.	In uptake.	Port.	Starboard.	Stokehole.	Uptake.	Atmosphere.	Feed.
		h.	m.				lbs.	lbs.					lbs.												
1	4th Mar.	1	32	2232	52·5	125·5	44,969	29,336	35,937	6·969	685	16·1	7907	5165	98·3	0·432	3·54	3·13	0·65	1283	1150	75	1150	44	37
2	13 ,,	1	23	2232	52·5	125	44,004	31,809	38,998	6·889	742·8	17·47	7840	5667	107·9	—	3·605	3·446	0·25	877	909	66	1163	37	36
3	18 ,,	1	5	2232	52·5	120	36,264	33,474	40,905	6·566	779·1	18·32	6720	6203	118·1	—	3·07	3·36	0·633	925	1171	77·5	1210	40	39
4	20 ,,	1	41	2232	52·5	116·2	54,900	32,613	39,821	8·566	758·5	17·84	7826	4648·8	88·5	—	2·0	3·706	0·812	769·2	1212	87·6	1200	50	40

Summary of Results of Evaporative Tests (continued).

No. of trial.	Class of coals.	Weather.	Remarks.
1	Cowpen Coal Company's ordinary best steam coals; not hand-picked; rather damp and small	Light westerly wind; dry, but cold	Ordinary fire-bars. No opening through fire doors. Both fans discharging into stokehole.
2	Cowpen Coal Company's ordinary best, as above	Fresh easterly wind; snow falling	Thin fire-bars. $\frac{1}{8}$in. air spaces. No opening through fire doors. Fires thinner. Both fans discharging into stokehole.
3	Cowpen Coal Company's ordinary best, as above	Light easterly wind; dry	Thin fire-bars. $\frac{1}{8}$in. air spaces. One fan on to ash-pit; other to stokehole. Air was getting into fire doors. One boiler steaming.
4	Nixon Navigation; new, dry, and good	Light westerly breeze; fine and dry... ...	Thin fire-bars. $\frac{1}{8}$in. air spaces. One fan on to ash-pit; other to stokehole. No air got through fire doors. One boiler steaming.

In test No. 1, ordinary fire-bars were used, $\frac{5}{8}$in. thick, and $\frac{1}{2}$in. air spaces between the bars being placed as usual, longitudinally in the furnace.
In tests Nos. 2, 3, and 4, thin fire-bars were used, $\frac{7}{16}$in. thick, and barely $\frac{1}{8}$in. air space between. The bars were placed across the furnace.
In tests Nos. 1 and 2, both fans discharged, as usual, into the stokehole.
In tests Nos. 3 and 4, one fan discharged direct, by means of a casing, into the ash-pit, while the other discharged into the stokehole, so as to prevent the flame from issuing from the fire door when fresh coal was being supplied.
With the ordinary fire-bars used in test No. 1, a water trough was required in the ash-pit, as the heat was intense.
With the thin fire-bars used in the other tests, the ash-pit was quite cool, and the edges of these bars, after thirty hours steaming, were quite sharp as from the mould.

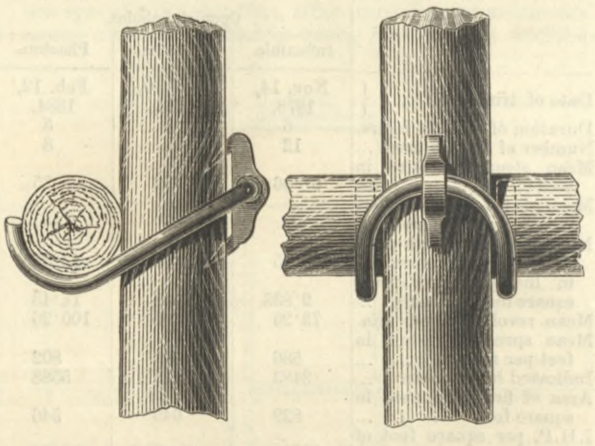
Mr. Marshall also referred to the successful use of the forced draught on board a large vessel using Bulli coal with great economy. Mr. Watson, of the City of Dublin Steam Packet Company, referred to the results obtained with closed stokeholes on the Ireland, which we illustrated and described some time since, and said that with water gauge of from 0·375in. to 0·75in. the power of the engines of the Ireland was about 6000, while with natural draught it was about 5000. Mr. W. Parker thought Mr. Howden had proved that from 30 lb. to 40 lb. of coal could be economically burned per foot of grate per hour, with an air pressure of about 1·25in. below and from 0·25in. to 0·375in. above the grate. He explained the coming down of flues in certain cases referred to as due to the use of Bulli coal, which contained about 50 per cent. of ash, making it necessary to keep the fire doors open and admitting cold air more than twice as often as with good coal. The authors replied to the two discussions, and a paper was then read by Mr. S. Baxter "On Modern Improvements in the Working of Cables and the Stowage of Anchors." This paper described the system of anchor, anchor housings, and hoisting gear described in our impression of the 19th February, 1886. The room had nearly emptied when the two preceding discussions were concluded, and hence there was practically no discussion on Mr. Baxter's paper.



HOWDEN'S CLOSED ASHPIT, FORCED COMBUSTION BOILERS.

KOTTGEN'S STEEL SCAFFOLD CLAMP.

The wear and tear upon the lashings of scaffold poles and the risk to workmen being very great when hemp ropes are used, has led to the proposal of several substitutes, most of which, however, have been prevented from coming into general use by their high price. The accompanying illustrations represent a novelty of that kind which is free from the latter difficulty, the cost being only about half-a-crown. The inclined hook which holds the cross bearer is made of Bessemer steel, and the dog



clamp of best wrought iron. The figures will be sufficient to show that the grip of the cross bearer upon the upright pole is tightened with increase of load upon the former. The advantages claimed for this contrivance, which is made by H. Köttgen and Co., of Bërgisch, Gladbach, in Prussia, are, in addition to increased safety to the building operatives, a saving of time in erecting and striking scaffolding, durability, and the absence of any injurious effect of changes of weather.

Steam Fire-float for the Egyptian Government.—Messrs. Merryweather and Sons, of London, have constructed for the Egyptian Government, for the protection of the Port of Alexandria, a powerful floating steam fire-engine. The public trial of the float took place on Tuesday, April 20th, in the presence of the members of the Metropolitan Board of Works and officers of the Metropolitan Fire Brigade, representatives of the various dock and railway companies, and other authorities. It has double pumps made in one casting, specially designed for rough harbour and dock usage, with large clearway valves which will pump foul and muddy water without fear of stoppage or injury to the parts. The steam cylinders are 9in. diameter, pumps 7in. diameter by 24in. stroke. The suction is taken direct from the sea or river through the side of the boat, and an arrangement is provided on deck for attaching a flexible suction hose for the purpose of pumping out water-logged ships, or filling ships' tanks from fresh water barges. Seven delivery outlets are provided with valves under control of the engineer. This fire-engine discharges at a maximum 1100 to 1200 gallons of water per minute, and will work one massive stream 280ft. from a 1$\frac{3}{4}$in. or 2in. jet. The six jets from the deck are each $\frac{3}{4}$in. and 1in. diameter, and they are discharged to a height of 140ft. A series of tests took place. At the first trial the deliveries were merged into one line of hose of large size, a 2in. jet being used, and the stream being very powerful and compact. Further trials then followed, two, three, four, and six jets being used simultaneously. Messrs. Merryweather and Sons also exhibited one of their new pattern double-cylinder land steam fire-engines, "Greenwich" pattern, which has also been adopted by the Manchester Corporation, for whom two engines are in construction, each capable of delivering 750 gallons per minute.

CLARKE'S SIGNAL WIRE COMPENSATOR.

MESSRS. PEARN AND CO., MANCHESTER, ENGINEERS.

Fig. 1

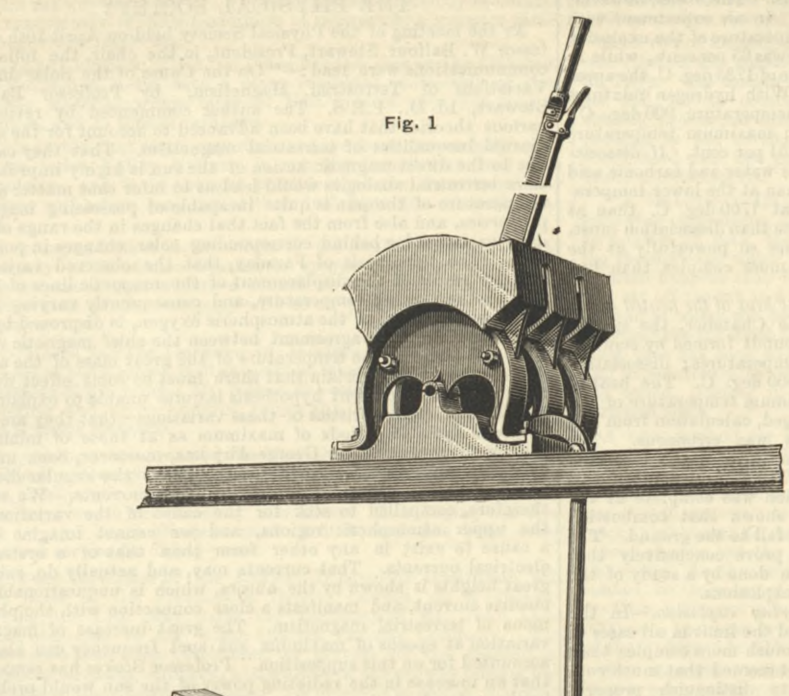
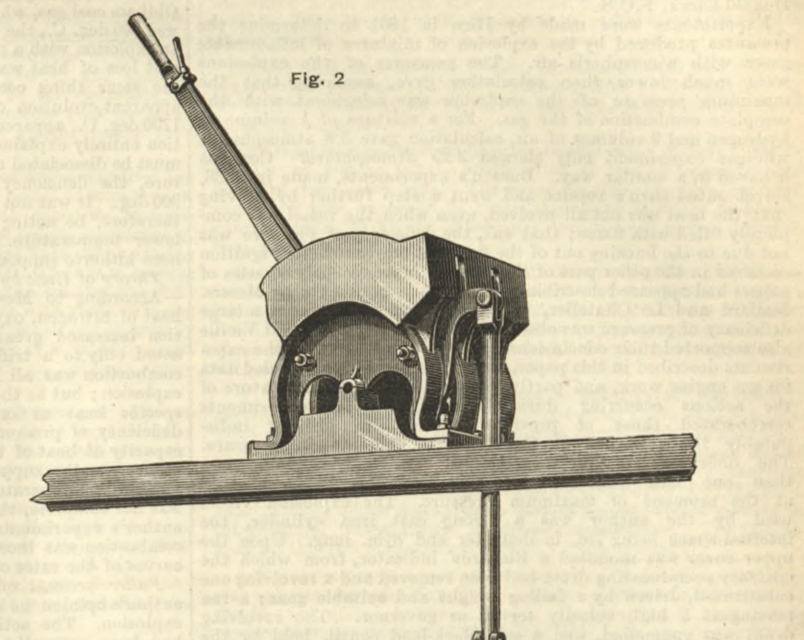


Fig. 2



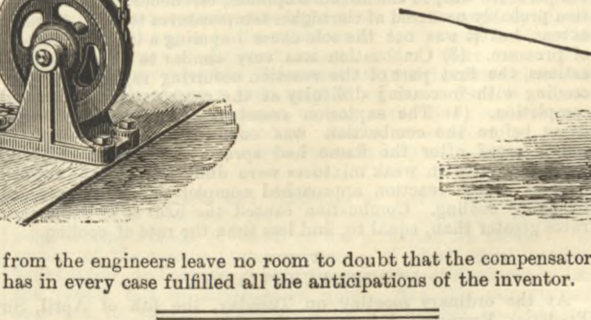
CLARKE'S SIGNAL WIRE COMPENSATOR.

THE accompanying engravings illustrate a signal wire compensator, patented by Mr. Clarke, of West Gorton, Manchester, and manufactured by Messrs. Frank Pearn and Co., of the same place. The object of the invention is to keep railway signal wires always tight. The action of the apparatus is very simple. A chain is attached to the end of the signal wire, and passes over a plain grooved pulley, and then over combined V and chain pulley, sufficient weight being attached to the end of the chain to keep the wire always in a perfect state of tension. A pawl is fixed in such a position that when the signal stands at danger it is held out of the V groove in the combined pulley by an adjustable stop piece, thus leaving the combined pulley free to rotate in either direction, the wire thus being perfectly free to contract or expand, according to the variations of the temperature, and still be kept rigidly tight by the weight on the end of the chain. Fig. 1 represents the compensator in this position. When the signalman moves his lever to pull the signal off, the compensator is thereby changed to the position shown in Fig. 2. Simultaneously with the first movement in pulling the lever over the pawl falls into gear, locking the combined V and chain pulley, and thus gripping the chain, gives a corresponding pull on the wire, transmitting the same to the signal. When the signal is thrown off the compensator returns to its original position, as shown in Fig. 1, and the pawl is automatically thrown out of gear by the stop piece, again leaving the wire free to move according to the atmospheric changes as already mentioned. From the foregoing it will readily be seen that whatever movement may be made in the lever at the signal-box, it is impossible for any doubt to arise as to the signal shown, and we may note that as the apparatus is fixed underneath the signal-box, it is practically within observation and immediate supervision. This is of immense importance, as the compensator is so arranged that the weight on the fulcrum can be adjusted to any pull required. Briefly summed up, the claims set forth by the inventor and attested by daily experience are—perfect automatic compensation, with instantaneous action; a minimum number of working parts, thoroughly simple in construction and arrangement; universally applicable to all lengths and descriptions of wires; absolute impossibility of pulling over the lever without the chain pulling off the signal; the extreme facility with which it can be adapted to all existing wires.

The compensator is in use on the Midland, the Great Northern of Ireland, the Cheshire Lines, the Furness Railways, the North Staffordshire and the Highland Railways, and autograph letters from the engineers leave no room to doubt that the compensator has in every case fulfilled all the anticipations of the inventor.

BATES' EQUILIBRIUM SLIDE VALVE.

THE accompanying illustrations show a balanced slide valve manufactured by Messrs. G. H. Taylor and Brother, Love-street, Sheffield. It will be seen that the valve is of that type in which a mobile relief plate is applied to the back of the main slide, the relief plate being allowed a certain small range of movement by the elasticity of a thin metallic plate fitted as shown. The relief plate is set up against the back of the main slide by the set screws and springs shown. The four small nuts shown in the perspective view are for the purpose of preventing the relief valve tightening on the back of the slide. This valve has, we are informed, been in successful work for some time in several engines.



RAILWAYS IN BRAZIL.

THE following statement (taken from the *Schweizerische Bauzeitung*) represents the development of the Brazilian lines to the end of last year. From the extreme diversity in the width of gauge adopted it is evident that long line travelling in through coaches is not likely to be adopted for some time to come in the great Empire of the South.:—

Width of gauge. ft. in.	Length of lines open on Dec. 31st. 1884. Miles.	1885. Miles.
5 3	842·0	842
4 8¾	0·0	6·2
4 7	7·5	7·5
3 11	11·8	11·8
3 7⅓	207·5	210·6
3 3⅓	2548·0	2986·0
3 1½	118·1	96·3*
2 6	61·5	61·5
2 0	3·7	4·4
Total	3800·1	4226 3

From these figures, which represent rather more than thirty years' development, the earliest line, Principe do Grao, Para, having been opened in April, 1854, it appears that the 39in. (metre) gauge is the most popular, as it is adopted for more than two-thirds of the whole length of lines, and practically for the whole of the extensions made during the year 1885. In the length of 2986 miles are included two rack and pinion lines on Riggenbach's system, namely, the Corcovado line of 2·36 miles, and 3¾ miles on the mountain section of the Principe do Grao and Para line. On the Santos and Jundiahy line the crossing of the Serra do Mar, or coast range, is effected by a system of inclined planes, worked by stationery engines, of a total length of about five miles. The Fell centre rail system has been used on a length of about eight miles of the Cantogallo line. With the exception of fourteen miles of the Don Pedro II. line, ll the roads have only a single line of way. The entire network is divided into fifty-six different undertakings as follows:—Seven Imperial Government lines, having a total length of 884 miles; two provincial lines, having a total length of 152 miles; forty-seven private lines, having a total length of 3190 miles. The total number of stations, including stopping places of all kinds, is 608; and the rolling stock includes 630 locomotives, 1006 passenger coaches, and 7232 baggage and goods wagons.

THE revenue of the Tees Conservancy Commissioners is, like revenues of all kinds, beginning to feel severely the effect of the general slackness of trade. The total receipts for March, 1886, amounted only to £3925 18s. 11d., which is less than the receipts for March, 1885, by £251 11s.

* This diminution is probably due to a conversion of twenty-two mile to another gauge.

THE INSTITUTION OF CIVIL ENGINEERS.

ON THE EXPLOSION OF HOMOGENEOUS GASEOUS MIXTURES.

At the ordinary meeting on Tuesday, the 9th of March, Mr. Edward Woods, vice-president, in the chair, the paper read was on "The Explosion of Homogeneous Gaseous Mixtures," by Mr. Dugald Clerk, F.C.S.

Experiments were made by Hirn in 1861 to determine the pressures produced by the explosion of mixtures of inflammable gases with atmospheric air. The pressures of the explosions were much lower than calculation gave, assuming that the maximum pressure of the explosion was coincident with the complete combustion of the gas. For a mixture of 1 volume of hydrogen and 9 volumes of air, calculation gave 5·8 atmospheres, whereas experiment only showed 3·25 atmospheres. Coal-gas behaved in a similar way. Bunsen's experiments, made in 1866, corroborated Hirn's results, and went a step further by proving that the heat was not all evolved, even when the vessel was completely filled with flame; that was, the deficiency of pressure was not due to the burning out of the flame at one part before ignition occurred in the other part of the vessel. More recently a series of papers had appeared describing numerous experiments by Messrs. Mallard and Le Chatelier, in all of which experiments a large deficiency of pressure was observed. Messrs. Berthelot and Vieille also supported their conclusions. The author had made the experiments described in this paper, partly to obtain much needed data for gas engine work, and partly to study more fully the nature of the actions occurring during explosion. His experiments corroborated those of previous workers, in proving indisputably the existence of the limit to increase in pressure. The deficiency in pressure being very great, seldom more than one-half the heat of the explosion being evolved at the moment of maximum pressure. The explosion vessel used by the author was a strong cast iron cylinder, the internal space being 7in. in diameter and 8½in. long. Upon the upper cover was mounted a Richards' indicator, from which the ordinary reciprocating drum had been removed and a revolving one substituted, driven by a falling weight and suitable gear; a fan moving at a high velocity served as governor. The revolving drum was enamelled, and a soft black-lead pencil, held by the indicator motion, marked upon it a line caused by the movement of the indicator piston. A pair of insulated points projected through a plug in the bottom cover and served to ignite the mixture when a spark from a coil and battery was passed between them. The line traced on the drum by the indicator showed the amount of rise in pressure, and the times of rise and fall in terms of revolution of the drum. The tracing was precisely analogous to the indicated diagram from an engine. The rising line was due to the explosion, the falling line was due to the cooling action of the cold walls upon the hot gases. The tracing was in fact a record of the rapidity, intensity, and duration of an explosion. Careful tracings were made, which were reproduced. Tables were given of the results obtained from various mixtures of air with Glasgow coal-gas, Oldham coal-gas, and pure hydrogen.

GLASGOW COAL GAS AND AIR MIXTURES.

Temperature of Gas before ignition, 18 *deg. Cent.; pressure, atmospheric*, 14·7 *lb.*

Experiment.	Proportion of gas by volume.	Mean pressure.	Max. temp. Cent.	Time of explosion.
			Degs.	Secs.
a	1	52 lb. per square inch above atmosphere	1047	0·28
b	$\frac{1}{12}$	63 ,, ,, ,,	1265	0·18
c	$\frac{1}{10}$	69 ,, ,, ,,	1384	0·13
d	$\frac{1}{8}$	89 ,, ,, ,,	1780	0·07
e	$\frac{1}{6}$	96 ,, ,, ,,	1918	0·05

OLDHAM COAL-GAS AND AIR MIXTURES.

Average Temperature of Gases before ignition, taken as 17 *deg. C., pressure, atmospheric* (14·7 *lb.*)

Experiment.	Proportion of gas by volume.	Maximum pressure.	Max. temp. Centigrade.	Time of explosion.
			Degs.	Second.
a	$\frac{1}{15}$	40·0 lb. per square inch above atmosphere	806	0·45
b	$\frac{1}{14}$	51·5 ,, ,, ,, ,,	1033	0·31
c	$\frac{1}{13}$	60·0 ,, ,, ,, ,,	1·02	0·24
d	$\frac{1}{12}$	61·0 ,, ,, ,, ,,	1220	0·17
e	$\frac{1}{10}$	78·0 ,, ,, ,, ,,	1557	0·08
f	$\frac{1}{8}$	87·0 ,, ,, ,, ,,	1733	0·05
g	$\frac{1}{7}$	90·0 ,, ,, ,, ,,	1792	0·04
h	$\frac{1}{6}$	91·0 ,, ,, ,, ,,	1812	0·055
i	$\frac{1}{5}$	80·0 ,, ,, ,, ,,	1595	0·16

HYDROGEN AND AIR MIXTURES.

Temperature of Gases before ignition, 16 *deg. C., pressure atmospheric* 14·7 *lb.*

Experiment.	Proportion of hydrogen by volume.	Maximum presssure.	Max. temp. Centigrade.	Time of explosion.
			Degs.	Second.
a	$\frac{1}{7}$	41 lb. per square inch above atmosphere	826 to 909	0·15
b	$\frac{1}{5}$	68 ,, ,, ,, ,, ,,	1358 ,, 1539	0·026
c	$\frac{2}{7}$	80 ,, ,, ,, ,, ,,	1615 ,, 1929	0·01

From these experiments the relative value of the different mixtures of gases for producing power might be calculated. In Glasgow gas, the most economical mixture for non-compressive engines was 1 volume of gas to 11 volumes of air; Oldham gas, 1 volume of gas to 12 volumes of air. Comparing Glasgow gas and Oldham gas, the pressure of explosion of the former was longer sustained than that of the latter, and the pressures produced for a given volume were equally good; therefore, more power was obtained from a cubic foot in Glasgow than in Oldham. Pure hydrogen, which was very commonly thought to be the best, was shown to be the poorest. An engine which would indicate 10-horse power with coal gas would not indicate more than 3·7-horse power with pure hydrogen. The author's results were in complete accord with those of previous experimenters on the question of the existence of a limit; in no case did the heat accounted for by the explosion pressure amount to more than 77 per cent. of the total heat present as inflammable gas; in the majority of cases it was little over 50 per cent. In the author's opinion, no single theory previously stated accounted for all the phenomena of these explosion curves. Although all experimenters were agreed upon the fact of the deficiency of pressure, they differed upon the causes producing this result. Three theories had been propounded:—

Theory of limit by cooling.—This was Hirn's theory. It supposed that when explosion occurred a point was attained when the cooling effect of the enclosing walls was so great that heat was abstracted more rapidly than it was evolved, and accordingly the combustion, although continuing, did not proceed with sufficient rapidity to prevent fall of pressure.

Theory of limit by dissociation.—This was Bunsen's theory, and was undoubtedly very largely true. The fact that no unlimited temperature could be attained by combustion was so conclusively established, both by science and by practice, that gradual combustion from that cause might be safely taken as occurring at the higher temperature of gas engine explosions. There was, however, a difficulty in applying it to all cases. In an experiment with Oldham coal gas, when the maximum temperature of the explosion was 806 deg. C., the apparent loss of heat was 65 per cent., while in an explosion with a maximum temperature of 1733 deg. C. the apparent loss of heat was only 38 per cent. With hydrogen mixtures the same thing occurred:—Maximum temperature 900 deg. C., apparent evolution of heat 55 per cent.; maximum temperature 1700 deg. C., apparent evolution of heat 54 per cent. If dissociation entirely explained the limit, then, as water and carbonic acid must be dissociated more at the higher than at the lower temperature, the deficiency should be greater at 1700 deg. C. than at 900 deg. It was not so. Some other cause than dissociation must, therefore, be acting to check the increase so powerfully at the lower temperature. The problem was more complex than had been hitherto supposed.

Theory of limit by the increasing specific heat of the heated gases.—According to Messrs. Mallard and Le Chatelier, the specific heat of nitrogen, oxygen, and the compounds formed by combustion increased greatly at the higher temperatures; dissociation acted only to a trifling extent below 1800 deg. C. The heat of combustion was all evolved at the maximum temperature of the explosion; but as the specific heat changed, calculation from the specific heat at ordinary temperatures was erroneous. The deficiency of pressure was therefore a measure of the increased capacity of heat of the reacting gases. The crucial point of this theory was the supposition that combustion was complete at the maximum temperatures; if it could be shown that combustion was not complete, then the whole theory fell to the ground. The author's experiments seemed to him to prove conclusively that combustion was incomplete; this has been done by a study of the curves of the rates of cooling of various explosions.

Fuller account of the phenomena during explosion.—In the author's opinion no single cause explained the limit in all cases of explosion. The actions operating were much more complex than had been generally supposed. To him it seemed that much confusion had arisen through neglecting to distinguish properly between two distinct and separate phenomena which occurred during explosion. These phenomena were the inflammation or filling of the explosion vessel with flame, and the completion of the burning which was so originated. The explosion curves with coal gas showed some extraordinary features; in many cases an actual check seemed to occur in the rising curve, lasting for some time, followed by an increase of pressure, but at a slower rate than before the check. It was noticeable that the strongest mixtures showed it most distinctly. The hydrogen curves exhibited no such check. It seemed, then, that not only might combustion be incomplete when the vessel was filled entirely with flame, but the pressure at that time might not have attained its maximum, and might continue to increase rapidly after that point. Why did the pressure again increase after the pause in the explosion curve? The author suggested what he considered a sufficient explanation. In an ordinary fire grate, a flame communicated to the coal at one point gradually spread till the whole was incandescent. The solid coal might be every part of it burning, and yet a further accession of air would cause it to glow more brightly—that was to increase in temperature. Explosions have often occurred in flour mills and in coal mines from the diffusion, throughout the air, of minute combustible particles of flour and of coal dust. If present in suitable quantity a flame applied at one part caused an explosion. It by no means followed, however, that complete inflammation coincided with maximum pressure; the pressure might still increase. In coal gas explosions the flame had filled the vessel before any check occurred, and then the hydrocarbons decomposed, causing a pause, which gave way to increase when the hydrogen and carbon so liberated combined with the free oxygen. In all chemical combinations dilution caused slowness of action, and dilution during a reaction by the products formed made the last part of the action slower than the first.

Conclusions.—(1) Messrs. Mallard and Le Chatelier's theory of increased specific heat of the gases—nitrogen and oxygen—at high temperature was, in the author's opinion, erroneous. (2) Dissociation probably occurred at the higher temperatures to a considerable extent, but it was not the sole cause imposing a limit to increase of pressure. (3) Combustion was very similar to other chemical actions, the first part of the reaction occurring rapidly, and proceeding with increasing difficulty as the combination approached completion. (4) The explosion vessel was entirely filled with flame before the combustion was complete. (5) The limiting causes acted after the flame had spread completely. (6) The limiting causes in weak mixtures were diminution in the rate of burning as the reaction approached completion, and consequent limits by cooling. Combustion caused the heat to be evolved at rates greater than, equal to, and less than the rate of cooling.

WATER PURIFICATION.

At the ordinary meeting on Tuesday, the 6th of April, Sir Frederick Bramwell, F.R.S., in the chair, the paper read was on "Water Purification: Its Biological and Chemical Basis," by Percy F. Frankland, Ph.D., B.Sc., F.C.S. The earliest attempts to purify water dealt simply with the removal of visible suspended particles, but later, chemists turned their attention to the matters present in solution in water. Since the advance of the germ theory of disease, and the known fact that living organisms were the cause of some, and probably of all, zymotic diseases, the demand for a test which should recognise the absence or presence of micro-organisms in water had become imperative. It was, however, only during the last few years that any such test had been set forth, and this was owing to Dr. Koch, of Berlin. By this means the only great step which had been made since the last Rivers Pollution Commission had been achieved. It had been supposed that most filtering materials offered little or no barrier to micro-organisms; but it was now known that many substances had this power to a greater or less degree. It had also been found that, in order to continue their efficiency, frequent renewal of the filtering material was necessary. Vegetable carbon employed in the form of charcoal or coke was found to occupy a high place as a biological filter, although previously, owing to its chemical inactivity, it had been disregarded. Being an inexpensive material and easily renewed it was destined to be of great service in the purification of water. Experiments were also made by the agitation of water with solid particles. It was found that very porous substances like coke, animal and vegetable charcoal, were highly efficient in removing organised matter from water when the latter came in contact with them in this manner. Also, it was found that the well known precipitation process, introduced by Dr. Clark, for softening water with lime, had a most marked effect in removing micro-organisms from water. In the case of water softened by this process, it was found that a reduction of 98 per cent. in the number of micro-organisms was effected, the chemical improvement being comparatively insignificant. Water which had been subjected to an exhaustive process of natural filtration had been found to be almost free from micro-organisms. Thus the deep well water obtained from the chalk near London contained as few as eight organisms per cubic centimetre, whereas samples of river water from the Thames, Lea, and Wey had been known to contain as many thousands. The water supplied to London had been regularly tested during the last fifteen months, and most important and valuable information had been obtained as to the efficiency of the processes to which the water companies subjected the water supplied by them in removing micro-organisms, the average reduction during the last four months of the past year having been 97·9 per cent. for the Thames and 93·7 per cent. for the Lea. The biological testing of waters was of especial value to waterworks engineers, for they now had a means of ascertaining with exactitude the working condition of filter beds, instead of following the empirical methods generally in use.

THE PHYSICAL SOCIETY.

At the meeting of the Physical Society held on April 10th, Professor W. Balfour Stewart, President, in the chair, the following communications were read:—"On the Cause of the Solar-diurnal Variations of Terrestrial Magnetism," by Professor Balfour Stewart, LL.D., F.R.S. The author commenced by reviewing various theories that have been advanced to account for the solar-diurnal inequalities of terrestrial magnetism. That they can be due to the direct magnetic action of the sun is highly improbable, since terrestrial analogies would lead us to infer that matter at the temperature of the sun is quite incapable of possessing magnetic properties, and also from the fact that changes in the range of the daily variation lag behind corresponding solar changes in point of time. The hypothesis of Faraday, that the observed variations are the result of the displacement of the magnetic lines of force due to the varying temperature, and consequently varying magnetic permeability, of the atmospheric oxygen, is disproved by the fact that there is no agreement between the chief magnetic variations and those of the temperature of the great mass of the atmosphere, though it is certain that there must be some effect due to this. The earth-current hypothesis is quite unable to explain one of the chief characteristics of these variations—that they are half as great again at periods of maximum as at those of minimum sun-spot frequency. Sir George Airy has, moreover, been unable to detect any resemblance in form between the regular diurnal progress at the magnet and that of earth currents. We seem, therefore, compelled to seek for the cause of the variations in the upper atmospheric regions, and we cannot imagine such a cause to exist in any other form than that of a system of electrical currents. That currents may, and actually do, exist at great heights is shown by the aurora, which is unquestionably an electric current, and manifests a close connection with the phenomena of terrestrial magnetism. The great increase of magnetic variation at epochs of maximum sun spot frequency can also be accounted for on this supposition. Professor Stokes has remarked that an increase in the radiating power of the sun would probably imply, not only an increase in general radiation, but a special and predominant increase in such actinic rays as are probably absorbed in the upper regions of the earth's atmosphere. These regions will, therefore, greedily absorb the new rays, their temperature will rise, and, as is known to be the case for gases, the electrical conductivity will be increased. Thus, even if we imagine the general atmospheric current to remain constant, a greater proportion of it would be thrown at such times into those heated portions which had become good conductors, but it is also probable that the current itself would be increased. Assuming the existence of currents at great altitudes, the regularity and general characteristics of the diurnal variations would seem to point to a direct magnetic action of the currents, rather than to any general induced change in the magnetic system of the earth, which to produce the observed results would have to be of a very artificial character. The diurnal variation of the declination attaining a westerly maximum at 2 p.m. north of the equator, and an easterly maximum at the same time south of it, would suggest the existence of currents flowing northward and southward from the equator to the poles, attaining a maximum in each hemisphere about two hours after the sun had passed the meridian. To supply this flow we should probably have to assume the existence of vertical currents ascending from the equatorial regions of the earth. At this point Dr. Schuster has endeavoured to apply mathematical analysis to the subject. From the recorded observations at Greenwich, Lisbon, Hobarton, St. Helena, and the Cape he has shown that the work done by a magnetic pole describing a closed path in a horizontal plane at those places is equal to the work done upon it, and consequently no part of the ascending current can be enclosed by the path. Hence the potential at those places obeys the law expressed by the equation

$$\frac{d^2 v}{d x^2} + \frac{d^2 v}{d y^2} + \frac{d^2 v}{d z^2} = o.$$

From this Dr. Schuster has deduced two possible expressions for the potential, one referring to a system of currents above our heads, and the other to one beneath our feet. From the first of these expressions it follows that for latitudes greater than 45 deg. the maximum of horizontal force should coincide with the minimum of vertical force, and *vice versâ*, and this is actually the case at Greenwich, while the opposite should hold if the influencing system were beneath us. For latitudes below 45 deg. the reverse of the above should be the case, and the observations at Bombay, though less decided than those at Greenwich, would seem to point the same way. On the whole, then, it must be said that the results of the first attempt are very encouraging, and point to the supposition that the greater part of the disturbing cause lies outside the earth's surface.

In a discussion that followed, Mr. Whipple remarked that recent observations in high latitudes seem to show that the aurora is not always at such a great height as is usually supposed. Professor A. W. Rücker cited the well-known case when an observer saw what appeared to be a meteor fall into the sun, while simultaneously, or nearly so, there was recorded a magnetic disturbance on the earth, as showing a direct solar action. Mr. Whipple, however, stated that he had recently examined this point, and believed that the very slight notch in the record, many similar to which have occurred since, was of an accidental nature, and a mere coincidence. Professor McLeod suggested that the earth current theory might be tested by observations at the bottom of a mine, where, according to the theory, the disturbances should be reversed. Professor Adams believed that there was nothing physically impossible in the existence of such currents as the author imagined.

"On a Relation between the Critical Temperatures of Bodies and their Thermal Expansions as Liquids," by Professor A. W. Rücker, F.R.S., and Professor T. E. Thorpe, Ph.D., F.R.S. A paper by the authors, bearing the above title, was published in the *Journal of the Chemical Society* of London, for April, 1884. The substance of the paper was as follows:—Professor Mendelejeff has shown that the expansion of liquids under constant pressure between 0 deg. Cent. and their boiling points may be expressed by means of the very simple formula—

$$V_t = \frac{1}{1 - kt}$$

V_t being the volume at t deg. Cent.—that at 0 deg. Cent. being unity—and k a quantity which differs for different substances, but which may for any one substance be considered invariable between 0 deg. Cent. and the neighbourhood of the boiling point. From this law the authors have obtained, as a deduction, the following expression for the critical temperature (T_c) of any liquid—

$$T_c = \frac{T V_t - 273}{a (V_t - 1)}$$

where V_t is the volume at t deg. Cent., T the absolute temperature, and a a quantity which is very nearly constant for all substances, and which was shown to be very nearly 2.

In a recent paper (*Ann. Ch. Ph.*, March, 1886), MM. A. Bartoli and E. Stracciati have discussed both of these formulæ, and have applied them to cases in a manner never intended by the authors. They have expanded Mendelejeff's formula into the series—

$$V_t = 1 + kt + k^2 t^2 + k^3 t^3 \ldots \ldots$$

which is a geometrical progression; and they have objected to it that the results of Pierre, Kopp, Hirn, Thorpe, &c., do not give for the coefficient of t, t^2, t^3 quantities in geometrical progression. The results of these observers are given in the usual form—

$$V_t = 1 + at + bt^2 + ct^3 + \ldots \ldots$$

but owing to unavoidable errors of experiment, the constants c, d, e of different observers differ very largely, and Mendelejeff's simple expression gives the results of all quite as accurately as the facts will allow.

RAILWAY MATTERS.

THE tender of Messrs. W. J. Bunt and Co., of Sydney, for the second section of the Cooktown Railway, Queensland, has been accepted at £52,966.

THE railway servants of Western Australia recently celebrated the anniversary of the introduction of railways by a monster picnic and sports at Bayswater.

A LARGE steamer called the Clare left the Tees on the 18th inst. for Kurrachee, India, with a cargo composed exclusively of steel railway material, which included 1225 tons of rails, 748 tons of sleepers, and 23 tons of rail keys.

IT is stated that some experiments have been successfully made on the Indus Valley Railway in running locomotives fired with petroleum, and it is thought possible that the frontier railway engines will before long derive their fuel from the oil wells near Sibi.

THE large addition to the offices of the South-Western Railway Company at Waterloo Station is approaching completion, and it is expected that within a month or two from this date the clerical staff of the company will be in possession of their new quarters.

ON March 2nd the Governor of Western Australia turned the first sod of the Midland Railway, which, when constructed, will cover a distance of 280 miles. Mr. Keane, the contractor, entertained the Governor and three hundred guests at a banquet. The contract sum is about £900,000.

AN old locomotive named the Muckalee, on the South-Western Railroad of Georgia Railway, U.S., will be, the *Railroad Gazette* says, finally retired when the change of gauge occurs, not being considered worth the necessary alterations. This engine was first put on the South-Western road in 1856, and has been doing constant service for thirty years.

THE annual dinner of the Railway Benevolent Institution will take place at the Freemasons' Tavern, London, on Wednesday evening, the 12th May, under the presidency of Mr. John Dent Dent, chairman of the North-Eastern Railway Company. The Institution has been established to provide for the necessitous members, orphans, children, and widows of the railway officers and servants in the United Kingdom. Its object is to clothe, maintain and educate orphan children, and to grant relief by annuities and money allowances to members who, from old age, disease, or accident, may be unable any longer to obtain a livelihood, and to the widows of those who may be left in distressed circumstances. We understand that a special fund in connection with Mr. Dent's presidency is being raised, and that it has been arranged that subscriptions may be addressed to Mr. Dent at the company's office, York.

THE Société Impériale Polytechnique de Russie has issued a circular stating that on the 27th inst. the Society will celebrate by a *fête* and congress the fiftieth anniversary of the promulgation of the Imperial Ukase decreeing the construction of the first railway in Russia, that from St. Petersburg to Tsarskoé Sélo. This Imperial Ukase marks the commencement of the cordial relations which have ever since subsisted between the railway engineers of Russia and other parts of Europe, and engineers are invited to take part in the proceedings of the 27th inst. (Russian date 15th April). The programme of the Society for the day includes (1) discourses of the President of the General Assembly and of the President of the Railway Section of the Society; (2) report of M. N. A. Sytenko on the History of the Foundation of Railways in Russia; (3) report of M. V. J. Troïtsky on the History of the Construction of the Tsarskoé Sélo Railway. Papers referring to the several subjects and reprints of early decrees and documents will be distributed.

THE lack of direct railway communication to Constantinople is every day felt as an increasing grievance, not only in the North Balkan States, but in Central and Western Europe generally. Amongst other regrettable consequences of the late revolution in Eastern Roumelia and the Servo-Bulgarian War is the fact that through those events the Bulgarian authorities have been prevented from proceeding to the construction of the short line in Bulgarian territory which is all that is now wanting to complete the entire through-railway system connecting the Turkish capital with all parts of Europe. At length, taking advantage of the present respite from the pressure of external difficulties, Prince Alexander's Government is devoting its attention to this urgent question, with a view to discharge the engagements it entered into at the *Conference à Quatre*. Unfortunately, the Bulgarian company which had undertaken to build the Bulgarian section of this important international line has been compelled to go into liquidation. The contractor is seeking to form a fresh company to carry out the work; but—the Sofia correspondent of the *Standard* says—it appears doubtful whether Bulgaria will not ultimately be compelled to have recourse to foreign capital to enable her to fulfil her engagements in this matter.

THE Lord Chancellor has issued his award respecting the dispute which arose between the Metropolitan Railway and the Metropolitan District Railway as to the amount payable by the latter company for the purchase of half the ownership of the line between Trinity-square and Aldgate stations. The question was discussed at very great length at the close of last year and the early part of this, upon a claim of £368,618 put forward by the Metropolitan Company. Of this sum the District Company had admitted and paid £250,000, disputing their liability to pay the greater part of the balance. The award of the Lord Chancellor has been made in two parts, and will require a supplementary award to clear up several items. In the first part the Lord Chancellor deals with the properties taken and the question as to whether the District Company are bound to bear one-half the loss of the working of the railway from the opening of the undertaking. This question the Lord Chancellor decides in favour of the District Company—that is, that they are not bound to bear half the loss previous to their becoming joint owners. In the second part the Lord Chancellor deals with miscellaneous items, law and parliamentary expenses, in which several important deductions are made in favour of the District Company. As the result of the award, it is estimated that the District Company will have to pay between £25,000 and £30,000 beyond the £250,000 already paid, but that nearly the whole, if not all, of this will be recouped to the company by the proceeds from the sale of surplus lands.

A GENERAL classification of the railway accidents in the United States during February is made as follows by the *Railroad Gazette*:—

	Collisions.	Derailments.	Other.	Total.
Defects of road	—	17	—	17
Defects of equipment	5	11	5	21
Negligence in operating	24	6	—	30
Unforeseen obstructions	2	16	—	18
Maliciously caused	1	—	—	1
Unexplained	—	11	—	11
Total	32	61	5	98

Negligence in operating is thus charged with 31 per cent. of all the accidents, defects of road with 17, and defects of equipment with $21\frac{1}{2}$ per cent. A division according to classes of trains and accidents is as follows:—

Accidents.	Collisions.	Derailments.	Other.	Total.
To passenger trains	3	20	3	26
To a pass. and a freight	12	—	—	12
To freight trains	17	41	2	60
Total	32	61	5	98

This shows accidents to a total of 130 trains, of which 41—$31\frac{1}{2}$ per cent.—were passenger trains, and 89—$68\frac{1}{2}$ per cent.—were freight trains. Of the total number of accidents, 55 are recorded as happening in daylight and 43 at night.

NOTES AND MEMORANDA.

HERR HILT has shown that coal dust cannot be ignited with dynamite, even when it is mixed with 5 per cent. of marsh gas. The author, on the other hand, refers to some experiments made at the Segen-Gottes pit, which proved that coal dust can be fired with cartridges charged with Nobel's dynamite No. 1.

AT a recent meeting of the Paris Academy of Sciences a paper was read on the constitution of the earth's crust—concluded—by M. Faye. The author concludes that the revolutions of the globe are due, not to contraction caused by a general and uniform chilling process, as hitherto supposed, but to the circumstance, peculiar to the earth, that this chilling process goes on at an accelerated rate and more deeply under the marine basins than under the continents.

"A PRACTICAL DRAUGHTSMAN," in *Wood and Iron*, gives the following suggestions, some of which may be useful to some reader. In mixing up inks, the process is very much expedited by heating the dish and water in which it is mixed before commencing. It often happens that in the summer the flies walk over a tracing and eat off the ink in a very provoking manner. The use of vinegar instead of water will prevent this. In making a tracing, the cloth will take the ink much better if it is rubbed over with chalk. Tracing cloth that has been rolled up may be straightened out effectually and expeditiously by drawing it over the edge of a table or drawing board, holding it down meantime with an ordinary three-cornered scale.

A NEW method for the preparation of hydrogen gas has been described by MM. F. Hembert and Henry, in the *Compt. Rendus.* The inventors pass superheated steam in a fine spray over coke heated to redness, whereby a mixture of equal volumes of hydrogen and carbon monoxide is formed. This mixture is led into a second retort also heated to redness, filled with fireproof materials. The second process has the object of promoting a thorough mixing of the gases. In the second retort also steam is allowed to enter heated to its point of dissociation. These gases act upon one another, hydrogen is formed and carbonic acid gas. In this way 3200 cbm. hydrogen are obtained from 1 ton of coke, and the price of the hydrogen is ·015 franc per 1 cbm.

THE German Parliament has now under consideration a Bill that is intended to regulate the employment of lead in the manufacture of cooking and other domestic utensils, and so to diminish the risk of poisoning by that metal. The provisions of this measure forbid the use of vessels containing more than 10 per cent. of lead in their composition for the above purposes. No alloy with over 1 per cent. may be used in coating iron articles used in cookery. Solder may consist of lead to one-tenth of its amount, but no more. Enamels into which lead enters are treated with equal stringency. The effect of this Bill, if it be passed, will be to obliterate the legal existence of pewter and of soft solder as at present made, since these alloys contain from one half to one-fourth of their weight of lead.

WRITING to the American *Sanitary Engineer* on the life of wrought iron pipes, a correspondent says:—"I may mention a case which came under my observation some time ago which shows how liable to corrosion these pipes are in certain circumstances. The pipe in question was a 4in. water main, which had been laid underground beneath a large fireproof warehouse to supply the hydrants for fire-hose. Finding it necessary to alter the position of the hydrants, I had a portion of the pipe taken up and it was found completely rotten and honeycombed. As the main was solely for use in the event of a fire, it had never been used; and it is probably fortunate that the condition of the main was discovered before the necessity for its use arose. I may add that the building stood on piles on made ground, but the pipe was above the water-line. It had been in its place just five years."

FROM two determinations of the velocity of light made by Prof. Michelson—in 1879 and 1882—and from one made by himself in 1882, Prof. Newcomb concludes that the most probable value of this physical constant, expressed in kilometres per second, is 299860 ± 30. Adopting Nyrén's value of the constant of aberration from Pulkowa observations, viz, 20″·492, the corresponding value of the solar parallax is 8″·794, taking the earth's equatorial radius to be 6378·2 kilos., as determined by Clark. We may also draw attention to the circumstance that Prof. Newcomb considers that his observations negative the hypothesis put forward by Messrs. Forbes and Young as to the existence of a difference between the velocities of rays of different colours. Had there been such a difference to anything like the extent asserted by these physicists, it would have shown a well marked effect in Prof. Newcomb's apparatus. No trace, however, of any such effect could be seen. Prof. Michelson has arrived at similar conclusions as to the erroneous nature of the views expressed by the Scotch experimenters.

THE Chief Engineer and Inspector of Public Works in Java, M. van Geûns, has lately been on a journey through that and the neighbouring islands, of which he has published an account. He speaks of the various Javan volcanoes, of which much has been heard lately, and says that since the eruption of Krakatao in 1883 the people live in comparative quiet. But this calm is only apparent, for volcanic eruptions, always numerous, are incessant. The volcanoes on the Island of Java itself manifest everywhere great activity, but not so as to produce a serious cataclysm. Smeroc, which is the highest mountain in the island, and its neighbours Brômo and Lamonyon, are active from time to time. In 1885, for example, Smeroc overwhelmed plantations and villages on its side with eruptive matter. Merapi, in the centre of the island, shows constant signs of life; lava is constantly flowing from it, smoke and steam are almost always visible at its summit, so that it is one of the active volcanoes of the world. M. van Geûns reports another curious phenomenon. After a period of extreme drought continued rains have inundated one part of the country, while there is an absolute want of water in other places which should have it in abundance. This anomaly is attributed to the monsoons which blow irregularly, and which cause more anxiety to the Javanese than their volcanoes.

IN a letter dated Carleste Bay, Barbadoes, W.I., March 1, 1886, Commander A. S. Barker, commanding the Enterprise, writes as follows:—"I have the honour to transmit a report of deep sea soundings taken between Montevideo and Barbadoes. Seventy-two casts were taken, and the distance run was 5031 miles. In order to avoid the Challenger's track I steered to the northward towards Nelson shoal, where the chart shows nineteen feet. We found 2088 fathoms when over the spot, but there may be a shoal in the neighbourhood nevertheless. From this point I steamed slowly, running from 200 to 250 miles to the northward of the Challenger's line, taking casts at intervals of about sixty miles, the average depth being about 2000 fathoms. In latitude 31 deg. 22 min. south, longitude 36 deg. 39 min. west, the water shoaled to 1469 fathoms, and the next cast, taken in latitude 31 deg. 15 min. south, longitude 35 deg. 42 min. west, was only 547 fathoms. From this position casts were taken at intervals of five miles or thereabouts until over the shoalest part of the bank. The least depth found by us was 378 fathoms in latitude 31 deg. 2 min. south, longitude 34 deg. 27 min. west. Of course it is impossible to state how much water there may be on the bank in the neighbourhood of our casts. It is very doubtful if we crossed the shoalest part, as it extends for about 150 miles in longitude and how much in latitude is not known. If the vessels on the South Atlantic station were provided with deep sea sounding machines they could determine the extent of this bank with very little trouble. After leaving St. Thomas, W.I., March 5, we expended all the remaining shot we had on board taking deep sea soundings. The first cast was taken in latitude 19 deg. 53 min. north, longitude 65 deg. 45 min. west, where we found 4529 fathoms—excellent cast. The position of this cast is about 40 east-north-east of that where Lieutenant Commander Brownson found 4561 fathoms."

MISCELLANEA.

THE London office of the Stanners Closes Steel Company is now that of their London agent, Mr. F. A. Pullen, of 1, Church-court, Clement's-lane, E.C.

ACCORDING to a report by Professor Frearn, F.G.S., published in the *Mark Lane Express*, the pulverised phosphoric slag resulting from the basic process of steel making is really a manure of considerable value.

AT the Alhambra Theatre Messrs. Archibald Smith and Stevens are about to erect one of their hydraulic lifts, to be supplied by water from a tank at the top of the building, so as to be available for use at all hours.

THE Spanish Government have contracted with Messrs. Yarrow and Co., of Poplar, for the construction of two first-class torpedo boats of the Falke type. The speed in fighting trim, carrying seventeen tons on board, is guaranteed to be 23 knots, and when running light 25 knots. These are the highest speeds hitherto contracted for.

RAPID progress is being made with the graving dock, which for some time back has been in course of construction at Calliope Point, Auckland Harbour. This dock will be 500ft. on the floor, it will have 33ft. of water on the cill at ordinary spring tides, and there will be 35ft. of water in the dock. It will have a width of 80ft. at the entrance, and in the dock of 110ft.

A FAR-SEEING decision in respect to water supply has recently been arrived at in Australia. The *Colonies and India* says at a final joint meeting of the Victorian and New South Wales Water Commission it was resolved that the respective Governments should be invited to take joint and immediate action for a thorough examination of the Murray River and its tributaries, and the accurate gauging of its discharge at various points, with a view to an intercolonial water supply in the Murray districts. The importance of this recommendation is hardly to be overrated.

A BIGELOW paper, or rather, a report by Mr. John Bigelow, who was appointed by the New York Chamber of Commerce to examine the Panama Canal, has been issued. He says that if the work be vigorously prosecuted until the end of this year, about one-fifth of the excavation work will be completed. He also says there is no existing information that will enable any one to arrive at a probable estimate of the time of completion or of the cost, for many things regarding labour, and obstacles that may have to be overcome, but of which only the possibility or probability are at present seen, may yet appear that may have the most radical effect on the project.

ON the 24th of last month the obsolete French armour-clad Armide was towed to sea in the Juan Gulf and allowed to drift. The Colbert, Amiral Duperré, Friedland, Dévastation, Redoubtable, and Suffren, of the French Mediterranean squadron, then steamed about firing at her, at ranges of 3000, 4000, and 5000 metres, with 24, 27, and 32 centimetre guns—roughly $9\frac{1}{2}$in., 11in., and 12in. In time the hull resembled a cullender. Three shots had passed through the armour at the water-line, and would have sunk the ship if she had not been filled with casks. The Armide was then towed into harbour, and the effects of the fire carefully inquired into. This probably is the first occasion in which an armour-clad has been used as a moving target by ships firing when under way.

ARTESIAN tube wells are now being fixed at the following places in London:—For the supply of the flats and offices of the Albert Hall-mansions, South Kensington, and the Westminster-chambers, Victoria-street, S.W. The depth to be reached in either case to obtain the required supply will be over 400ft. Ere the chalk beds are reached, thick layers of London clay and Woolwich and Reading beds will have to be penetrated. It is only in recent years that this economical and expeditious system of obtaining large supplies of pure water from deep sources has been so perfected as to almost entirely supersede the old method of sinking dug wells. These artesian wells are protected by an even-sized tube, which is carried from the surface to the chalk beds, and it is absolutely impossible for any of the polluted springs which are found in the upper beds to contaminate the lower ones. Messrs. C. Isler and Co., of Southwark-street, have the works in hand.

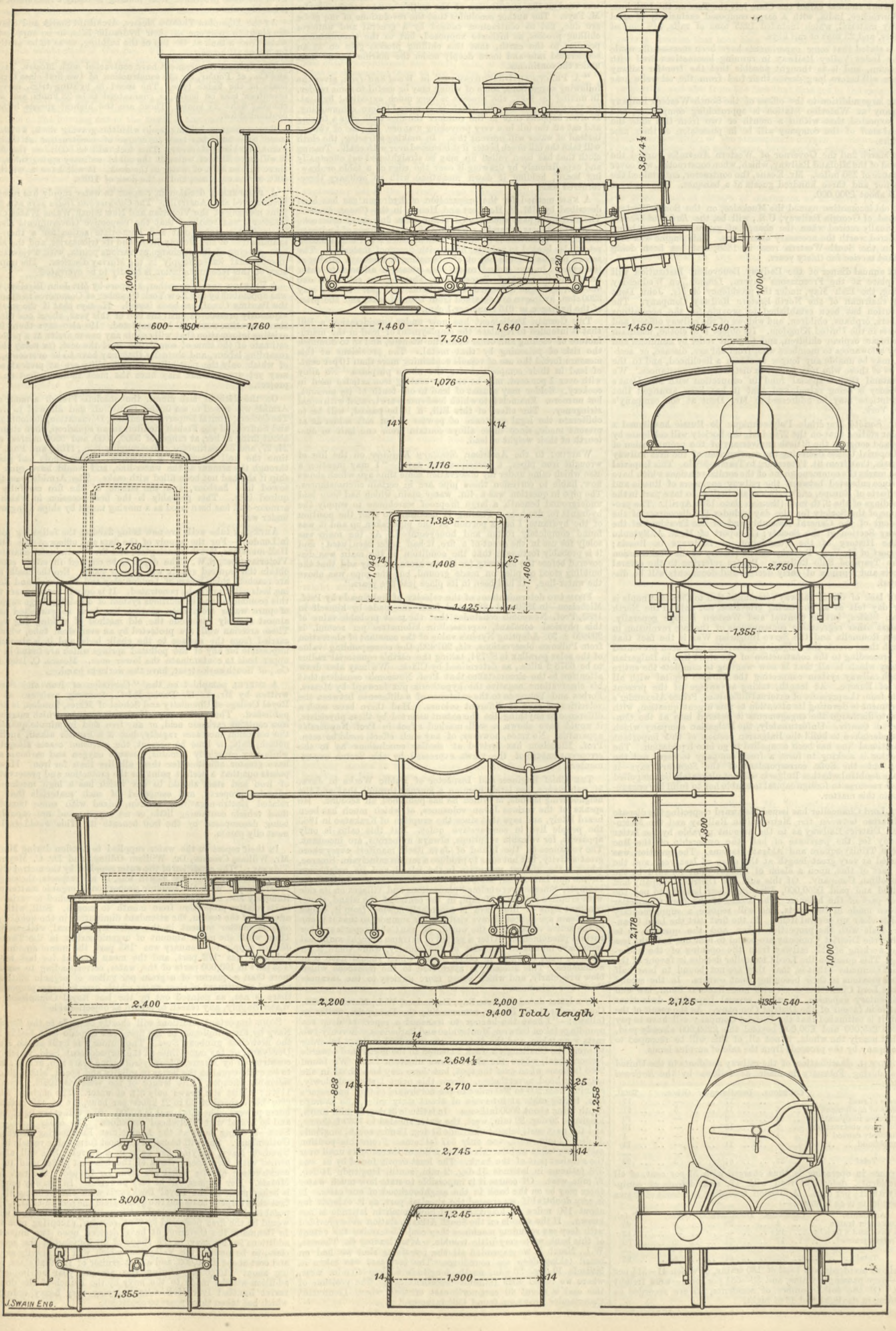
A USEFUL pamphlet on the "Corrosion of Iron and Steel," written by Mr. T. H. Davis, F.I.C., formerly assistant at the Royal College of Chemistry and School of Mines, London, is being published. The author says if the air or water which surrounds iron contains carbonic acid, or any free acid in minute quantity, the corrosion increases rapidly, but if a caustic alkali, such as potash, soda, or lime be present, the corrosion ceases altogether while any causticity remains, because oxygen and carbonic acid have greater affinities for these alkalies than for iron. He also points out that a perfect paint for the protection and preservation of iron and steel should be one which has a high mechanical adhesive property, and composed of such materials that are related electro-negatively to iron, mixed with some tenacious fluid vehicle containing little or no oxygen, and not capable of being decomposed by the iron beneath it. This would exclude most oily paints.

IN their report on the water supplied to London during March, Mr. William Crookes, Dr. William Odling, and Dr. C. Meymott Tidy say: "The condition of the water supplied by the metropolitan companies during the past month was, in all respects, thoroughly satisfactory. With the absolute proportion of organic matter continuously low, not much importance can be attached to variations in its relative proportion from month to month. Still, with the advance of the season, the attendant diminution in the quantity of organic matter present in the water is, as usual, well marked. Thus, while the mean amount of organic carbon in the Thames-derived supply for January was ·183 part, the mean amount for February was ·172 part, and the mean amount for last month ·153 part in 100,000 parts of the water, corresponding to scarcely more than a quarter of a grain per gallon of organic matter, a natural constituent of river water which, even in larger proportion, there is not, as pointed out by the last Royal Commission on Water Supply, any reason to regard as objectionable."

SOME important additions will shortly be made to the Swedish Navy by the completion of the first-class torpedo boat Galdr and the first-class gunboat Svea. The former was built at the Royal Dockyard, on the same lines as the torpedo boat Sejd, which was constructed by Messrs. Thorneycroft some years ago, and is stated to be quite equal to the latter in solidity and speed, although considerably cheaper. The length of the vessel is 103ft.; breadth, $11\frac{1}{2}$ft.; whilst she draws only 5ft. of water. The engines, which give her a speed of 20 to 21 knots per hour, are of 425 indicated horse-power. The total cost is £6000. She will carry light guns, and be armed with Whitehead torpedoes. The other vessel—the Svea—is being built at the Lindholmen Engineering Works, at Gothenburg. She will be one of the most formidable vessels in the Swedish Navy, carrying her guns in a turret. She will also be armed with torpedoes. Some of the heaviest plates used in the construction of this vessel are from Le Creusot; the rest from Motala. Her engines will be very powerful. In Norway progress is being made in the Royal Dockyards with the building of two first-class torpedo boats and two gunboats of the second-class. A proposal is also being made to build an ironclad of modern type, which would be the first possessed by that country, excepting monitors. In Denmark the Government have decided upon two important additions to the navy, in the shape of an ironclad of the second-class, to be named the Valkyrien, which will be heavily armed, and cost about £160,000, and a fast cruiser of the first-class, costing about £150,000. During the present year an important addition will be made to the navy by the launch of the double-turret ironclad Ivar Hvitfeldts, carrying very heavy ordnance, which has taken three years to construct.

GOODS AND SHUNTING ENGINES, BELGIAN STATE RAILWAYS.

(For description see page 323.)



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THE ENGINEER, April 23rd, 1886.

TO CORRESPONDENTS.

Registered Telegraphic Address—"ENGINEER NEWSPAPER, LONDON."

*** *All letters intended for insertion in* THE ENGINEER, *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

*** *We cannot undertake to return drawings or manuscripts; we must therefore request correspondents to keep copies.*

*** *In order to avoid trouble and confusion, we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must, in all cases, be accompanied by a large envelope legibly directed by the writer to himself, and bearing a* 1d. *postage stamp, in order that answers received by us may be forwarded to their destination. No notice will be taken of communications which do not comply with these instructions.*

LEITH.—(1) *Write to the Secretary,* 10, *Victoria-chambers, Victoria-street, Westminster.* (2) *Deposit two copies of the thing to be entered at Stationer's Hall, and pay* 5s.

JUSTICE.—*There is no gun in existence which will pierce armour 6ft. thick. Twenty-six inches of armour at* 1000 *yards range will cope with any gun yet made. The range of the* 80-*ton gun is about twelve miles; at the end of that range the shot would be inert.*

THE ENGINEER.

APRIL 23, 1886.

STEAM LIFEBOATS.

DURING the last meeting of the Institute of Naval Architects, the question of using steam lifeboats was made the subject of a very interesting and useful discussion. Messrs. Benjamin and Taylor have designed a very ingenious steam lifeboat, and they read a paper describing it, and exhibited a model. The boat in question is, of course, intended to be unsinkable, and, as we understand the description, she is also to be uncapsizable; a shallow hull has a rounded structure built up on top of it, within which the rescued crew of a ship are to find shelter, safety, and even a warm bath. Propulsion is effected by screws under the bottom of the boat, and partly encased in semi-circular tunnels, excavated, so to speak, in the floor of the hull. So far as can be seen, the craft does not possess any of the characteristics that a lifeboat, as the term is now understood, has. But, whatever the defects of the scheme, it possessed the advantage that, as we have said, it elicited a very good discussion.

It can hardly have failed to strike thoughtful people that oars and men are in many respects the worst propelling agents that could be employed in working a lifeboat; and numerous proposals have been made for using steam instead. It is of the utmost importance that a lifeboat should get alongside a wreck as soon as possible; but hours are now spent in pulling from the shore to a wreck, when each minute may mean a life lost. Indeed, so fully is the inadequacy of manual power recognised, that at all large and important lifeboat stations, such, for example, as Ramsgate, the lifeboat is invariably taken out by a tug steamer to windward of the wreck, down to which the lifeboat then drops. When a rescue has been effected, her sails are hoisted and she runs for a port. But there are dozens of lifeboat stations where no tug is available; and in not a few cases the lifeboat has been unable to do any good simply because she could not be rowed or sailed to the wreck. It is not too much to say that if lifeboats could be provided with steam power a very large number of lives now lost each year would be saved. There is consequently the greatest possible stimulus to invention, and nothing we believe but the utter hopelessness of the task has prevented inventors from solving the problem set before them. No doubt the magnitude and exceeding difficulty of the problem are not fully realised. Captain Chetwynd, of the National Lifeboat Institution, a man of over thirty years' special experience, set these difficulties very clearly before the Institution of Naval Architects, and when he sat down his hearers must have felt certain that whatever power may yet be used for the intended purpose, steam cannot be employed. Captain Chetwynd explained that none but those who have, like himself, been personally engaged in lifeboat work, can form any adequate conception of the force and fury of the waves on, for example, the Goodwin Sands. It is easy to talk about metacentres, and centres of gravity, and buoyancy; but in a heavy confused sea the laws of stability seem to be in abeyance. Over and over again a 30ft. lifeboat stands literally on end against a sea. On two occasions lifeboats have been turned clean over endwise. To say that they roll their gunwales under is nothing. The motion in them is simply inexpressibly violent, and apparently taking place in every direction at once. Apart from this the seas continually break into them with tremendous violence. "When," said Captain Chetwynd, "I have often urged a boat's crew to go off in a heavy gale, they have met my expostulations with the argument, 'Our backs would be broken by the seas falling into the boat.'" He had experience of cases in which a breaker has tumbled over the bows of a boat, without the slightest injury to men forward of midships, while the men in the stern were maimed or disabled by the smash of tons of water into her stern; those forward being saved by the sea leaping clean over their heads. In addition to this the boat must not draw 3ft., or she cannot get through the shallow water of breakers to go alongside a wreck. On the Goodwin Sands the lifeboats on a draught of but 3ft., are constantly thumped down on the bottom when they get in the trough between two waves. The graphic picture drawn by Captain Chetwynd places the indomitable courage and hardiness of our lifeboat crews in a stronger light than ever. Most of his hearers for the first time in their lives realised the character of the work done night after night on our coasts, and the wonderful qualities of the boats themselves. The National Lifeboat Institution possesses 270 self-righting boats. These latter craft have gone out 4700 times and saved 12,000 lives, and in only thirty-nine instances have they been capsized, while in only 21 were lives lost. Of large boats the Institution possesses 22. These have been out 653 times, and saved 1668 lives, without once being turned over. The possibility of using steam has been anxiously considered by the Lifeboat Institution. They experimented as far as was possible for two years in this direction, and a special committee was formed at Liverpool to consider the subject. They came reluctantly to the conclusion that steam could not be used for the purpose.

It is not quite impossible that a suitable engine and propeller could be employed. The difficulty lies in the boiler. It is very difficult to see how a boiler could be fired at all, but even if it could, it is clear that the water and steam would be continually changing places. What, for example, would occur when a boat stood up on end? And without going so far as this, it is plain that no gauge yet made could give the smallest trustworthy evidence as to what was the level of the water in the boiler. The only attempt that could be made at using a boiler would be to hang it in gimbals. Again, the propeller must be at times working in air, then deeply submerged. If placed anywhere outside the hull it would probably be torn off. If put under her it must in the nature of things be very inefficient. It is worth notice that neither Mr. Benjamin nor Mr. Taylor thought it worth while to deal with the boiler problem as if it was of any importance. Indeed, their proposed lifeboat being comparatively a big heavy craft, would not labour under the same difficulties as an ordinary lifeboat would. The weight of such a boat is about two and a-half to three tons. That of four large boats possessed by the Institution is ten tons each. The lifeboat of Messrs. Benjamin and Taylor weighs twenty-seven tons empty. But, as Captain Chetwynd showed, such a large craft would be useless in breakers. The modern lifeboat is a remarkable example of the skilful adaptation of means to an end, and to depart from its type in any way is, to say the least, an extremely doubtful experiment.

There is another difficulty in the way of the adoption of steam at sea which we have not yet considered. It is the grave objection which lies in the way of experimenting with an invention of this kind. Let us suppose that in a heavy gale a steam lifeboat put to sea with a dozen men on board. If the machinery broke down or became inoperative—let us say from excessive priming due to the rapidly changing position of the boiler—the lives of all on board would be lost. No one in authority would take the responsibility of trying so perilous an experiment. It is obvious, however, that before steam lifeboats can be pronounced satisfactory such an experiment must be made not once nor twice, but many times. Among inventors none have had any experience of lifeboat work. It is said that one enthusiastic individual, who believed that he had solved the problem, went out one night with a lifeboat crew to gather experience. Some hours subsequently he found himself on shore, half dead with cold and misery; sorely beaten and bruised and shaken; almost drowned and wholly miserable; when he had recovered, one of his first acts was to tear up his drawings and burn his models. Even with such an experience before them there are no doubt men who will still invent in this direction, and to such we would tender a word of advice. From any steam engine or other motor dependent on fire nothing is to be hoped. If it were possible to put a motor on board which would not depend on such aid it would, no doubt, prove very useful. It is a *sine quâ non* that the motor must be of such a kind that it will leave the men as free as they are now to use their oars or sails, so that should the motor fail the crew would run no additional risk because of its presence. There is but one scheme which holds out even a faint chance of being practicable, and that is the use of electricity. It would be possible to put storage batteries into a lifeboat, and to so secure them that they would continue to work under any conditions short of turning the boat upside down. The electrical launch shows that such a mode of propulsion is, under certain conditions, possible, and the experiment of using electricity might be tried without much risk of life. But when we have said so much we are bound to add that nothing has yet been done in electrical marine propulsion which leads us to believe that it can be applied with success to lifeboats. It may be that a steam engine may yet be devised on, say, the Lamm hot water system, which would render the use of a fire in the boat unnecessary; but of this we see, we confess, no hope. However, no one can place a limit to the power of engineers. We have set the broad facts of a most interesting problem before our readers; possibly they may find its solution.

THE FREEBOARD OF WELL-DECKED STEAMERS.

AMONG the many evolutionary developments in naval architecture which have resulted from the combined influences of steam propulsion, the employment of iron, and the operation of the tonnage laws, there is none which is more noteworthy or which has given rise to more controversy than the well-decked steamer. It was thought by many that all doubts regarding the comparative safety of this type of vessel had at last disappeared, and that the application of the freeboard tables of the Load Line Committee to well-decked steamers was, on the whole, acceptable to their owners. It was further understood that these tables were fixed for at least some time to come, and then an opportunity would be afforded for watching the results of their application to all types of sailing ships and steamers before any alterations in them would be contemplated. But this expectation has, unfortunately, not been entirely realised, and already there are rumours of change, or at all events of modification in the conditions governing the application of the freeboard tables to steamers with well-decks. These proposals have, as might be expected, again roused shipowners to action, and there are at present many indications of another angry altercation between those gentlemen and the Board of Trade. It is much to be regretted that, doubtless through some misunderstanding, Lloyds has been dragged into the controversy; so that a committee which has always hitherto been the chief defence of the shipowning community against the irrational and obstructive policy of the Board of Trade is now apparently in the position of an executive body for carrying that policy into effect. There can be no doubt that immediately Lloyd's Register recognises the anomalous character of the position into which they have been enticed they will no longer consent to occupy it. As a voluntary association and a representative body, they will, it is to be hoped, continue, as heretofore, carefully to guard the interests of all the classes they represent, and in so doing the efficiency of the ships composing our mercantile marine in all that relates to their strength and seaworthiness will be maintained without Governmental interference of even the most indirect character. Before entering into the merits of the question now in dispute between the Board of Trade and steamship owners, it is perhaps necessary that the subject matter should be explained. "Well-decked" steamers are those having either a long poop or raised quarter-deck joined to a bridge-house, and, in addition, a topgallant forecastle. The space between the forecastle and the bridge-house, bounded on both sides by the bulwarks, is termed the "well." The upper deck is evidently the bottom of this well; the bulwarks form two sides of it, and the bridge house and topgallant forecastle bulkheads form the other two sides. The height of the bulwarks fixes the depth of this well; for the bridge and forecastle are each about 7ft. in height, while the bulwarks range from about 4ft. to 5ft. It will be very clear that such a space as this, which may be about 50ft. to 60ft. long, and 35ft. to 40ft. broad, will contain a great weight of water; and it will be equally clear that in bad weather there is a possibility of a large body of water falling into it. To meet such a contingency as this, "water ports" are fitted in the bulwarks, in addition to the usual scupper holes, and these ports are so hung as to open outwards only.

The type of vessel just described is that which is known as "well decked;" but there is another type, having a poop, bridge house, and topgallant forecastle, to which the designation "double-welled steamers" has been given, there being one well between the topgallant forecastle and the bridge house, as in the former case, and in addition, another well between the bridge house and the front of the poop. Both these descriptions of steam vessels, and especially the first, owe their origin to the ingenuity of the shipowners and shipbuilders of the North-East Coast of England; and it is to the ports of that coast the majority of these vessels belong. To this it is scarcely necessary to add the further remark that the shipping communities of the same localities are the most ardent defenders of the well-decked vessels, and in common fairness it must be admitted that they have established a very good case. It must, however, occur to any intelligent person who is not acquainted with the technicalities of the subject to ask why vessels have these wells at all? It is not unusual to see steamers having poops, bridge houses, and topgallant forecastles which collectively occupy nearly the entire length of the vessel, but yet they have either one or two of these "wells." Why not, then, it may be reasonably asked, join these erections together and make a light, continuous deck covering the upper deck? By so doing very little additional weight would be added to the vessel, and the cost of building her would not be materially increased. In other words, common sense, unfettered in its operation, would give us spar or awning decks in most of the cases where we now find the well-deck system adopted. To explain how it comes about that our North East Coast builders found it advantageous to build well-deckers would require a treatise upon the tonnage laws of the country. It must suffice to say that so irrational has been the legislation upon this subject that penalties are actually imposed upon conditions conducive to safety. A Royal Commission considered this question about four or five years ago, but in the then state of the load-line question it was found impossible to arrive at such an agreement as would result in the removal of the existing anomalies. The only proposals which really touched the question were those from Messrs. Waymouth and Rothery, who were members of the Commission; but, unfortunately, they were in a minority. The amendments in the tonnage laws recommended by the majority of the Royal Commissioners have left untouched those clauses which render covered-in spaces so costly to the shipowner that he cannot afford to have them to a desirable extent in his vessels. Hence the wells and the well-decked system which has recently been the subject of special application of the Load-line Committee's freeboard tables.

Those who object to the well-deck system, such as Mr. Rothery, the Wreck Commissioner, and Sir Digby Murray, of the Board of Trade, say that not only are such vessels liable to be temporarily borne down by the weight of a body of sea falling into the well, whereby stability is diminished, and damage to the deck openings and bulkheads made possible, but the lives of the crew are at the same time endangered when they have to proceed from their berths in the forecastle, through the well, to the midship or after part of the vessel in the course of their ordinary duties. A sea falling into the well upon the seamen would be likely to knock them forcibly against the bulwarks or hatchway coverings so as to break their limbs or even kill them; and such a body of water, if not speedily liberated, would be a source of danger to the vessel. Sir Digby Murray, who was a member of the Load Line Committee, asks for two conditions to be fulfilled in well-decked vessels, in order that they may have the full advantages in loading, which the freeboard tables concede on account of the buoyancy afforded by their deck erections. He desires (1) that there shall be a certain proportionate area of water ports to that of the bulwarks, and (2) that an efficient flying bridge arrangement may be provided to enable the crew to go from one erection to another without passing through the intervening well. Unless these requirements are fulfilled, the freeboard of the vessel is, by the Board of Trade's recent circular, to be increased by a certain specified percentage of her moulded depth.

It is to this that the shipowners of Hartlepool and the adjacent ports take exception, and their arguments are not without weight. In the first place the statistics which they produce—and the accuracy of these is not disputed—show that well decked steamers are not nearly so often in trouble as most other types of cargo vessels, and their percentage of losses is relatively very small. Mr. Gray, of West Hartlepool, who has built, and now owns, many of these steamers, asserts that the objections to them are imaginary, and not warranted by experience. Indeed he goes so far as to say that in the working of certain marine insurance associations, which take risks upon all types of steamers, it has been found that the well-decked steamers are the least liable to loss, and other statistics which that gentleman produces show that the cases of injury to crews are proportionately least in the vessels which the Board of Trade considers especially dangerous.

While there is every reason for placing faith in the honesty of the gentlemen who defend the well-decked steamers and in the statistics which they bring forward, it is right at the same time to listen to what captains and crews have to say regarding them. It is admitted that among these there are many warm defenders of this type, but it is likewise true that many equally experienced and trustworthy officers and seamen object to them, and object, too, not for imaginary reasons, but because of what they have personally witnessed. This is particularly the case in the Atlantic trade, for which well-decked vessels should never be employed in the winter months unless with an abnormally high freeboard. When comparing flush-decked with well-decked vessels the comparison should be instituted between the latter when loaded as the Hartlepool shipowners propose, and a similar vessel with a continuous light deck above the upper deck, and loaded just as much deeper as is necessary for carrying the additional weight of hull. If the tonnage laws of the country encouraged rather than penalised the production of such a steamer, we should see the last of well-deckers. And if such vessels were to work in competition with the well-decked steamers, it would surprise not a few if statistics in favour of the latter were forthcoming.

The shipowners of this country, and, indeed, of the whole civilised world, are now driven to employ types of steamers which under wise laws would not exist. It is hopeless to expect that men will expend their capital upon ships which cannot be sailed at a profit. Shipowners have to do the best they can with the materials which international law has thrust into their hands. While that law remains as it now is, all we can expect shipowners to do is to make the best of what they have, and to take every precaution in their power for the safety of the crews who work for them. The great majority of them do this, but for the sake of the few who require watching some regulations must be enforced. It is most necessary that these regulations should not cripple or in any way impede the action of the honest shipowner. The best interests of the British mercantile marine have for very long past been well looked after by Lloyd's Register, simply because the committee of that association is composed of representatives of all the interests concerned, which are more or less conflicting in their character. In this way the rules for building merchant ships have been made by those who build, own, sail, load, and insure ships. The same association first solved the load line problem in a satisfactory manner, and furnished the materials which largely guided the deliberations of the Load Line Committee. Surely, then, Lloyd's Register can cope with this well-deck freeboard question without the guidance or prompting of the Board of Trade. Let Mr. W. Gray—who represents the owners of the well-deck vessels—bring his case before the full Committee of Lloyd's Register, of which he is a member, and let the question be discussed and settled there by all the interests concerned. It was a mistake on the part of the Board of Trade to go further in this matter than the Load Line Committee recommended in its report, and it was a mistake of Lloyd's Register to listen for a moment to the allurements of Sir Digby Murray.

Regarding the proposed flying bridges, it is not possible to say much that is favourable. Most people would prefer facing the risks of a run across the well to those of being washed clean overboard out of the flying bridge. Probably hand lines, run through the eyes of portable stancheons at the corners of the hatchways and elsewhere, will be found much more trustworthy for the purpose in view than the flying bridge which Sir Digby Murray desires. The addition of a few water-ports is so small a matter to the shipowner that it is somewhat surprising to find objection taken to it. When we hear of 200 tons of water falling into a well—as is well authenticated in the case of an Atlantic steamer of the type under consideration—it becomes clearly a matter of importance to furnish ready means of exit for the same. This view must commend itself, upon fair consideration, to the owners of these vessels; and it is to be hoped that so far as the question of area of water ports is concerned there will be no further difficulty experienced in settling the freeboard question in regard to well-decked ships. That this difficulty has arisen will, however, be regretted by nobody if it should in any way contribute to the bringing about of a radical amendment of the tonnage laws, whereby the production of well-decked vessels should no longer be encouraged.

MINIMUM RATES OF FREIGHT.

A MOVEMENT has been commenced in the north-east which seems likely to have considerable effect on the shipping trade, and on the shipbuilding trade in the end. It is that which aims at defining a minimum rate of freight below which the owners of vessels will not allow them to be chartered. It is the response of the managers to the remonstrances of the co-owners of steamers against the losses involved in working at rates of charter which are not only unremunerative, but which entail a rather serious loss. This has gone on until it has become known that some of the holders of shares in steamships have served legal notice on the managers to the effect that they will refuse to be responsible for their share of losses so incurred. It is the effect of this that there has been that action to which we have referred, and which is likely to lead to some effect on the freight market as a whole. The intention is first to attack the Cronstadt charters, and the minimum rate below which the owners will not allow their steamers to trade is 5s. 6d. This is above the average rate of the past year; but it is considerably below the opening rate at the beginning of the season of last year, the average rate being 4s. 6d. and the opening rate 8s.; and it is noticeable that at the first meeting in Newcastle, which decided on the movement, there were in favour of it the managing owners of more than two hundred and ten steamers, so that the adherence of these gentlemen to their declaration must sensibly affect the market, for it will be in some degree followed by others, and must have its value as a factor in determining the rates of freight. The period at which it has begun makes the movement the more formidable, for there is just now an opening out of the over-sea trade to a large extent, and this would in the ordinary course call up a mass of tonnage. The principle of the movement must be taken as sound, to the extent that it is unwise to work steamers at a loss, as it is known has been the case for some time in many instances; and that it is quite allowable for owners to seek the advantage and unity in banding themselves together to resist the merchants who wish them to charter at what seems to the shipowner an unprofitable rate. The system, which is known in the North as the "C.I.F." system—the sale of goods or commodities by a merchant delivered at some port abroad, and in which the price agreed to be paid includes the cost, insurance, and freight of the article—is said to be responsible in a very considerable degree for the fall in the range of freights against which the new movement in the North is a strong, and it is probable an effective protest. Merchants who thus contract for the sale of, say, coal abroad, have an interest in reducing the range of the freight market, and in keeping down the freights, for by so doing their own profits as sellers of coal are increased. And the fact that some of these merchants act in the twofold capacity of merchants selling coal in the method named and of managers of steamships, enables them at times to give a slight impetus to the downward movement of freights, it is supposed, by the manner in which they may put their own vessels in to work contracts if others are refused owing to what are thought low rates. The course of the contest must be considered one of the utmost interest to the trader, and the steamship owner, and in the end it will affect the builder and the engineer.

THE TILBURY DOCKS.

MOST of the questions which have from time to time been asked concerning the policy of constructing enormous docks and dock facilities thirty miles down the Thames from London, and the probable or possible commercial success of the docks when finished, are being again put by those who have not ceased to be incredulous about the wisdom of the enterprise. The whole work, including that undertaken by the Tilbury Railway Company, has involved an expenditure of about three millions sterling in less than four years. The many reasons ascribed for building docks at Tilbury have often been recounted, and we need not reproduce any of them now, but, contenting ourselves with the fact that the Tilbury Railway Company has thought the outlook good enough to spend over a million upon it, and the other fact that the docks are opened, and are certainly much more likely to be successful than any works based on the opposite policy of carrying ships further inland by locked canals, we need do little more than record the completion of one of the most gigantic commercial enterprises ever carried out. There probably never has been before in the history of the world the spectacle of so enormous a machine—if an enormous dock with all its appliances may be called a machine—capable of accommodating more shipping than that which would make a nation great in merchandise, and the Rhodes of old a maritime dealer in "a small but respectable way," presented to the world like a giant born full grown, idle, yet asking for nothing but work on which to exercise its mighty capacities. An insignificant idea is conveyed to a reader by mentioning the size of the docks with their nineteen acres of tidal entrance basin, lock of 700ft. in length, main dock and branch docks of 1800ft. and 1600ft. in length, their twenty acres of shedding, and 61 travelling cranes, leviathan floating crane, four graving docks, with pumps to lift 12 million gallons per hour, all lighted by eighty arc lamps of 3000-candle power and 1362 incandescent lamps, driven by engines of a total of about 500-horse power. We may refer to THE ENGINEER of September 23rd, 1881, and of April 3rd, 1885, for plans and descriptions of the work, and can then convey but a poor idea of the gigantic facilities now thrown open, and inviting the shipping which now does and which may be attracted by it to the Thames. In another impression we shall give some details concerning this great work, together with some illustrations.

THE IRON TRADE.

NOTWITHSTANDING that iron smelters from all parts of the country met in secret conclave at the Westminster Palace Hotel last Friday, and passed certain resolutions with a view to a general reduction of output, very few people believe that any practical result will ensue. It has leaked out that there was a great difference of opinion among those present, arising from the fact that few of the smelters are interested in that industry alone. Some have mines or collieries, some have finished iron or steel works, and others are interested in shipyards, foundries, or general constructive works. It is clear that under these circumstances the interests of the various competitors can never be identical. It cannot suit either those who supply materials to smelters or those who take pig iron from them, that the output should be artificially diminished; and even supposing these apparently insuperable difficulties could be surmounted, there would be the uncomfortable remembrance fresh in the minds of everyone, that the International Railmakers' Association utterly collapsed. It was a most elaborate affair, undoubtedly well managed by a competent staff of paid officials; yet the intrinsic difficulties were too many, and too great, and after a brief career it went the way of all combinations which aim at interference with natural laws. What better chance of success is likely to attend this new scheme for restricting the output of pig-iron? In all probability, therefore, the movement will come to nothing, and Darwin's law of the survival of the fittest will assert its sway, and decide in the only possible way who shall go on and who shall stop.

LITERATURE.

Reports from H.M. Diplomatic and Consular Officers Abroad. Part IV. 1885. *Report by H.M. Chargé d'Affaires at Dresden on the Effects of the German Customs Tariff Reform of* 1879, *and on the Revision of* 1885. Folio. C. 1530. London, 1885.

IT has been lately suggested, and, we think, with justice, that our diplomatic and consular officers abroad might be made of much more use to England, commercially speaking, than they are, by supporting her commercial interests, and keeping us supplied with useful information on trade matters. In this respect the example of the United States of America might be followed with advantage. The United States Consuls, as English merchants know, are in the habit of reporting at short intervals on all matters of any commercial interest, even interspersing their reports with hints and suggestions as to the kind of goods best calculated to meet with approval in the particular countries they are reporting on. These reports are published monthly, and freely circulated all over the great Republic. That our own representatives abroad are quite capable of duties of a similar character the able Report by Mr. George Strachey, which is now before us, amply proves. A more exhaustive, a more interesting, and a more instructive document than this Report it would be difficult to find in the archives of any Government. That Mr. Strachey is a confirmed strong Free Trader will only make his observations carry additional weight with the majority of his readers. Mr. Strachey has the courage of his opinions, and there is no uncertain note about his delivery of them. At the same time, his Report is remarkably fair and unbiassed.

Some time back, when we had occasion to review Mr. Jeans' very able work on "England's Supremacy," we ventured the opinion that statistics, unsupported by the experience of individuals, were unsatisfactory and inconclusive. We regretted that Mr. Jeans, instead of contenting himself by quoting figures had not given us the views of either himself or the influential gentleman with whom he is officially associated. Mr. Strachey's Report is an illustration of what we meant. Although he supplies us with as many figures as any reasonable being can possibly wish for, he does not stop there, but gives us the opinions of business men besides; and is not afraid of occasionally adding his own, to which, by the way, we are disposed to attach considerable importance. For, as he tells us in his introduction, "My own investigations have been tolerably extensive. They have included visits to local manufactories, and correspondence with eminent specialists in several countries. In regard to the technical and commercial characteristics of the staples of Germany, my report embodies, or reproduces, the judgments of experts of undisputed competence personally obtained, or otherwise, from Berlin, Lyons, Milan, Zurich, London, Manchester, Sheffield, Nottingham, Leeds, Dundee, and other cities." In an earlier paragraph he incidentally mentions that he has read more than one hundred volumes of the reports of the German Chambers of Commerce, for which last piece of martyrdom he has our sincere and heartfelt commiseration, which every one at all acquainted with German official literature will abundantly share. Mr. Strachey also assures us: "Nothing could be further from my intention than to get up a case for 'Fair-Trade,' or to furnish materials for a pamphlet by the Cobden Club." Yet, after all the trouble he has taken, and, notwithstanding his impartial attitude, he finds himself forced to admit, in his conclusion, that the German system of Protection has proved a failure. This opinion we are perhaps not inclined altogether to share, and we believe that our reason will become sufficiently manifest from a mere recapitulation of the main points brought out by the report. To begin with, Mr. Strachey gives us a sketch of the "Earlier History of Iron in Prussia and Germany;" and here it may be of interest to remind our readers that German industry is not a thing of yesterday, and that it has a history almost as old as that of France and England. But it is only in comparatively recent times, since the days of high Protection, in fact, that Germany, as a manufacturing country, has become a serious rival of France and England. This may be due very much to the political stability and national strength which has come with the union of the Empire, or its causes may be traceable to other sources. It is nevertheless interesting to note that, "In Prussia high Protection is modern, comparative Free-Trade is ancient. What Adam Smith and Pitt preached Hardenberg and Altenstein practised. In 1818 a Royal Commission, presided over by the greatest of the intellectual authors of the resurrection of Germany—Wilhelm von Humboldt—drew the lines of a great fiscal reform which was accomplished by degrees, and gave Prussia a Customs tariff of extraordinary liberality, the rates being of unexampled moderation for the time. . . . Pig iron was duty free, malleable iron and steel paying on import in the eastern provinces a 3s. duty per cwt., but in the western provinces only 1s. 6d. It happened that in 1819, the year subsequent to the inauguration of the fiscal reform of Hardenberg and Humboldt, the British tariff was modified, when the wisdom of our ancestors fixed the duty on malleable iron at nearly 7s. per cwt., the importation of foreign pig being sometime afterwards altogether prohibited." We leave our readers to form their own conclusions. It is, however, just to say that the adoption of a high Protection in Germany had been preceded by a period of remarkable and universal trade depression. A celebrated Russian economist, M. Bésobrazof, has established the axiom that the effect of war on trade is to stimulate it. Going to war and carrying on a war stimulates the productive capacity of a country to its utmost, and the subsequent conclusion of peace, by restoring general confidence, gives trade an additional fillip. But such abnormal activity is invariably followed by a period of reaction; and it was while Germany and France were both passing through this last stage, and consequently trade depression was assuming wide and European dimensions, that Germany flew to Protection for aid. Whether Protection was the cause of her moving, of course it is difficult to say, because two, or, as some allege, three, accidental circumstances were calculated to assist her. One was the remarkable lowness of wages in Germany, but this factor had always been present; it was now, however, to become of additional importance from the second accident—the discovery of the basic open-hearth process, by which German white forge iron, which the Bessemer method had been so detrimental to, again found a market. Another factor in the prosperity of the German iron industry was the alleged deterioration of Scotch foundry iron, a charge which, Mr. Strachey says, is not unfounded. It may be said, and with reason, that these facts alone are sufficient to account for the revival of German trade, and that there is, therefore, no occasion to go further afield and endeavour to account for it by assigning Protection as the cause. On the other hand, we must remember that it is to Protection that the Germans themselves—who, it must be admitted, ought to know something about the subject—attribute their return to prosperity. Besides, if Protection be really so detrimental to industries, how is it that the German iron trade managed to revive, in spite of the adoption of protective tariffs, at a time when it was greatly depressed? But that Protection is not so very vicious in its operation even Mr. Strachey admits, and this in connection with a question of particular interest to ourselves, for which reason we will let him speak for himself:—"The complaints of the Germans against their tariff must next be noticed. Allegations that the duties on iron and steel impair the power of Germany to compete in the export trade with Great Britain are made by founders, by makers of machinery in general, of steam engines, and sewing machines, of rivets and pipes, with muffles, chains, hinges, screws, shovels, loom spindles, watch springs, needle files, inlaying saws, stay closers, tin plates, and other articles. Bavarian makers of the last-named article, and of bar iron, assert that they can hardly maintain their sales in Austria and Italy on account of the import duty which loads their primary material—viz., the charcoal pig iron of Styria. In another class of complaints stress is laid upon the augmentation of the cost of foreign metal, as compelling the use of inferior native raw material. The great cutlery centre—Solingen—protests against the duty on iron, as their middle, fine, and tool steels are almost exclusively made from Swedish metal; and that place denounces the duty on raw steel as being no higher than that on the Swedish malleable from which it is made. . . . It seemed proper for the sake of completeness and impartiality to give this list of alleged evils to which Free Traders attach no small importance. It is my own opinion that the grievances and the inequalities are not unfairly distributed over a number of branches of production, and that the gain of some of the complainants from the duties on finished goods balances their loss from the extra price of foreign iron and steel. Moreover, my personal inquiries have convinced me that these complaints are not always seriously meant. From them and from the reports I gather that the representatives of the machine department are, as a rule, well satisfied with the existing tariff, and that they do not desire an abolition of import duties all round. Some of the inequalities of pressure described would be removed if makers could benefit by the drawback theoretically receivable by exporters of finished goods to the amount of the duty paid by them on the foreign raw material, where such is used. . . . Another side of the picture is the particular entire closure of foreign markets by retaliatory tariffs."

We had promised ourselves to touch upon those sections of the report which dealt with textiles, chemicals, &c., but find our space will not permit us to enlarge on those branches. We may, however, be allowed to say that perhaps the most interesting chapters next to those on iron and steel are those dealing with silk and lace. Mr. Strachey's summing up is interesting and commendably fair. He says: "According to some contemporary German politicians . . . Protection does not operate in the manner usually supposed. Assuming, however, the accuracy of the vulgar belief of mankind that Protection protects, it will be admitted *à priori* that the customs duties of 1879 have raised the cost of commodities to the German people. It is positive that some of the requirements of life, certain foodstuffs included, cost more in this empire than in some other countries, and that the extra charges thus entailed on personal income make a perceptible addition to the chapter of outgoings in the domestic budget of each individual German. . . . But nothing indicates that the burden thus laid on the population is oppressive, that national impoverishment is in progress, or that saving and accumulation have been arrested. On the contrary, the Imperial and local revenue receipts, the estimates of property liable to income-tax, and similar State and municipal returns, are symptomatic of fair public prosperity. . . . If it be asked what signs there are in Germany of that incipient Free Trade reaction which some of our politicians contrive to discern on the Continent of Europe, especially in the particular countries most wedded to Protection, there can be no hesitation in replying there are none. . . . Protection is in the national air, and it will not be dissipated by foreign arguments, however accurately deduced from the axioms of scientific doctrine."

At this no one will express any astonishment. A nation that is flourishing under its present system of fiscal tariffs—that is, notwithstanding its Protectionist proclivities, actually showing every sign of prosperity—must be of so obstinate a nature that even the most satisfactory scientific arguments against its present system would probably fail to convince it.

Mr. Strachey deserves great credit for his laboriousness, his fairness, and accuracy, but, above all, for his interesting and entertaining style, a merit rare in a Blue Book. Indeed, Mr. Strachey's Report failed to exercise over us that peculiar narcotic influence which, we regret to say, most Blue Books possess. In taking leave of this interesting work, we cannot help expressing a hope that Reports of this nature may issue with greater frequency from the sacred precincts of our Foreign-office.

GOODS AND SHUNTING ENGINES, BELGIAN STATE RAILWAYS.

On page 320 we illustrate two types of locomotives in use on the State Railways of Belgium.

The first of these is a shunting engine with six wheels coupled. The cylinders are 15in. diameter, the stroke is 18in., the wheels are 4ft. in diameter, the diameter of the boiler is 3ft. 9in. There are 165 tubes, 9ft. long and $1\frac{3}{4}$in. diameter outside. The heating surface in the fire-box is 57 square feet, in the tubes 610. The water tanks hold 850 gallons. The weight on the leading wheels is 10 tons, that on the driving wheels 10 tons 5 cwt., and that on the trailing wheels 9 tons 5 cwt. approximately. The total weight in working order is 29 tons 10 cwt.

Our second illustration shows a very powerful goods engine exhibited at Antwerp last year. This locomotive has six coupled wheels, 4ft. 3in. diameter. The diameter of the cylinder is $19\frac{5}{8}$in., the length of stroke $23\frac{5}{8}$in. The boiler is 4ft. 7in. diameter. In it are 251 tubes, 11ft. 6in. long and $1\frac{3}{4}$in. diameter outside. The grate surface is no less than $55\frac{1}{2}$ square feet. The heating surface in the fire-box is 122 square feet; in the tubes, 1150 square feet. The weights are very fairly distributed on the wheels. The total weight of the engine in working order is 42 tons. The form given to the springs is peculiar, and not pleasing to English eyes. The valve chests are outside, and the valves are driven by a modified Waelschaërt's gear. The chimney is of very abnormal shape and dimensions, being rectangular in cross section instead of being round. At the base it is nearly as wide as the diameter of the smoke-box. It is, we believe, claimed that the form gives a more equally distributed draught through the tubes. The workmanship of these engines is very good, and they do very hard work on a very indifferent small coal. Some principal dimensions will be found in French measures on the engraving.

TENDERS.

WATERWORKS—SOUTHAMPTON.

Result of tendering for buildings as advertised in The Engineer. Mr. Wm. Matthews, C.E , F.G.S., engineer.

	£	s.	d.
W. H. Simonds, Reading - accepted	7991	0	0
J. W. Pickthall, Southampton	8100	0	0
Bull and Co., Southampton	8345	0	0
H. J. Sanders, Southampton	8450	0	0
Crook and Sons, Southampton	8789	17	0
Stevens and Sons, Southampton	9387	0	0
Engineer's estimate	8800	0	0

ARNOLD LOCAL BOARD OF HEALTH.

Tenders for widening of roads, kerbing, channelling, sewering, and asphalting the same at Arnold, near Nottingham. Mr. Fredk. Jackson, F.S.I., engineer, 18, Low-pavement, Nottingham. Quantities by the engineer.

	£	s.	d.
E. Hopkins, Sutton-in-Ashfield	1492	0	0
T. Smart, Nottingham	1257	18	3
S. Thumbs, Nottingham	1245	16	0
R. and J. Holmes, Alfreton	1245	0	0
J. Greaves, Arnold	1244	0	0
J. Shortland and Co., Carrington	1210	12	0
J. Hawley, Ilkeston	1210	0	0
J. Herring, Arnold	1180	18	0
W. Cordon, Burton Joyce	1058	5	0
E. Morris, Red-hill, Arnold—accepted	970	3	6

Naval Engineer Appointments.—The following appointments have been made at the Admiralty:—John H. Brettell, fleet engineer, to the Northampton; Henry D. Garwood, fleet engineer, to the Hector; Richard Green, engineer, to the Northampton; Edward J. Rutter, assistant engineer, to the Northampton.

PRIVATE BILL LEGISLATION.

It is probably due somewhat to the approach of the Easter recess now realised, and to uneasiness as to the result of the Irish Bill crisis, that so large a number of Private Bills have now been disposed of either through the withdrawing or minimising of opposition. At the same time the general state of trade has powerfully operated to curtail resistance to these measures; and there is the further consideration of an unusually late Easter to account for so good a record of work as is now shown at the first interruption of the session. But whatever the explanation may be, members are not likely to have any alarming quantity of work when they reassemble, so far as the ordinary class of measures is concerned. The Ship Canal Bill, the Salford Bill, the Electric Lighting Bills, and some others of an exceptional character, may give more trouble than the respective Committees upon them will like; but this will not be the case much beyond those limits.

With regard to the Ship Canal Bill—which, while it remains before Parliament, cannot be kept out of a systematic *résumé* of this kind—a fresh element has been introduced which not only affects gravely the particular scheme, but is fraught with serious consequences to future measures. It is rumoured that in view of probable stout opposition to the Bill in the House of Lords, the Government are inclined actively to help the scheme through; but on the other hand Lord Redesdale, Chairman of Committees in the Upper House, has drawn up and laid on the table a memorandum explaining the Standing Order on the payment of interest out of capital, and suggesting certain alterations in the Order. He contends first that this clause, which is under the Standing Orders inserted in railway and other Bills to prohibit such payment out of capital, only declares the general law applicable to trading companies; and next, that if such payment is to be made legal, that cannot be done by omitting the clause, but by Parliament expressly legalising the payment—that is, Parliament must enact that a particular company may do that which is by the general law of the land illegal. Discussing the question whether there is adequate reason for such a change, Lord Redesdale mentions that the only instance since the Standing Order was adopted, about thirty-eight years ago, in which the payment of interest out of capital has been authorised, is the Regents' Canal, City, and Docks Bill in 1885; but he points out that the Standing Order was only suspended in that case "on eleemosynary grounds," to avoid the inconvenience of stopping the expenditure of money in support of labour at a time of extreme and almost unprecedented calamity, and he adds, that in spite of this but little capital has been subscribed up to the present time, and no work of any kind has been begun. After setting forth the general arguments in favour of a change, he observes:—"It may be fairly surmised that the real, though not the ostensible reason for the change, is that the promise of the payment of interest during construction offers a tempting bait to small capitalists." He cannot, however, believe that Parliament would give a deliberate sanction to a system capable of being worked as a means of deception, and he contends that if the promoters of the change are right in the only serious argument which they advance, viz., that investors will not take shares in new undertakings unless some return is secured to them during the unremunerative period required for construction, this difficulty can be partially met, as the law now stands, by the directors inviting such shareholders as wish to do so to pay up their shares in full on allotment, and thus entitle themselves to interest on their payments in advance of calls. If this is considered inadequate, the Committee on the Bill might be empowered either to insert a clause requiring the company to receive from any shareholder who makes the tender a sum of money on deposit, to be returned to him by equal instalments during a given period, such deposit to be in addition to and independent of the shares, and not to pass by a transfer of the shares unless expressly assigned, or to authorise the company, in addition to the permanent capital, to issue a proportionate amount of temporary capital, to be returned to the shareholders by instalments during a given period, such temporary capital to be employed only for the purpose for which it is subscribed, and not to be entitled to dividend. There is no serious difficulty in working out either of these methods in such a way that the real nature of the transaction cannot be mistaken, and that no principle of law or parliamentary practice is infringed. "But," he asks, "will the public be tempted by the promise of interest during construction if they clearly understand that it is simply so much of their own capital returned to them?" Lord Redesdale proposes a number of provisions to carry out this view, and finally suggests that every Railway Bill shall contain a clause rendering liable to severe penalties any director or other representative of the company who directly or indirectly pays or procures to be paid any interest or dividend contrary to the provisions of the Bill, and making illegal and void any contract entered into by the company, or the promoters or directors or agents thereof, or any of them, under which payment of any interest or dividend shall be directly or indirectly provided for contrary to the provisions of the Bill. At the same time, Lord Houghton has obtained a Select Committee to be appointed to inquire whether it is expedient to amend Standing Order No. 128, and if so, in what respect; and to move, "That no Bill containing provision for payment of interest out of capital during construction of works be read a second time before the report of the said Committee has been laid upon the table." The Committee will consist of the Lord Chancellor, the Marquis of Salisbury, the Earl of Morley, the Earl of Northbrook, the Earl of Redesdale, Lord Houghton, Lord Watson, Lord Bramwell, Lord Hillington, and Lord Grimthorpe.

The Bill to enable the Salford Corporation to invest a quarter of a million in the canal is still threatened with vigorous opposition, and the appointment of the Committee just mentioned greatly and seriously increases the danger to the Canal Bill, which must fail if the Committee decide against the payment of interest principle, and the House of Lords endorse that view.

Of the 197 Bills for which petitions were deposited, seventy-three commenced in the Lords and 124 in the Commons. Twenty-six Bills are at the stage of first reading, forty-seven at second reading, twenty-five at report, twenty-six at third reading, and twelve have received the Royal assent. Twenty-six Bills are dead, some have been rejected at the Standing Order, second reading, or commitment stages, while others have been voluntarily withdrawn by their promoters. In the House of Lords several Bills, including the Manchester Ship Canal Bill, are in suspense during the inquiry above described into the expediency of authorising the payment of interest out of capital.

The Select Committee on the Electric Lighting Bills consists of Earl Cowper, the Earl of Camperdown, Viscount Bury, Lord Balfour of Burleigh, Lord Rayleigh, the Earl of Crawford and Balcarres, Lord Methuen, Lord Houghton, and Lord Lingen—a strong and representative Committee. The Earl of Camperdown has been appointed Chairman, and the Committee will meet for evidence on May 10th.

MACHINERY FOR MAKING ROOTS' BLOWERS.

MESSRS. THWAITES BROTHERS, BRADFORD, ENGINEERS.

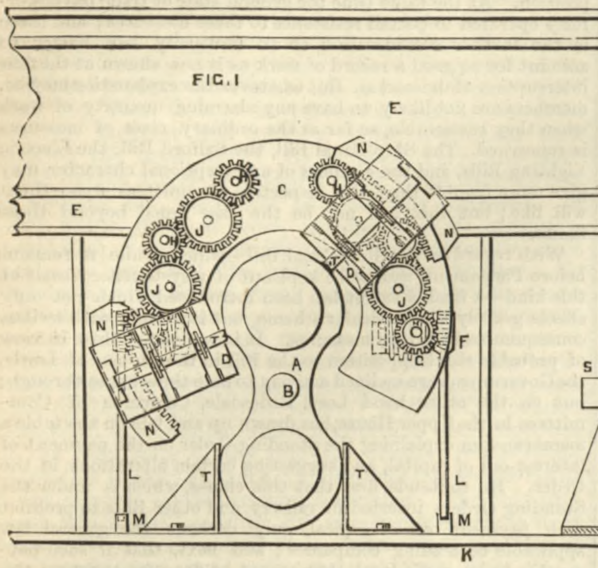


FIG. 1

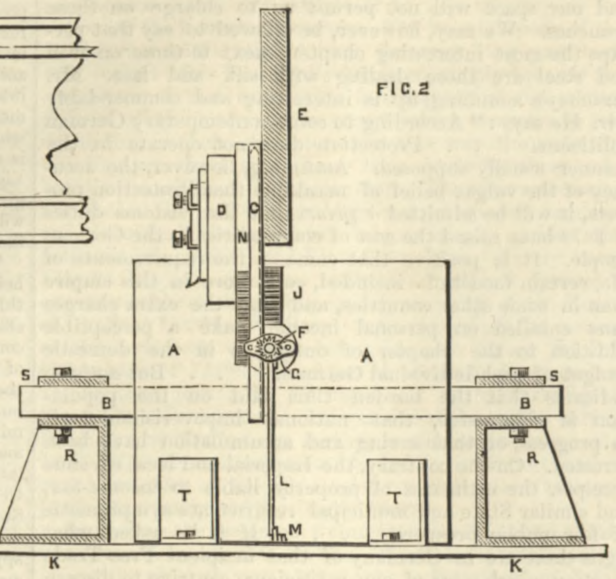


FIG. 2

FIG. 3.

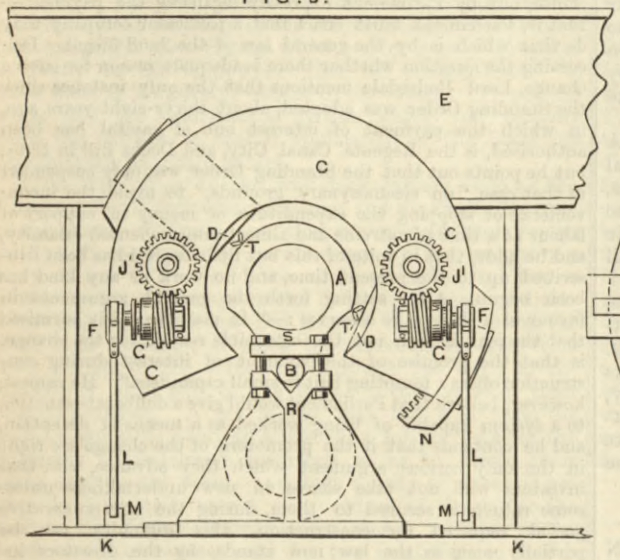
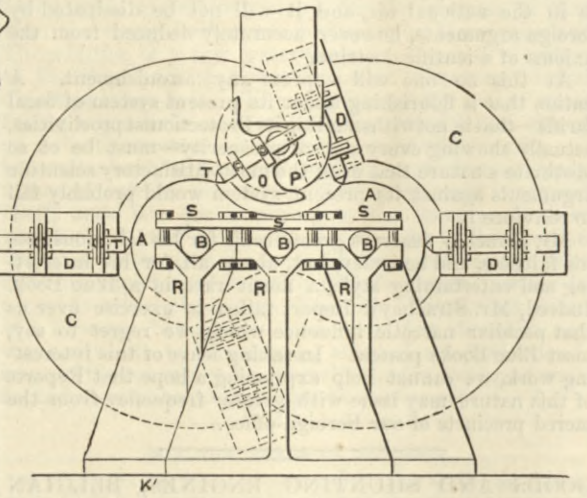


FIG. 4.



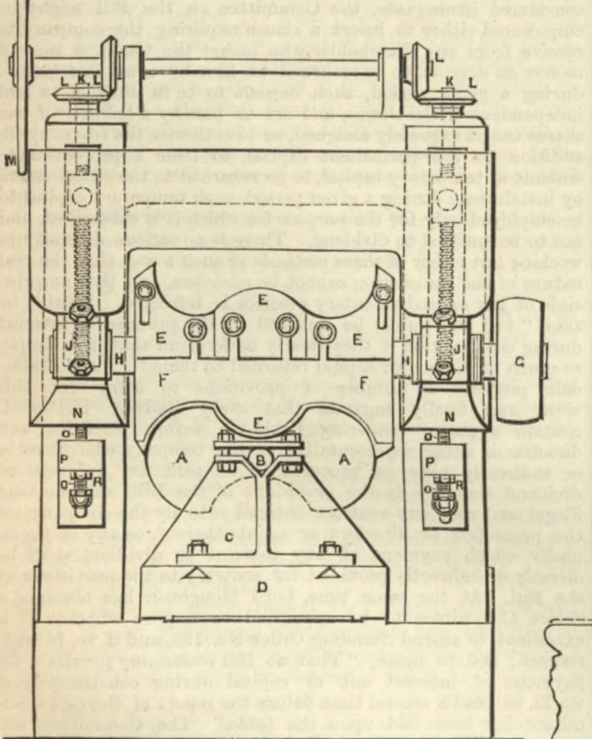


FIG. 5

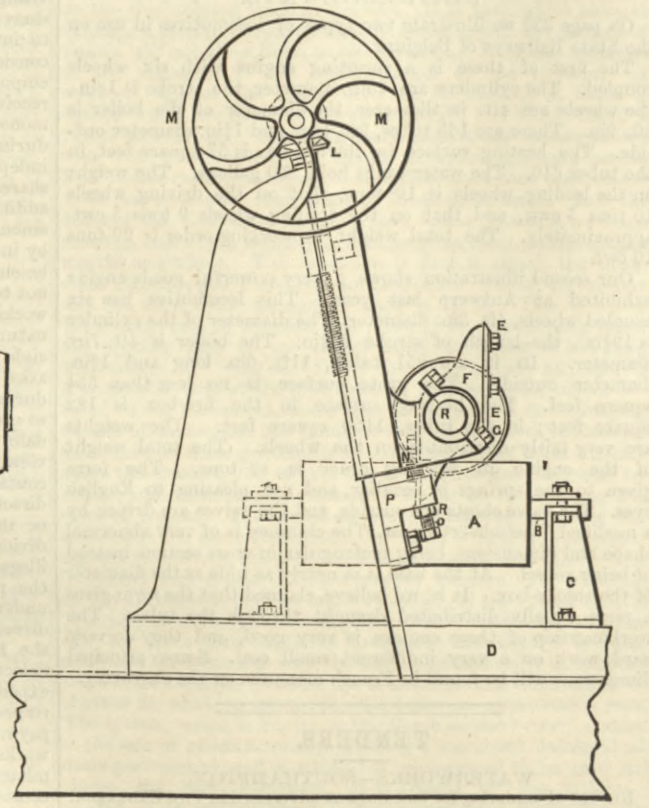


FIG. 6

MESSRS. THWAITES' BLOWERS.

We recently illustrated machinery for shaping the "revolvers" of Root blowers, and we now illustrate the very ingenious appliances used by Messrs. Thwaites Bros., Vulcan Ironworks, Bradford, for shaping the revolvers of the improved Root blower, which they have manufactured for several years. The general construction of these blowers is too well known to need description. All that we have to deal with now are the tools used in their manufacture.

Fig. 1 represents a front sectional elevation of a machine for planing or shaping the convex ends of revolvers constructed wholly of iron. Fig. 2 represents a side sectional elevation, and Fig. 3 represents a back sectional elevation of the same. Fig. 4 represents a front sectional elevation of a modification of the same machine, in which a greater number of tools are caused to operate upon the revolver at the same time, and whereby the concave recess in the revolver is planed or shaped at the same time as the convex ends. Fig. 5 is a front elevation of a machine for shaping wood-covered revolvers which have an interior framework of iron; and Fig. 6 is a side elevation of the same. The revolver is shown at A, and B is the mandril upon which it is supported and held firmly in its place while being planed; in the machine shown at Fig. 4 three mandrils are used to support the revolver. The curved guide C upon which the tool holders D travel for the purpose of planing or shaping the convex ends of the piston or revolver is held securely in the centre of the cross slide E of the planing machine. At the back of the guide C are two pawls and ratchets F, which actuate worms G, which give motion to wheels J[1], and thereby to a set of pinions H and intermediate wheels J. The worms are actuated by the pawls and ratchets F, which receive motion at each traverse of the planing table K from levers L, which come in contact with the blocks M fixed to the planing table K. The pinions H engage in the teeth of the racks N which actuate the tool holders D in such a manner that as the tool holders pass round the curved guide C one or more of the pinions is always in gear. The method of planing or shaping the recessed or concave part of pistons or revolvers is illustrated in Fig. 4, in which four tool holders D are shown operating upon the convex ends of the piston or revolver, and one radial tool holder O, which works upon a fixed centre, and is caused to travel in the usual manner, planing the recessed or concave part of the revolver. The mandril upon which the piston or revolver is supported during the time that it is being planed or shaped is shown at B, and its ends rest in V-shaped recesses in the top part of the pedestals R, and are further secured by the caps S firmly held by bolts and nuts. The revolvers are held in position laterally while being operated upon by wedges or chocks T, which are bolted to the planing table K. The steel tools used are ordinary planing tools for cast iron, and are shown at T.

The method of planing revolvers with an iron framework and an outer covering of wood is represented in Figs. 5 and 6, in which the revolver being planed is shown at A, and is supported by means of the mandril B resting upon the pedestals C, which are bolted to the table D of an ordinary wood planing or similar machine. Before being fixed to this machine the outer wood covering of the revolver is roughed out to a size rather larger than it is required to be when finished. Two sets of cutters or plates of steel with cutting edges E which have the same outline as the finished piston or revolver, are firmly bolted to a strong backing or frame of iron, through the centre of which passes an iron shaft H, one set of cutters being upon the opposite side of the shaft to the other set. The shaft carrying the cutters is caused to revolve at a high rate of speed by the drum G driven from a counter shaft. Before the operation of planing commences the table of the machine is caused to move until one end of such table comes under the cutters, upon which end of the table is secured a finished iron model of the exact size that the wood-covered revolver is required to be. The cutters are then adjusted in a perfectly vertical position, and are lowered by means of the screws K actuated by the mitre wheels L, which can be turned by the hand-wheel M so that the adjusting screws K are moved equally and simultaneously on both sides of the machine. When the cutters have been brought down upon the surface of the finished iron revolver until they touch it evenly across, the set screws or stops O are screwed up until they touch the underside of the adjustable brackets N, which carry the shaft of the revolving cutters, and the set screws or stops are then fixed firmly as adjusted by the check nuts R. The cutters are then raised by a few revolutions of the hand wheel M, and the planing table moved until the wood-covered revolver comes under the cutters. The machine can then be started, and the

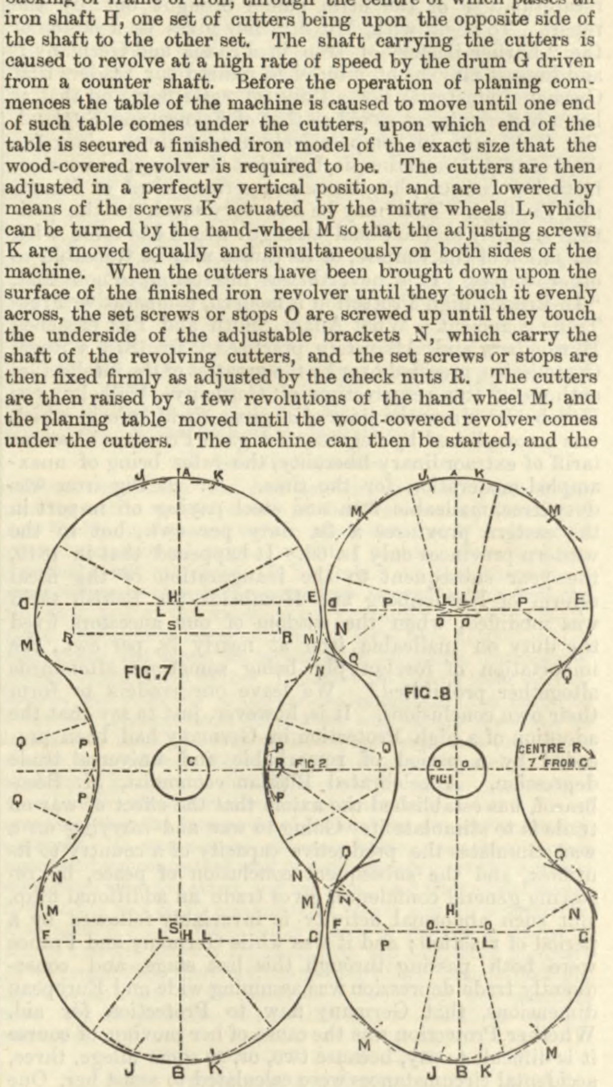


FIG. 7 FIG. 8

wood is cut away until the bottoms of the brackets N rest upon the set screws or stops O, and one side of the revolver will then be finished; the revolver is then turned over and the other side finished in the same manner as the first.

Figs. 7, 8, and 8A show an improved form of revolver patented by Mr. T. H. Thwaites. The invention consists in forming the curved outlines of revolvers of a series of arcs of circles joined one to another in regular and flowing lines, avoiding any breaks or angles at the junctions, whereby the action of the blowers is rendered more uniform and steady, and the irregular beat and vibration caused by the angles and broken outlines of revolvers hitherto in use are avoided and a more steady stream of air is produced; at the same time the pistons or revolvers come as nearly as possible into contact with each other without actually touching in all parts of their revolution, thereby avoiding any unnecessary escape of air between the pistons or revolvers, and consequent loss of power.

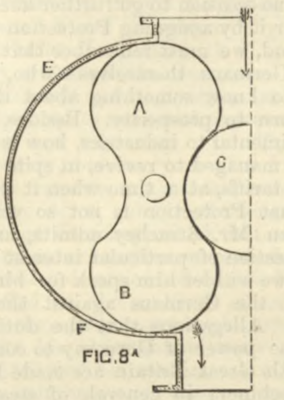


FIG. 8A

Blowers made in this way allow of delivering a larger volume and greater pressure of air with a smaller expenditure of power, and are capable of running at a higher speed with less vibration and less noise than is possible with pistons or revolvers heretofore in use.

Messrs. Thwaites have not confined themselves to effecting improvements in the systems of making the revolvers, and in the forms given to them; they have modified the entire machine, to augment its efficiency. Fig. 9 illustrates an improved adjustable bearing, which can be set up when worn without affecting the position of the centre of the revolver. The shaft of the revolver is shown at A, and upon this shaft is firmly driven the case or bush B of gun-metal, which is prevented from turning round upon the shaft by the key C. D represents a bush of hardened steel which fits truly into the parallel aperture in the boss cast upon the side of the case of the blower or pump F. The case or bush B revolves with the shaft A and not upon it, and in the hardened bush D, and as such case becomes worn the check nut H is slackened and the screw cap G is tightened by means of a semicircular wrench made for the purpose and having two pins fitting into the apertures in the screw cap J. By tightening the screw cap G the hard steel bush is forced further into its seat in the aperture of the blower case, as far as may be required from time to time to compensate for the wearing away of the gun-metal case B. When the screw cap G has been tightened sufficiently, the check nut H is screwed up to it and holds it firmly in position.

When a steam engine is coupled direct to the blower, Fig. 10 shows the connecting-rod used at A. The crosshead is shown at B and the pin at C. The pin C is made of hardened steel, and is turned parallel at the smaller end, which fits into one eye of the crosshead. The middle portion of the pin is tapered where it fits into the brass or gun-metal bush D, which bush is turned or bored with a tapering hole to receive the pin C. The thicker end of the pin C has a thread cut upon it for the purpose of screwing into the larger eye of the crosshead. When the bush D becomes worn, the pin C is screwed further into it by means of a wrench placed upon the square head E, and the pin is then held fast by screwing up the check nut F. At the opposite end of the connecting-rod the crank pin G is tapered in form, and as the bush H becomes worn it is forced further upon the crank pin G by tightening the nut J and locking it in position by the check nut K. Fig. 11 is a sectional elevation of a revolver for use in a rotary pump. At A is shown the piston, and at B tongues or strips of packing of india-rubber, vulcanite, or other suitable material, which are attached to the piston by hinges at C. The packing is pressed outwards by spiral springs, shown at D. In Fig. 12 the packing is shown at C.

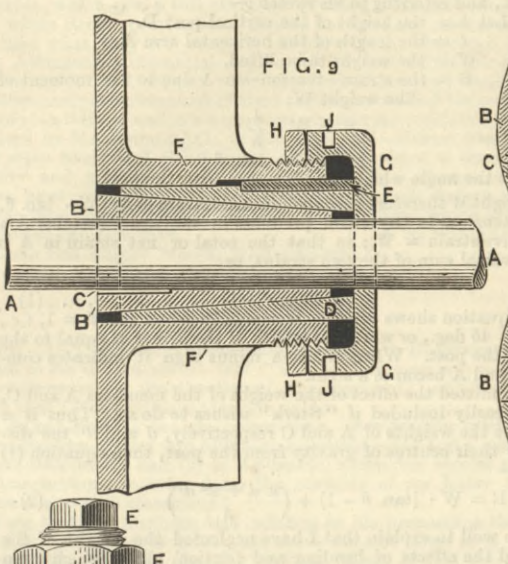


FIG. 9

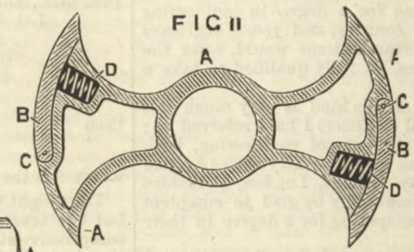


FIG. 11

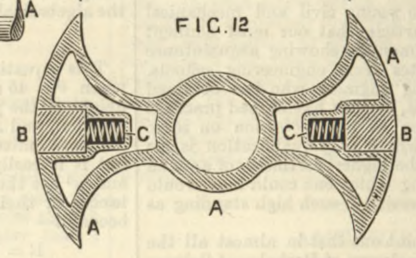


FIG. 12

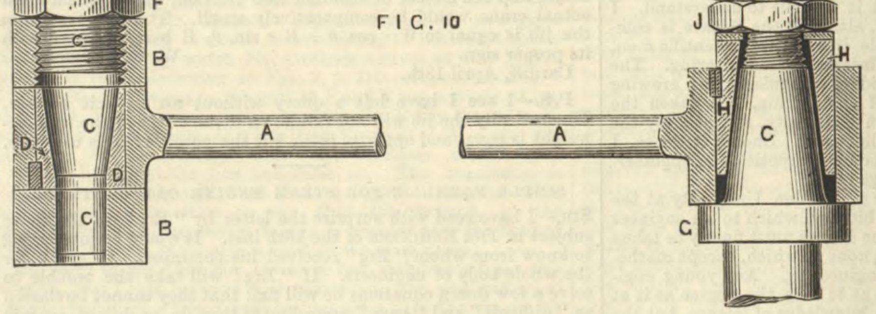


FIG. 10

The Root blower, as is well known, came originally from America. The improvements which it has undergone in this country have rendered it a much more silent and efficient machine than it was when it first reached our shores.

LIGHT RAILWAY LOCOMOTIVES AT THE ANTWERP TRIALS.

THERE were, strictly speaking, in connection with the Antwerp Exhibition of last year, two separate tramway competitions, each embracing two groups, the first group of the first competition consisting of locomotive or automotive vehicles for circulation in towns and cities; and the second group, of similar vehicles for light or secondary railways in the country, where the conditions of working need not be so rigorous; while the second competition was of tramcars for horse or mechanical traction, both in towns and in the country.

Our leading article of January 29th dealt with the first group of locomotive and automotive vehicles; and the paper read by Captain Douglas Galton before the Society of Arts exhausted that branch of the subject. We therefore propose, on the present occasion, to dwell more particularly on the competition between the locomotives for light lines, called in Belgium *chemins de fer vicinaux*, or parish railways.

Captain Galton concludes his paper by observing that, in England, with depressed trade and agriculture, there is great want of cheap means of conveyance from railway stations to the surrounding districts; that such a means of communication might be afforded by light railways along, or near the roadside, if expensive making and working were dispensed with, and that this question must come to the front as soon as a representative system of local government has been adopted, when each local authority can decide on the measures necessary to develope its resources without interference from a centralised bureaucracy.

In the discussion which followed the paper, Mr. Scott Russell regretted that some information had not been afforded about the *chemins de fer vicinaux*, because such a system had been begun in Ireland. It will not, therefore, be out of place to give a short account of this movement for bringing outlying districts within reach of existing railways, finding work for a large number of men who would be otherwise unemployed, and also affording orders for permanent way and rolling stock which come in most acceptably at the present moment.

The vicinal, or secondary railways of Belgium, are intended in no way to compete with the main lines, but rather to act as feeders. They are generally of metre, or 3ft. 3⅜in. gauge, and are laid, where possible, along the side of a road, so as to require scarcely any earthwork. Steam is employed for traction; and the trains are run at frequent intervals with numerous stoppages. The Société Nationale des Chemins de Fer Vicinaux was legally constituted the summer before last, and its statutes were revised last summer. Independent of the Government, though subsidised by it under certain conditions, the society has been formed to insure light railways being laid all over the country, in poor districts, as well as those certain to afford a return. By virtue of an article in the law of June 24th, 1885, provision is made, on the intervention of the Minister of Agriculture, Industry, and Public Works, for concessions of secondary lines being granted to individuals or companies other than the Société Nationale des Chemins de Fer Vicinaux. But, failing this, each railway projected by the National Society gives rise to the issue of a series of shares to the amount required for construction and eventual working. Companies, firms, or individuals interested in the line may subscribe to the extent of one-third the capital, the remainder being found by the State, the province, and the commune or parish, each in certain proportion. The capital thus brought together affords a fund for making the line which is let by public contract, for the purchase of rolling stock, and also for working in the event of no local company undertaking it for 1500f. per kilometre, or £96 per mile, with a percentage on the receipts. The cost of construction and rolling stock is estimated at from 35,000f. to 40,000f. per kilometre, or between £2240 and £2560 per mile. The heaviest gradient is not to exceed 1 in 17, nor the sharpest curve be under 15 metres, or 16½ yards radius, while the engines weigh 13½ tons empty, and the wagons carry 5 tons. Contractors' rails, 43 lb. to the yard, have hitherto been laid on light oak sleepers, but strong representations are being made in favour of metal sleepers. Indeed, in three lines projected near Charleroi, and amounting to above 24 kilometres together, the local authorities have made their sanction subject to the adoption of metal sleepers. Instead of station buildings, a mere shed will be put up where an *estaminet* or inn cannot be made to serve the purpose. As a matter of policy, those lines which may be expected to give good returns are taken in hand first, so as to provide a fund for covering any future deficiency. Vicinal railways have already been opened between Ostend and Nieuport along the coast, and also between Antwerp and Hoogstraeten, the total length of the two being, in round numbers, 60 kilometres, or 40 miles, while more than 1000 kilometres, or 620 miles, have been surveyed for speedy execution.

Several circumstances contributed to invest the second group of vehicles in the Antwerp competitions with great interest for Belgium. Before the conclusion of the trials, the Vicinal Railway Administration had definitely adopted as its standard one of the competing locomotives, that of Cie La Métallurgique, which eventually received a diploma of honour. These engines have for some time "horsed" two light lines in successful operation, though independent of the National Society, one between Brussels and Boondael, and the other between Liége and Jemappes, both of which are to be extended. Moreover, for some years past tramway trains, consisting of a light engine and tramcars, are run on the railway between Liége and Visé on the Dutch frontier, between the ordinary trains, at more frequent intervals and with more numerous stoppages. In consequence of the success of this dual method of working, the officials of the Belgian State Railway Administration are making trials of tramway stock for running between the regular trains on those portions of their system where the traffic is not heavy.

The second group included locomotives or automotors designed for steam tramways or secondary railways, and the conditions were:—(1) Absence of smoke; (2) minimum of noise; (3) width not to exceed 2¾ metres or 9ft.; (4) the pressure of no wheel on the rail to exceed four tons; (5) all moving parts, except wheels, to be out of sight; (6) the fire to be concealed; (7) the drivers, with all their levers at hand, to be able to see 2 metres ahead, and (8) curves of 35 metres, or 38 yards radius, to be passed without difficulty. The jurors' attention was also directed to the following points in making their awards:—More or less complete absence of noise and a cloud of steam, as well as elegance of appearance and absence of smoke; more or less complete protection of the motion from dust and mud; regularity and quietness of working; minimum consumption of coke and lubricants; sharp pulling up by brake; greatest amount of boxing-in of the engine while permitting access by the driver; simple and rational construction; facility of inspecting and cleaning the inside of boiler; continuous daily running without other stoppages than those required by the service; and expense of maintenance per train-kilometre. Account was also to be taken of any defects or drawbacks, of the necessity of turning at the termini, and the working by one man only or two.

Whereas all the engines entered in the first group are of normal gauge, four in the second are of normal and two of metre gauge, there having been three rails in the tramway laid down between the station and the Exhibition. On the other hand, while three in the first competition are automotive and two locomotive—besides two of them not being worked by the direct action of steam—all six in the second are steam locomotives, some with the cylinders and motion inside and some outside, while two of them partially condense their steam. All, however, have their moving parts concealed from sight and protected from dust and mud. The following are the entries in the second competition, with the awards:—Henschell and Son, Cassel, diploma of honour, tramway locomotive of metre gauge, partially condensing; La Métallurgique, Brussels and Tubise, diploma of honour, two tramway locomotives, one of metre and the other of normal gauge, and one partially condensing; Krauss and Co., Münich, gold medal, non-condensing tramway locomotive of metre gauge, with outside cylinders and all the motion outside and accessible; Esslingen Maschinen-Fabric,—Kessler—gold medal, non-condensing tramway locomotive of normal gauge, with brasses completely enclosing the crank pins and the curtain absent in front of the wheels.

The annexed Table A, from the Jury Report, gives the leading particulars of each engine, with certain relations established therefrom, which appeared to the jury interesting to determine.

In arriving at their decision, the jurors considered the four competing locomotives from three separate standpoints. As regards absence of steam, noise and smoke, brake power and boxing in, they classified the engines in the following order:—1, Krauss; 2, Métallurgique; 3, Henschell; and 4, Esslingen. With respect to protection of moving parts, regularity of working, simple and rational construction, ready inspection, absence of break-down and low expense of maintenance, the order was:—1, Henschell; 2, Métallurgique; 3, Krauss; and 4, Esslingen; while as regards consumption of fuel and grease, they stood as follows:—1, Esslingen; 2, Henschell; 3, Métallurgique; and 4, Krauss. But it was thought fair to slightly modify this last order by taking the weight of engine into consideration. Then, taking the three standpoints together, the decision recorded above was arrived at.

The secondary locomotives worked, turn by turn, with the town locomotives and the automotors; but they always drew four tramcars after them, the speed never exceeding 12 kilos., or eight miles, an hour. They ran, as a rule, for four days, and then had two days for overhauling. Some doubt has been thrown upon the possibility of keeping an efficient check on the fuel consumed; but one of the best guarantees lies in the fact that, besides the jury delegates, all the competing firms or companies had not only their own representatives but also their own drivers, who, being of different nationalities, entered thoroughly into the spirit of the competition, and kept a sharp watch upon each other, and upon the officials. The coke for each journey was weighed in the yard, and again in the open Boulevard, before each driver, who signed for it; and the receipts for each engine's stores were printed on variously coloured papers, so that they might be identified in the event of the signature being illegible. There was no chance of taking up a surreptitious supply on the journey, for the only stoppages were at pass-by's, when each driver was under the eyes of a rival. We have before us copies of the forms on which the receipts for coal, coke, oil, tallow, &c., were given; of the way-bill on which the particulars of each run were recorded; of the daily report of the performance of each engine, with the hours of entering and returning, the number of hours' work, the number of passengers carried, the number of kilometres traversed, the number of carriages attached, the number of men, and the time spent, with the consumption of coal, coke, wood, oil, grease, tallow, cotton waste, and water.

The second competition was for tramcars, the first group for the country and the second for towns, in which all the Belgian makers competed. Some of the seat backs were made reversible to save the necessity of turning end for end; and one—the Mechlin Company—sent three tramcars that could be made open or closed at pleasure. The following are the jury awards in this second competition:—First group: Gold medal, La Métallurgique; silver medal, Verhaeghen—Ragheno—Mechlin; bronze medal, Nicaise and Delcuve, La Louvière; and A. and V. Halot, Louvain. Second group: Gold, Société Franco-Belge; silver, W. R. Rowan.

The rails for the tramway on which the trials took place were lent by the Administration of the Grand Central Belge, and were taken up directly the Exhibition closed. The prime mover and active spirit throughout these competitions was M. Charles Dupuich, the Belgian juryman of railway exhibits, and engineer to the Société Générale des Chemins de fer Economiques, Brussels, which provides foreign countries with steam or horse tramways.

TABLE A.—*From the Jury Report.*

Locomotives.		Weight. Empty.	Weight. In running order.	Heating surface. Direct.	Heating surface. Total.	Grate surface.	Pressure in atmospheres.	Cylinders. Piston stroke.	Cylinders. Diameter of cylinders.	Diameter of wheel.	Tractive effort calculated by the formula: $E = 0{\cdot}5\,\frac{t\,d^2\,l}{D}$	Height above rails of boiler centre line.	Water tank.	Coke bunker.	$\frac{d^2\,l}{S}$	$\frac{d^2\,l}{s}$	$\frac{P}{P_1}$	$\frac{P_1}{S}$	$\frac{P_1}{s}$	$\frac{P_1}{G}$	$\frac{S}{G}$	$\frac{P}{E}$
		kilogs.	kilogs.	m².	m².	m².		m.m.	m.m.	m.m.	kilogs.	metre.	litres.	litres.								
Henschell		11200	14700	3·25	26·35	0·64	14	350	260	800	2070	1·69	2300*	500	0·0008979	0·00728	0·7619	557·875	4523·077	22968·750	41·1718	5·411
Métal-lurgique	Liége-Seraing ..	11300	15200	3·04	18·60	do.	12	330	230	800	1428	1·24	930	740	0·0009385	0·006264	0·7434	817·204	5000·000	23750·000	29·0625	7·913
	Bruxelles-Ixelles..	12000	14600	3·04	18·60	do.	12	360	260	832	1755	1·24	1400	600	0·0013083	0·008005	0·8219	695·238	4802·632	22812·500	29·0625	6·838
Krauss		8600	10700	1·89	20·71	0·34	15	300	210	750	1323	1·43	1010	460	0·000638	0·007000	0·8037	516·658	5661·376	31470·588	60·9117	6·500
Esslingen		10300	12650	3·20	26·30	0·67	14	300	245	800	1589	1·73	1200	250	0·0006846	0·005627	0·8142	480·988	3953·125	18880·597	39·2537	6·482

* This engine was made for a line with few watering-places.

Reference to Table.—P = weight empty. P_1 = weight in running order. d = diameter of cylinder. l = piston stroke. D = diameter of wheels. E = tractive power. S = total heating surface. s = direct heating surface. G = grate surface. t = boiler pressure in atmosph.

LETTERS TO THE EDITOR.

[*We do not hold ourselves responsible for the opinions of our Correspondents.*]

GOOD AND BAD WORK.

SIR,—I have read with much interest the discussion which has been opened in your journal on the subject of "Good and Bad Work," and the opinions given by various men in the trade as to whether good or cheap work should be the means not only to attract customers, but also to gain money. These few words, I think, clearly set forth the question, and although for those interested it could not be otherwise, I am astonished that after having been so clearly and fully discussed by many of your correspondents, there should be so few who seem to take account of the arguments put forth, some of which can be, and are, so easily proved every day, that it is difficult to understand how they can be so often questioned.

As the work exhibited at Antwerp has been in some measure the cause of the discussion which has been opened in your valuable journal, and as it is a question of universal interest, I feel it my duty to return for a few moments to this Exhibition, in which the builder exhibited pieces of work particularly well finished, and which may certainly be classed among the "good work," to prove that good work often costs less than bad. He even gave the time required to finish certain pieces. Are our adversaries prepared to prove to us that bad work could be done in less time? In one word, to give another example, can less be done than was done to the most correct cylindrical pieces which were exhibited and which were finished in three cuts—the first a roughing cut, the second to bring the object near to the required dimensions, and the third the finishing cut, and all this with the maximum displacement of tool which it was possible to make use of without springing the object whilst being turned?

It might be objected that it would not be impossible to do the same work with two cuts instead of three, to have only the appearance of a good job, but yet to be a bad job, although time would be gained upon the first. Well, this is not possible, for to take off in one cut what has been removed in two would require more time than when the operation is conducted in a methodical manner, *i.e.*, by employing the most correct and direct process.

As your correspondent "G. B." very truly remarks in his article of the 3rd inst., "all depends upon the use of good tools and good methods." In these conditions maximum of production can certainly be obtained without diminishing the excellence of the object produced.

As to maintaining, as your correspondent "Fair Play" does, that it is not possible to produce interchangeable pieces at the same cost as ordinary work, I pretend that it is precisely in such cases that the object can be most easily attained; and for this reason, that to produce them it is necessary to use machines adapted specially for the work they have to do, and of such a quality that all subsequent hand-labour becomes needless, or almost without importance. If it were not so, how would it be possible to turn out at such low prices small arms, sewing machines, watches, flax and cotton machinery, and other kinds of work, whose prices are incomparably below that where interchangeability is not absolutely indispensable, and where it has not occasioned a special fabrication schemed particularly with a view to attain this twofold result?

Allow me to say that "Fair Play" is still wrong in attributing the falling off in the quality of English work to the introduction of the piece-work system. This system, which engages the absolute responsibility of the workman, is, on the contrary, in my opinion, the only way to arrive at the production of good work; for if the workman is obliged to realise certain conditions of accuracy which exist in the sample given him, and to which his work cannot be inferior under pain of seeing it refused, how is it possible that the quality of the work can decline? This can only happen with the consent of the master, who may imagine that, by giving a bad sample and allowing it to be copied imperfectly, he can produce an object at a lower price than by giving one which is correct. Moreover the observance of a pattern and the taking of correct measurements is ofttimes but a matter of attention, and the use of correct methods.

In turning, for instance, when giving the finishing cut to gauge, does it take more time to finish the object to measure with the greatest exactness for the first ¼in. turned? and when this has been done, does it cost more to allow the tool to go over the object in these conditions than to do the same work without this care? I would say the contrary; if this care has not been taken, the workman will in all probability have to take another cut, owing to his having perceived too late that the piece was not to dimension; or else he will be obliged to use the file, which will take time, and the work will not be cylindrical. On which side then will be the advantage and the good work? I always suppose that to arrive at the minimum cost and excellence of quality that the most perfect machine tools are made use of, without which it would be impossible to arrive at these results. If "Fair Play" will read again the article in The Engineer of August 14th, September 11th and 18th, and October 30th, 1885, he will see that with such tools one can turn cylindrical pieces to within one three-thousandth part of an inch of perfection. It is certain that it would not be so easy to obtain the same result in heavy work of large diameter and great length, and that for each particular case special means must be employed; but as we are not dealing here with watch-work, but with parts of engines of some hundreds of horse-power, I consider that the example is sufficient to be conclusive.

One must not run away with the idea that I am of opinion that good work should not be paid for at a higher price than bad work. Where would be the merit and recompense of the good builder if he is to be put upon the same footing and paid in the same manner as the inferior builder? It is sad to have to say it, but the principal cause of the decline of the quality of work is that there are so few persons capable of distinguishing between the good and the bad; to all appearance they are the same, and it is only a practised eye or the using of the object which enables one to appreciate its worth.

I was told the other day by an engine builder of high standing "that to make the good work prevail, competent men and first-class trustworthy industrial publications should strive to induce a preference of good work over the bad by assisting all those people who are not connoisseurs with their advice and counsel." But how many are there, apart from a few exceptions, who do this? Do we not see most publications bestow the same praise upon work of very different quality? It is very rare that publications are sufficiently independent to state the truth; but this is nevertheless what they should do even at the risk of displeasing some of their readers. For without this there is no serious publication nor useful advice, nor even stimulant to progress, often dormant in a false security or blinded through unmerited praise. When such a journal as The Engineer takes up such a discussion, and after having drawn attention to it, invites a free discussion in its own columns, sometimes expressing in a most energetic manner its own convictions, it is evidently rendering the greatest service to all who are interested —for discussion naturally brings forth light, and a great number of its readers gather from it, if not a complete solution of the question, at least some useful information which enables them to form an opinion.

P. K.

Ghent, April 17th.

THE EDUCATION OF ENGINEERS.

Sir,—In venturing, with your permission, to occupy a small portion of your valuable columns on the above subject, I am emboldened by the interest you have evinced in the education of engineers in two recent articles. The University of London, as is well known, is the only one in the kingdom at which a student may obtain a degree without first passing through a prescribed course of study at the university. In thus throwing open its degrees to all who are competent to take them, this university confers a great boon on a large number of deserving students. Its degrees are more difficult to obtain than those of other universities, but this is not generally considered a disadvantage, since they are, therefore, the more valuable, and are more highly prized when obtained. A glance at the figures given in the calendar of the university will show how largely its examinations for degrees are taken advantage of throughout the country. Yet we find that in that particular branch of scientific study dealt with in your journal, viz., engineering, no degree is offered. This I think is a most flagrant omission. Surely it cannot be supposed that a young engineer cannot be qualified to take a degree in engineering without having undergone special training at one or other of the Universities in the country, where he might take a degree. I am of opinion that, so far as mechanical engineering is concerned, it is utterly unnecessary for any youth who intends to follow out that branch of engineering, and leaves school with a tolerably good education, to spend three or four years in passing through a complete University course of training. There are many young engineers, who have never attended a University course, with a thoroughly good theoretical knowledge of their profession, and who only require training in some of the higher branches of mathematics to enable them to carry off a degree in engineering were it established by the University of London. Many of these—and I refer chiefly to young mechanical engineers—acquire their theoretical knowledge mainly by attending evening classes at technical science colleges at the same time as they are engaged in every-day practice in the workshop. I venture to say that at least three-fourths of the Whitworth Scholars appointed of recent years have passed through no University curriculum, but have obtained their honours by studying practical and theoretical engineering simultaneously. The higher stages of the examinations for this scholarship are quite as advanced in their character as the examinations for a degree in engineering at some of the Universities in the country, and young engineers who take a foremost place in such examinations would, after the study of more advanced mathematics, be fully qualified to take a degree.

I think that the want of a degree of this kind is very much felt amongst the class of young practical engineers I have referred to; but besides these there are many students of engineering, both civil and mechanical, at those colleges in the country where degrees cannot be obtained, *e.g.*, University College, London, Yorkshire College, Leeds, &c., who would undoubtedly be glad to complete their theoretical apprenticeship by competing for a degree in their own particular branch of study.

As to the value of a degree to young civil and mechanical engineers, you point out in your article that our most eminent engineers value more highly testimonials showing acquaintance with practical work than certificates from engineering schools. This is very true, but, still, a young engineer who has obtained certificates from engineering schools, besides having had practical experience, competes for a position in his profession on more favourable grounds than another whose only qualification is his practical knowledge; and, further, the highest certificate of a sound theoretical knowledge of engineering which one could hold would be a degree in engineering of a University of such high standing as the University of London.

It is hardly necessary for me to point out that in almost all the other Universities in the kingdom the degree of Bachelor of Science may be taken in engineering, and why the University of London, which is the only one whose degrees are open to all students, should stand alone in this matter it is difficult to understand. I can only attribute it to the fact that, although the Senate is composed of a large number of very able literary and scientific men, yet none of these have any direct interest in engineering. The Senate of the University of Cambridge, recognising the growing importance of a scientific study of engineering, has taken the matter up in connection with its own University, and possibly the Senate of London University may follow suit. Should it do so, I am sure that any honours it may offer for competition in engineering will be very fully taken advantage of.

In competing for the B. Sc. degree of London University at the present time it is necessary to study biology, which to an engineer is very largely a waste of time, and the degree must finally be taken in three out of a list of nine subjects, none of which, except mathematics, have any connection with engineering. Any young engineers who go so far out of their way as to take the degree as it at present stands must have a thorough knowledge of science, but the degree which they may ultimately obtain does not in any sense form a testimonial of engineering ability. The matriculation examination of the University presents a barrier to many, since a good general knowledge of three languages is required; but this is not a matter of difficulty to those who have received a good education at school, and may be overcome with a little perseverance by those others whose school education did not extend to classics. For students of science, however, I think that the University of London would do well to substitute mechanical drawing for one of those languages—a proposal which, I believe, has already been made.

I have no doubt but that many of your readers will be able to confirm what I have said as to the prevalence amongst young engineers of a desire for an open degree in engineering, and the benefit which the University of London would confer on many if it were induced to establish it.

A Student of the Inst. of C.E.

London, March 30th.

Sir,—I have read with interest and considerable sympathy your remarks in a late number of The Engineer on the scientific and technical training of engineers, and I am quite of opinion with you that, though a man may graduate high in the Engineering Tripos at Cambridge, it is no test that he is a capable engineer. In fact, it almost proves the contrary; for the years which should have been spent in practical training have been devoted to the study of mathematics, physics, and mechanics, which, though of invaluable assistance, are useless without that practical knowledge only to be gained in the workshop and drawing-office.

Thus the long and severe technical training, though it does not make a man an engineer, places him in a position to make full use of every opportunity of acquiring practical skill and experience, and if only he has the wisdom to begin at the bottom, in a few years he will outrun those who started earlier, but without the previous scientific training. Cambridge University is therefore to be congratulated in the provision which she has made for engineers, and in this respect she presents a favourable contrast to her modern rival, London University, which hitherto has afforded little encouragement to those who would infuse into practical work a truly scientific knowledge. In fact, just at the present time she has withdrawn the only examination in engineering which came within her purview. I refer to the new regulations of the D.Sc., under which the examination in mechanical science is a thing of the past. It is true that, up to the present time, no engineers have succeeded in obtaining that degree, owing probably to their inability to secure the highly theoretical as well as practical knowledge required. Now, however, there should be as little difficulty in obtaining the former at the various technical colleges and institutes scattered over the country as the latter.

Since London University has thus broken the slight tie which connected her with the engineering profession, it would be well for her, if she is to maintain her rank as a leading University, to follow the example of Cambridge, and establish a complete and thorough examination course for engineering students.

A. C.

April 13th.

Sir,—From my experience in workshop and school, I should say that years spent in workshops as an apprentice are a great waste of time to a young man intending to practice as an engineer. The advantage of being in a large works for a few years is that one gets a sight and comprehension of all kinds of machines as they are constructed and practically turned out. But this insight may more profitably be gained by being in the drawing-office, and from time to time inspecting the machines in progress.

I am of opinion that in a school, under competent supervision, a young man has even a better chance of becoming a judge of good work than in a factory. In a school the superintendent is wholly occupied with teaching, and the groundwork and development of each craft will be taught much more thoroughly than by a mechanic who has no interest in imparting his acquirements to the gentleman-apprentice casually placed under his care. I attended a course of engineering at King's College, London, for two years, and then went to a large factory for three years; and I must say I learned much more at King's of good, practical work than I should have done in double the time at the factory. In fact, in many cases I found I could instruct those put to instruct me. On the other hand, I had a chance of examining machines which I should not have dreamed of at school, or which would have remained as ideals only, without the workshop experience.

I fully agree with Mr. Lyon in thinking that hard study after a day's work in the shop is all but an impossibility to the ordinary young man. I know there are plenty of men who do read for many hours after their day's work in the shop; and I know also that ruined constitutions are only too often the result, and I would never recommend this strain of the capacities. There is hardly a workshop operation that may not be practised and efficiently learned in a college workshop under a competent practical teacher, and I am convinced that a man trained at college in theory and practice will earlier prove a competent engineer than one who gets his schooling first and then his workshop experience in the factory.

Hendon, April 14th. H. H. A. S.

STRAINS IN CRANES.

Sir,—In reply to "Stork's" inquiry in The Engineer of the 16th inst., and referring to his sketch:—

Let h = the height of the vertical post D.
l = the length of the horizontal arm A.
W = the weight to be lifted.
S = the strain—tension—in A due to the moment of the weight W.

then

$$S = W \cdot \frac{l}{h} = W \cdot \tan.\ \theta$$

where θ is the angle which the jib makes with the post.

The weight W therefore produces a tensile strain in A = W · tan. θ, but the tension in the chain produces in the same member A a compressive strain = W; so that the total or net strain in A is the algebraical sum of the two strains, or,

$$R = W \cdot \tan.\ \theta - W = W(\tan.\ \theta - 1) \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

This equation shows that R is zero only when tan. $\theta = 1$, *i.e.*, when $\theta = 45$ deg., or when the length of the arm A is equal to the height of the post. When R has a minus sign it indicates compression, and A becomes a strut.

I have omitted the effect of the weight of the members A and C, but it is easily included if "Stork" wishes to do so. Thus if w and w^1 are the weights of A and C respectively, d and d^1 the distances of their centres of gravity from the post, then equation (1) becomes—

$$R = W \cdot (\tan.\ \theta - 1) + \left(\frac{w\,d + w^1\,d^1}{h}\right) \quad . \quad . \quad . \quad . \quad (2)$$

It may be well to explain that I have neglected the weight of the chain, and the effects of bending and friction, all of which in an actual crane would be comparatively small. The compression in the jib is equal to W · cos. θ + R · sin. θ, R being inserted with its proper sign.

W. B. Coventry.

Cardiff, April 18th.

P.S.—I see I have left a query without an explicit answer. Theoretically the jib will not fall down if the effect of the counterweight is equal and opposite to R, but the equilibrium is unstable.

SIMPLE FORMULÆ FOR STEAM ENGINE CALCULATIONS.

Sir,—I have read with surprise the letter by "Erg" on the above subject in The Engineer of the 16th inst. It would be interesting to know from whom "Erg" received his commission to speak for the whole body of engineers. If "Erg" will take the trouble to solve a few dozen equations he will find that they cannot be classed as "difficult" and "easy," according as they do, or do not, contain fractional indices.

None of the equations given by Professor Unwin in his paper are difficult of solution to anyone having even an elementary knowledge of logarithms, and although tables are very useful things, it seems to me a pity that the existence of such tables should be used as an excuse for not having a sufficient knowledge of elementary mathematics to enable one to solve the equations from which such tables are derived. "Erg" should further remember that even admitting that "steam engine makers, or designers, or users" are not likely to make use of the equations in the above paper, there still remains the large class of students to whom such equations cannot help being useful, and Professor Unwin is entitled to their thanks for the trouble he has taken on their behalf.

Great George-street, April 19th. J. Forrest Brunton.

Sir,—Your correspondent "Erg" raised last week a far more important question than he perhaps thinks. It involves the general relations borne by professors and other teachers of engineering to the profession. What he says of Professor Unwin's paper is in a large sense quite true. That paper is in its way perfect. It is an admirable paper, but it really possesses no practical value to men doing every day work as engineers. It is impossible, indeed, to see that it possesses any value save an abstract one. It will not help a man, for example, to proportion the three cylinders of a triple-expansion engine to each other. On Friday night a very excellent paper on "Converting Existing Compound Engines into Triple-expansion Engines" was read before the Institution of Naval Architects. It is a pity Professor Unwin was not present. If he had been he would have learned what it is that engineers really want to be told by men like Professor Unwin.

The great defect of the modern engineering professor is that he has lost touch with the engineers. The reason why Rankine still remains so popular—in spite of the excess of mathematical formula to be found in his books—is that he always seemed to know what it is an engineer wants to be taught. Rankine, in a word, thought like an engineer. The papers which he wrote in The Engineer have never been nearly approached, not only in lucidity and accuracy, but in their marvellous utility.

It is certain that any of our professors who will shake themselves clear of the school, and think as if they were in the workshop, have a great future before them. I only know two at this moment who comply even partially with my views. There is nothing invidious in mentioning names in this relation, and I may say that the men I mean are Professor Kennedy, of University College, and Professor Smith, of Mason College, Birmingham. The first, gentleman, however, never writes anything; the last was for years a practical mechanical engineer. Professor Osborne Reynolds was at one time quite in touch with the profession—see, for example, his admirable papers, "Limits to Speed," published some years ago in The Engineer. Of late, however, he has become more and more a school man. Professor Lodge is a giant in his way, but, unfortunately, he has gone in for nothing but electricity of late.

London, April 19th. M.

RESIDUUM IN GAS ENGINES.

Sir,—I read with great interest your article on Körting's new gas engine, which appears to me to have some important improvements. First, the manner of ignition. I have a letter from Messrs. Körting Bros., stating that their igniter has worked for years without ever having been touched except cleaning the soot away from burner, but this has been improved by applying the Bunsen principle to the Master light; and to satisfy myself about this igniter I obtained one some time ago, and having experimented on same, can testify to its superiority over the slide ignition as regards its non-liability of grooving and attention required. The second improvement is the application of gearing four to one with double cams for working the exhaust and ignition valves. This mode will have less wear and tear, less noise, and less friction over the two to one mode of working same. But as regards the claim to the advantage governing the engine by the exhaust, leaving residuum more or less above the clearance space, I think is a move contrary to experience and in the wrong direction. You state that they have a method of obtaining regularity in speed without in any way interfering with the economical working of the engine as described; but I think Messrs. Körting ought to give us, in proof of this statement, some facts as to the consumption of gas per horse-power with their old mode of governing and the new mode. Mr. Atkinson, in his letter in your issue of April 9th, says that he had previously attained the same object by a reduced charge, without leaving in any more of the residuum, as this must weaken and partially neutralise the reduced charge of entering gases. He says in our engines we drive out the residuum as completely as possible before admitting any explosive mixture; and he gives us a diagram showing the action of a full charge and one with half charge with the relative pressure expansion and results. A splendid example of the results of no residuum theory in practice, and I think Mr. Atkinson proves that it is a move in the wrong direction to keep or use the residuum as Messrs. Körting propose to do. Mr. Atkinson refers to Messrs. Crossley Bros., stating that they, too, instead of governing the exhaust, use pure air instead, according to the power required in separate engines having a V-shaped cam to give longer or shorter supplies of gas; but they have also a number of engines working, which give a full charge or no charge but pure air during the whole stroke, proving that they do not want any more residuum in than what they are compelled to have in the clearance space. Mr. Atkinson's differential engine, which was exhibited at the Inventions Exhibition, and which expelled all the products of combustion, and yet a silent and efficient engine proves that the residuum theory is a fallacy, and it is a question whether the residuum so much desired by Mr. Aston, Q.C., in the late trial—Otto *v.* Steel—was not more because of the difficulty of getting rid of it than for its utility and usefulness, and the verdict which Messrs. Körting Bros. have got against Otto in Germany is the only verdict, according to facts proved both in Germany and England which practical engineers can side with. J. R. Woodhead.

Leeds Gas Engine Works, Whitehall-road,
Leeds, April 17th.

AMERICAN BRIDGES.

Sir,—In The Engineer for this week Mr. R. H. Graham attributes to me the statement that "the bending moment in a cantilever decreases in the direction of the fixed end;" and further on says that I "subscribe to this principle."

I do not think I can do better than leave to your readers the consideration of the two following questions:—(1) Did I make the above statement? and (2) is it possible, within the utmost stretch of imagination, to infer from the contents of my letter that I subscribe to that statement?

I see that Mr. Graham still adheres to his proposition that the tension in the post is much less above the foot than it is at the foot itself. The fact that the truth or fallacy of this proposition affects the whole of Mr. Graham's arguments, led me to suggest in a former letter that it would be interesting to have particulars of the calculations by which Mr. Graham arrives at this result. The case is this: Referring to Fig. 2, p. 180 *ante*, and calling V and Q the direct tensions in the post at F and K respectively, it has been shown by Professor Smith and by Mr. Reilly that $Q = V$. According to Mr. Graham, Q is less than V, say $Q = (V - x)$. My suggestion was practically that Mr. Graham should give his value of x, but he has not done so. The conclusion is obvious. I will only add that it is a logical deduction from Mr. Graham's proposition to say that the tension in the suspension rod of a suspension bridge is greater near the floor of the bridge than it is at its attachment to the main cable.

I am sorry to see that Mr. Graham has withdrawn from this discussion, and I look forward with pleasure to the publication of his second paper, in which I hope to find some light thrown on his remarks in reference to the form of flange sections, the effects of rolling loads, and the strength of rivetted joints. The mere hints of his views on these matters which are given in Mr. Graham's first paper are far from satisfactory, and suggest to me that besides the subject which has lately been discussed in the columns of The Engineer, there are other principles of bridge design with regard to which Mr. Graham fails to represent the opinion or practice of English engineers. W. B. Coventry.

Cardiff, April 17th.

Sir,—It hardly seems necessary to say much more on this subject. Mr. Graham retires from the discussion at the end of a long letter in which he argues that, accepting Professor Waddell's premises, his solution is incorrect. That solution has been examined both graphically and by analysis, and demonstrated to be correct on the assumptions made. Mr. Graham does not prove any one of the results obtained to be wrong, nor does he show how correct results are to be found. He states that it is impossible for shearing force to be transmitted from the fixed to the free end of a cantilever, and ridicules Mr. Coventry's illustration of a freely supported beam. As a matter of fact, the wind forces are transmitted through the lower unbraced panel to the bottom system of lateral bracing in precisely the manner described, giving rise to bending moments on the sections of the post diminishing in value towards their lower ends (The Engineer. page 241, *ante*).

It is one of the assumptions in the data of the problem that the bending moments at the feet of the posts are *nil*, and there is no reservation in respect to that point implied in the statement that a certain more or less small moment, totally indeterminate in value, will actually exist, owing to the torsional stiffness of the lower chords, which in the American type of bridges with linked chords and suspended cross girders can only be small in comparison with the moments of the wind forces. H. Reilly.

April 19th.

STANDARD DIAMETERS OF GAS SCREWS.

Sir,—I should be obliged if any of your readers could furnish me with a table of the proper outside diameter of gas thread and working taps from ⅛in. to 3in.

I have been informed that a standard is in use for these, as for the ordinary Whitworth pitch taps, but have been unable to get more than the number of threads for pipes of given inside diameter. Gas Tap.

April 13th.

SCREW PROPELLER EFFICIENCY.

At the Philosophical Society of Dumbarton on Monday, the 29th ult., Mr. E. H. Parker, of the experimental tank department in Leven's shipyard—Messrs. Wm. Denny and Bros.—and formerly with Mr. R. E. Froude at the Experimental Works, Torquay, read a paper on "The Screw Propeller" before a good audience. The author traced the history of the screw propeller from its crude and rudimentary stages on to the present time, and exhibited by means of wall diagrams and models many of the innumerable and varying forms of propellers invented and practically introduced during the period. The second part of the paper was devoted to an investigation of the causes of loss in the efficiency of propellers, and the results of practical experiments undertaken with a view to the elucidation of this difficult problem were interestingly referred to and explained. Proceeding to sum up the results of such investigations, the author said:—"We have acquired much knowledge from the valuable researches of Rankine, Froude, Cotterhill, and others, and from the experiments of Griffiths, Isherwood, Yarrow and Co., and many others, but after all that has been done it is doubtful whether any sound theory or rule has been deduced whereby we can fix upon the most suitable dimensions of propeller for a certain ship. Hence, screws which have proved to be of unsuitable dimensions are often fitted, and in sister ships, to be worked under similar conditions, but built by different firms, propellers have been fitted differing widely from each other. It is the practice of some to proportion the disc area to the wetted surface, and of others to the immersed mid-section, thus governing the diameter, while not a few use as large a diameter as possible consistent with due immersion. Other matters of pitch, blade area, &c., are fixed on even more diverse grounds, and there seems to be great need for further experiment in order to deduce some more uniform and generally authoritative rules. Pecuniary considerations stand much in the way of private individuals experimenting thoroughly on full-sized ships, but it is within the power of most shipbuilders and engineers to experiment with steam launches, and not a few might resort to model experiments. Messrs. Denny and Co. have already made numerous experiments with the screw yacht attached to the Leven shipyard, and it is the intention of Messrs. Denny and Bros. to commence as soon as possible exhaustive experiments with model screws in their experimental tank department. We have already seen that loss of power may result from the application of excessive diameter, and it is not surprising to hear that after a vessel has lost a portion or portions of her propeller blades her speed is increased. It merely proves, I think, either faulty design or undue dimensions. I maintain that as there is one form of ship better adapted than another to be driven at a certain speed, so is there one propeller better suited than another to drive the ship at that speed. The smaller a screw capable of doing the work required, the smaller the engine necessary to drive it, and the weight thus saved, increasing the carrying capability of the vessel, would be a decided commercial advantage. I do not see why screws of smaller dimensions should not be used. It would necessitate lighter and quicker running engines; but piston speed and careful balancing are matters which good engineers would not consider insurmountable. I believe there is one position of screw better adapted for efficient propulsion than another. In single screw vessels the smallness of the aperture gives little to come and go upon, and to make it larger might introduce unavoidable weakness. In twin screw vessels, however, there is not this difficulty. Finally, we cannot pay too much attention even to details in fitting. Body posts should be tapered, and the brackets supporting the propeller in twin screw ships should be made fish-shaped with the blunt end forward, thus minimising the chances of eddy-making affecting the screw. The bosses should be coned, and the blades made as thin as possible consistent with strength. In fact, everything should be done which aims at increasing the efficiency of the propeller, and that is the most efficient propeller which utilises for propulsion the greatest amount of the power expended."

AMERICAN NOTES.

(*From our own Correspondent.*)

New York, April 10th.

Several meetings have been held during the past week by persons interested in railway construction, at which measures were adopted for the immediate prosecution of construction on about 1800 miles of road. Most of the territory is level and requires but little track making outlay. Several large bridges are to be built, one of them across the Mississippi river at Memphis, to provide a short cut through the Southern States, with the South-Western system of roads. Three other large bridges are to be built this season, and the builders of bridge iron have within a few days received inquiries for large blocks of structural iron, to be delivered during the summer, fall, and winter. Brokers representing Pennsylvania and Ohio iron interests have several inquiries this week from projectors of mill and railroad work, and a better feeling in consequence is prevailing. It is not yet twelve months since predictions were made that the iron and steel making capacity was beyond the market requirements for at least two years. During the past six months, more mill work has been contracted for than during the preceding two years. The manufacturers of machinery in Pennsylvania are exceptionally busy; some large contracts for railway material will be placed in this city within a week or ten days at about 35 dols. at mill. Very little foreign material has been ordered this week. Business is prospering in Southern iron centres. Within the past five years, 5,000,000 dols. capital have been invested in iron making and manufacturing operations in Chattanoga, Tennessee. The population has increased from 5000 to 30,000 persons. Birmingham, Alabama, is also expanding rapidly. A coal syndicate has purchased all the most desirable coal territory of that section of the State, amounting to nearly 300,000 acres. Manufacturing towns are projected, and some large establishments will be built in different sections of the South this year. Southern railroads are developing very valuable territory, and capitalists are taking advantage of the opportunity to secure timber territory, and coal and iron territory. In trade circles a satisfactory feeling exists. The strikes have been generally settled, and business is resuming its normal proportions. The business interests anticipate a failure of tariff legislation.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(*From our own Correspondent.*)

Up to date of writing none other of the marked iron houses have followed the example of Messrs. Noah Hingley and Sons in reducing the price of bars 10s. per ton. What action they may take is uncertain. The receipt of Messrs. Hingley's circular last Friday was a surprise. The firm have for a long time past made no secret of their opinion that no good purpose was being served by keeping up bars on a false basis, and they had openly advocated a reduction to £7. It was not, however, thought that they would take the course which they have done, and reduce prices independently. The prices of Messrs. Hingley now become: Netherton crown bars, £7; best rivet iron, £7 10s.; double best crown bars, £8; double best plating bars, £8 10s.; and treble best bars, £9. Messrs. Hingley's action is the more significant since no alteration has previously been made in marked bar quotations in Staffordshire, of an official character, for more than three years. It was at the beginning of February, 1883, that quotations were last changed. Messrs. W. Barrows and Sons at that date took the lead by issuing a circular announcing a drop of 10s. per ton, reducing the previous £8 standard to £7 10s. Their action was quickly followed by similar circulars on behalf of the Earl of Dudley and Messrs. Hingley. For four months previous to that reduction the firms named had stood at 10s. per ton higher than most of the other best bar firms.

The market this week awaits possible action by such firms as the Earl of Dudley, Messrs. Barrows, Messrs. John Bradley and Co., the New British Iron Company, and Messrs. John Bagnall and Sons, all of whom at present retain the £7 10s. standard. Second-class qualities rolled by the list firms are £6 10s. Messrs. Philip Williams and Sons stand at £7 5s. for best sorts, and £6 5s. for second sorts. Earl Dudley's bars are £8 2s. 6d. for ordinary, £9 10s. for single best, £11 double best, and £13 treble best.

The bar quotations of the New British Iron Company are:—Lion bars, £7 10s.; Corngreave bars, £6 10s.; best Corngreave plating bars, £7; Lion plating, £8; and best ditto, £9 10s. Best Lion rivet and chain iron is £9; double best, £10; and best Lion turning bars, £11. Double best scrap bars are also £10; treble best, £11; and best charcoal, £11 10s. Best Corngreaves horseshoe bars are £6 10s.; Lion ditto, £7 10s.; and fullered horseshoe, £8 10s. Best Corngreaves angle and T bars are £7; Lion ditto, £8 5s. to £8 10s.; and best Lion, £9 15s. to £10. Window sash bars are £8 10s. to £9 10s.; oval, convex, and half-round bars, £6 10s.; round cornered and round edged, £7 10s.; and bevelled and headed tire bars, £9.

Unmarked iron is without much change upon the week, and prices are irregular; but there is no quotable alteration since quarter day. Common bars are procurable at under £5 at works; merchant sheets are obtainable at from £6 upwards; and hoops from £5 5s. to £5 10s.

The amount of new business which has been placed this week has not been conspicuous, since the on-coming of Easter has made buyers desirous of limiting purchases in nearly every direction. Not much will be done at the works next week, since the men will be keeping the holidays, and the premises will be in the hands of the boiler cleaners and machinery repairers.

The galvanised sheet makers are nearly all running on part production. Export orders on account of Australia, India, and South America keep below the average, and the Australian trade in particular is still suffering from the system of making heavy consignments from this side independently of the condition of the market out there. The competition of galvanised sheet makers nearer the coast for the colonial and foreign trade is still severe, and the advantage which they possess is in times like these of much importance. Makers here, however, are doing all they can to hold their own, and are, for example, giving to buyers the whole benefit of the recent drop of 2s. 6d. per ton in the railway rates to London. A general quotation at the present time for 24 gauge delivered, Liverpool, is £10 5s. per ton, and delivered, London, in lots of under 10 tons £10 10s., and in lots of 10 tons and upwards £10 7s. 6d. For 26 gauge 30s. a ton additional is asked, and for 28 gauge 45s. additional.

The Shrubbery Iron and Steel Company, Wolverhampton, of whom the proprietary is the Wolverhampton Corrugated Iron Company and Mr. Earnest Farnworth, and which will manufacture sheets mainly for the Corrugated Company's own use, is progressing rapidly with its new works. These stand upon one of the sites formerly occupied by the celebrated firm of G. B. Thorneycroft and Co. The company hopes to make a start sometime next month. A considerable amount of new machinery, in the shape of rolls, boilers, heating furnaces, puddling furnaces, and the like, is being put in. A start will be made with twelve puddling furnaces, two ball furnaces, four heating furnaces, and two double trains of rolls. There are three engines of the vertical beam pattern, one of 120-horse power, and with 54in. cylinder, to drive the mill, a second of 60-horse power and 34½in. cylinder, to drive the forge, and a third of 30-horse power, for driving shears, pumps, &c. The works stand on something like six acres of ground, and have railway siding and canal wharf running into them. The production will, it is anticipated, be from 120 tons to 150 tons of sheets per week, and something like 200 hands will early find employment.

Continental steel manufacturers are making an increasing effort to get hold of customers here. Steel plating bars of German manufacture are now to be bought at £5 per ton delivered into this district, notwithstanding that they have to bear a carriage of 26s. per ton. The Welsh makers are doing their utmost to meet the competition by offering to fill orders at the same price.

The pig iron trade shows but little change upon the week, and makers still remark upon the difficulty of getting buyers to accept deliveries. New business is mostly confined to small lots, instead of to quarterly contracts, and consumers are thus able to take advantage of every turn of the market in their favour. All-mine pigs are 52s. 6d. to 55s.; part-mines, 37s. 6d. upwards; and common cinder, 27s. 6d. to 30s.

A meeting of the Iron Trade Wages Board was held in Birmingham on Monday, in accordance with notice from the operative section. Mr. B. Hingley, M.P., presided. Upon business being commenced, the operatives' secretary announced that, finding that trade had not improved sufficiently to warrant their claim for an advance, they were content to let wages remain as now, and continue at work under Alderman Avery's award. They, however, considered that the employers should enter a formal protest against the course which several firms had of late pursued of resigning their connection with the board in order to enforce larger reductions in wages than Alderman Avery's award carried. Mr. Hingley announced that the board had no statutory authority in the matter. It was reported that the lock-out at three Shropshire ironworks continued. Alderman Thomas Martineau, Mayor of Birmingham, had, it was announced, accepted the position of arbitrator, in the place of Alderman Avery, resigned.

Iron pipe founders are anticipating the probabilities concerning where Messrs. Briscoe and Co., merchants, of Wolverhampton and London, are likely to place their orders for the supply of cast iron pipes with which they have contracted to supply the municipal authorities of Sydney. It is understood that the contract embraces 100,000 4in. and 10,000 6in. cast iron pipes, at £4 16s. 9d. per ton; for 300 24in., 600 20in., and 400 15in. cast iron pipes, at £5 6s. per ton.

The strike in the wrought iron tube trade has extended to Wolverhampton. Messrs. E. Lewis and Son have there taken the initiative in following the example of the Wednesbury masters, and have given notice for a 10 per cent. reduction. The men have declined to accept the drop, and have come out on strike. They assert that already they are working at 7½ per cent. reduction under the scale which prevails at most of the tube works.

A sub-committee of the Worcester Watch Committee, appointed to inquire as to whether it would be well for the Corporation to buy up the Gas Company, have presented a report emphatically declaring that it would be well. The directors refused to grant the sub-committee an interview, but promised to lay the application to acquire the works before the shareholders. Regarding the company's recent advance in the price of gas, the report remarks that the accounts of the company for the past eleven years indicate that, instead of increasing, the company might very well have reduced the cost. The report sums up the position with the remark that the purchase by the Corporation would result in better gas at a reduced price without injuring the shareholders. The consideration of the report stands adjourned.

Mr. Reuben Farley, of the Summit Foundry, West Bromwich, has been elected chairman of the South Staffordshire Ironfounders' Association, in place of the late Mr. Thos. Perry, deceased. The association has resolved to petition Parliament in favour of the Railway and Canal Traffic Bill.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—A dull, cheerless outlook continues throughout the iron market of this district, and the opinions expressed by some of the leading representatives of the trade will be valuable as indicating the prospects with regard to the future which are entertained in the best informed quarters. The persistent efforts which are being made to secure a restriction of the output are, in the first place, an evidence of a very general want of confidence in any immediate legitimate improvement in trade, but it is interesting to note the different points from which the question is viewed. Amongst the opponents of an artificial means of bolstering up trade, the theory of "the survival of the fittest" is put forward as the only real solution of the present difficulty; but, on the other hand, it is very forcibly argued that if the extinction of the weakest makers meant also the extinction of their furnaces, it might apply, but seeing that the collapse of some of the makers would still leave behind them the furnaces to be probably taken over by another set of makers at a price very considerably below their original cost of building, the effect would be rather to perpetuate an excessive production of pig iron at low prices. On the other hand, it is further urged by makers who have a large output of pig iron to deal with that if a combination for blowing out furnaces is simply aimed at to bring about a fictitious rise in values, the result is likely to be disastrous rather than beneficial, seeing that the users of pig iron complain that even with the present exceptionally low price of the raw material they are in no favourable position for commanding trade, and that consequently any material enhancement of the price of pig iron, whilst it could only be effected at considerable cost owing to the subsidies which would have to be paid to the furnaces blown out, would possibly tend only still further to a restriction of the consumption. Then again, there are makers of pig iron who have other important branches of industry dependent upon the continued working of their furnaces, and to them a restriction of the production would entail a serious loss in other directions. No one, however, questions the fact that the present production of pig iron is far in excess of existing requirements, and although some of the obstacles in the way of any really strong combination for restricting the output are forcibly set forth in the opinion I have above quoted, the conviction that the only means of, at any rate, checking the ruinous decline in prices which has been going on for some time past is to be found in the blowing out of a large number of the furnaces now in blast seems to have exercised considerable weight at the adjourned meeting last Friday in London for the further consideration of the proposed movement for restriction. The opinion strongly entertained in this district, and to which I have previously referred in my "Notes," has been that the movement would not receive sufficient support to enable it to be carried out to any really practical issue, and the attitude which has been taken by the Scotch makers has tended to strengthen this conviction. I understand that the want of sympathy shown by the Scotch makers in the movement, which is being vigorously pressed forward by the makers in the North of England, threatened at first to bring about a collapse of the project almost without discussion, but that some disposition was ultimately shown to co-operate with the Cleveland makers, and eventually it was agreed that circulars should be sent out with the view of ascertaining what agreement could be come to. Whether the movement to restrict the output will make further progress remains to be seen. At present its prospects of being successful do not seem to be very hopeful, and it is almost certain that some of the large makers will decline to join in any combination that may be formed.

The approach of the holidays has had a tendency to check business of any weight being attempted during the past week, and there was but a very quiet iron market at Manchester on Tuesday. In many instances no business of any moment whatever was reported, and so far as pig iron was concerned, prices were scarcely tested. Lancashire makers still hold to about 37s. 6d. for forge and 38s. for foundry, less 2½, as their minimum rates for delivery equal to Manchester, and in district brands one or two of the Lincolnshire makers still hold out also for about the same figures for delivery here; whilst there are some brands to be got at quite 2s. per ton under these prices. In outside brands makers' prices for both Scotch and Middlesbrough are pretty near quite as low as ever, and so little are they affected by the renewed efforts at restriction that I hear of Scotch iron being sold for long forward delivery at about current rates.

For hematites there is still only a very small inquiry, with prices extremely low, 50s. 6d. to 51s., less 2½, delivered here, remaining about the average figures at which No. 3 foundry qualities could be bought in anything like quantities.

In the manufactured iron trade rather more inquiry is reported in some instances, but there is no improvement generally, the business doing in most cases being still of a small hand-to-mouth character, with prices quite as low as ever. Makers do not actually quote under £5 per ton for bars delivered here, but in some instances they will cut 1s. 3d. per ton under this figure to secure orders to keep works going. Hoops average about £5 7s. 6d. for both local and Staffordshire; sheets can be got at £6 10s. per ton; with north-country plates offering as low as £5 per ton delivered here.

The condition of the engineering trades remains without improvement. Special work and Government contracts, as I have previously pointed out, keep a few firms busy, but generally slackness prevails throughout all ordinary branches, with a constant cutting down of prices in competition. The locomotive builders in this district, who are very short of work, competed keenly for the engines for India, which have just been given out, and but a very narrow margin separated the tender of one of the local firms from the Glasgow makers who secured the order.

Messrs. William Collier and Co., of Manchester, have just completed a set of special milling machines for finishing the flats, or stretcher bars, carrying the card clothing used in the manufacture of carding engines. For the various operations requisite to finish the flats, there is a set of seven specially constructed machines. For the first operation, there is a double-ended milling machine for facing and cutting up the ends of the flats; for the second, a double-ended machine for milling out the circular part of the flats; for the third, a double machine for milling over the face of the flats; for the fourth, a double-ended machine for milling out the circular part on the top of the flats; for the fifth, a double-ended machine for rounding the underside of the flats; for the sixth, a double-ended machine for drilling both holes at once in the ends of the flats, and for the seventh a double-ended tapping machine for tapping both holes at once in the ends of the flats, with measuring stop and automatic reversing motion to withdraw the tap when it has traversed the required distance. Each machine is provided with ample power to perform the work assigned to it at one operation. The spindles are of steel, running in gun-metal bearings, adjustable to take up wear and tear and keep the milling cutter running perfectly true. A motion is also provided for automatically disengaging the feed when the operation is completed, and there is an accelerated movement to wind back. A special holding chuck is provided at each end of the bed of the various machines, between the tools to grip the flat whilst it is being milled, drilled, or tapped, and is so constructed that the attendant can instantly fix the flat securely or release it. This set of machines has been made for a firm in Manchester for their special flats, but they are also applicable for those made by any other firm by substituting suitable holding chucks and milling cutters. Messrs. Collier have also recently supplied the same firm with lathes for turning the outside and ending out carding engine and doffer cylinders, multiple drills for the holes in the surface of the carding cylinders, special double slide lathes and vertical drills for end frames, &c.

Throughout the coal trade there is a quieting down generally in the demand, and although some of the collieries are still kept on full time, four or five days a week represent about the full average as a rule. The better qualities of round coal still meet with a moderate demand for house fire consumption, but requirements are falling off rapidly, and although there has not as yet been any material quoted giving way in prices, the tendency is downwards, and concessions are made as sellers find they have to meet the market. Common round coals continue extremely bad to sell for steam and forge purposes, with a good deal of cutting in prices where sales in anything like bulk are to be effected. The railway contracts for locomotive fuel are being competed for very keenly, with the result that the companies are holding out for reductions, even upon the very low prices at which their contracts were taken last year. Engine classes of fuel meet with a fair sale, but with the exception that in some instances collieries are getting short of the best qualities of slack, owing to the lessened quantity of house fire coal now being screened, supplies are plentiful in the market, and ordinary descriptions of engine fuel are to be got at very low figures. At the pit mouth the average quoted figures are about 8s. 6d. to 9s. for best coals, 7s. to 7s. 6d. for seconds, 5s. to 5s. 6d. common coal, 4s. to 4s. 6d. ordinary burgy, and 3s. to 3s. 6d. ordinary good qualities of slack, with best sorts in some instances fetching 3s. 9d. to 4s. per ton. With the exception, however, of the best qualities of engine fuel, there is generally some concession to be obtained upon the above figures where buyers have orders in anything like quantity to give out.

For shipment there is only a slow demand generally, and the prices at which steam coal can be got at the ports on the Mersey continue very low. The better qualities maintain about 7s. to 7s. 3d. per ton, delivered at the high level, Liverpool, or the Garston Docks, but there are inferior sorts to be got without difficulty at 6s. 9d. per ton.

Barrow.—There is no actual change to note in the condition of the hematite pig iron trade of the district, but I am pleased to see there is a much better tone, and that the inquiry from all sources is not only strong, but more and more healthful. The output of pig iron remains steady at about half the capacity of the furnaces. It is not probable that the west coast makers all agree to the restriction in the output of iron at present, inasmuch as they are for the moment and will be for some time to come, well supplied with orders considering the number of furnaces they have in blast; and, on the other hand, it is clear there will be an increase in the requirements of steel makers who are in receipt of some heavy colonial orders for rails already, and who are likely soon to book some further heavy parcels for foreign markets during the ensuing few weeks, while on home account some of the large companies have already in hand tenders for contracts they intend placing during the ensuing few days. Prices are certainly low; £4 per ton and slightly over is quoted for heavy sections of steel rails, and at these rates it is expected some large parcels will change hands. Some of the foreign makers are reported to have booked orders at lower values than are ruling here. It is not likely that British makers will reduce their prices to this level, as the existing rates are too low to enable makers to secure a profit. Shipbuilders have secured no new orders, and very few are offering. Engineers are still busy in the marine department only. Iron ore finds a very quiet market, and prices are steady at from 8s. 6d. per ton at the mines. Coal and coke in quiet but regular consumption, and at undisturbed rates.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

THE members of the Steel Rail Confederation seem reluctant to admit that the "ring," as it is called, has come to an end. There can be little doubt, however, that this is the case. The price fixed by the confederated makers was £4 15s. a ton, and there has lately been a "drop" equal to 10s. per ton, which was the amount anticipated when the collapse was first thought of. The other day a considerable order for steel rails—some 28,000 tons—was tendered for by an Italian company. It was taken at £4 4s. a ton delivered, which is about equal to £3 15s. per ton at works. This is the first time a contract has been taken for such a low figure since the formation of the rail combination two years ago. What a difference in values in a few years! In 1872-3 as much as £16 to £18 was given per ton, and within ten years the rate has been £10. Now the struggle for inland companies to make steel rails at any profit will be more severe than ever. The coast establishments will have the battle very much in their own hands, and the war of values will be keener than ever. Where there is no arrangement, and each fights for his own hand, the conditions are all in favour of the consumer. Shareholders in limited companies who lean on steel rails for dividends are not likely to be troubled with much unearned increment for a considerable time.

Messrs. Wm. Jessop and Sons, Brightside Steel Works, have recently obtained a considerable order for steel castings for shipbuilding purposes from the Admiralty.

The keenness of foreign competition is driving manufacturers to the use of machinery in almost every possible way. In the file trade it is estimated that over sixty steam hammers are employed in forging, and similar means are employed in grinding and cutting. The Union have done their utmost to secure hand-cut files being preferred in the market by specially recommending them at every turn. Sometimes they issue lists of firms who do not resort to machinery in the production of files. But it is no use. If the market is to be kept—if, in historic phrase, Sheffield files are to "hold the field"—they must be made in competition with those manufactured in lands of long hours and low wages; and what is going on in the file trade is only one instance of what has been proceeding in other industries. The cruel though inevitable result is to deprive workmen of employment, especially in the old staple trades, which at one time had more work than workmen could be found for.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

BUSINESS in Cleveland pig iron has been well nigh at a standstill during the past week, by reason of the blast furnacemen's wages dispute. Makers were not disposed to sell so long as there was any likelihood that the furnaces would be stopped. Buyers, on the other hand, being aware that the stocks in the district amount to more than four months' output, and being therefore incredulous of any serious advance in prices, were quite willing to withhold their orders. Quotations have therefore remained unchanged since Tuesday, the 13th inst., and what few transactions have taken place have been at 30s. per ton for No. 3 g.m.b. for prompt delivery, and 29s. per ton for forge iron.

Warrants are now offered at 30s. per ton, but there are no buyers.

Only small quantities are being sent into Messrs. Connal and Co.'s Middlesbrough store just now. The stock on Saturday last amounted to 215,295 tons, being an increase of 1311 tons for the week.

Shipments of pig iron have slightly improved in comparison with those of last month, but foreign consignments appear to have been below the average. The quantity sent away during April up to the 17th was 31,580 tons, against 29,025 tons shipped in the corresponding portion of March, and 38,775 tons in April, 1885.

Messrs. Wm. Gray and Co., of West Hartlepool, received an order last week to build a steamer of 3000 tons burden.

No signs of improvement in the finished iron trade are as yet discernible. Orders are given out sparingly, and though the specifications are, as a rule, neither large nor favourable, the competition for them is keen, and the prices accepted very low. Plates are offered at £4 10s. to £4 12s. 6d. per ton, angles at £4 5s. to £4 7s. 6d., and common bars at £4 10s. to £4 15s., all on trucks at makers' works, less 2½ per cent.

Readjustments of workmen's wages seem lately to have been everywhere in progress in the North of England. The difficulty as regards the payment of blast furnacemen seems to have almost disappeared except at two works, namely, those of the Consett Iron Company and those of Messrs. Walker, Maynard, and Co. Elsewhere all the operatives signified their willingness to accept the reduction of which notice had been given a fortnight previously. This result was, however, not achieved until the employers actually commenced to damp down their furnaces throughout the district, and the extra cost for coke thereby involved will absorb the value of the reduction for a long time to come. It is not generally understood how small a proportion of the cost of a ton of pig iron is due to blast furnacemen's wages. Not more than 3s. per ton goes for labour, and as the reduction will not apply to everyone, the relief obtained will not be more than about 1½d. per ton. It is believed that the men who had not on Saturday accepted the reduction, will all do so as soon as they have fully realised the fact that their comrades elsewhere have agreed, and see that further opposition will certainly be futile. With regard to the mechanics and others employed in the repairing shops at Messrs. Bolckow, Vaughan, and Co.'s works, the notice of a 5 per cent. reduction expired on Saturday last. Some of the men affected left rather than accept it. Some were discharged without being allowed the option of remaining; and the remainder went to work at the reduced rate. At the iron foundries of the Cleveland district, reductions varying from 5 to 10 per cent. have also just been successfully made. Not less than 1000 men are affected thereby at Middlesbrough alone.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THE practical failure of the negotiations in London for a national agreement to put out a proportion of the blast furnaces has had a depressing effect upon the speculative department of the Glasgow pig iron market. At a meeting last week, the Scotch ironmasters fully considered the question, and arrived at the conclusion that it was impossible, in the present state of divided opinion among themselves, to adopt restriction. The present output is about 1600 tons a week greater than at this date last year, notwithstanding the great reduction in the amount of the shipments, and the large additions to stocks; and the only hope of arresting the plethora of output lies in the belief that some of the producers may be compelled ere long, by unavoidable circumstances, to damp out furnaces. There are 97 furnaces in operation, as compared with 90 at this date last year. In the course of the week about 5000 tons of pigs were added to the stock in Messrs. Connal and Co.'s Glasgow stores.

Business was done in the warrant market on Friday at 38s. 7½d. to 38s. 4½d., closing at 38s. 6d. cash. On Monday forenoon transactions occurred at 38s. 4d. to 38s. 4½d. cash, and in the afternoon at 38s. 4½d. to 38s. 5d., closing with buyers offering the latter figure. Transactions took place on Tuesday forenoon at 38s. 4½d. to 38s. 5d. cash, and in the afternoon at 38s. 4½d. Business was done to-day—Wednesday—at 38s. 5d. to 38s. 3½d., closing at 38s. 4d. cash.

The values of makers' pigs have been depressed by the state of the warrant market and the circumstances of the trade:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, is quoted at 43s. 6d.; No. 3, 41s. 6d.; Coltness, 47s. 6d. and 43s. 6d.; Langloan, 44s. 6d. and 41s. 6d.; Summerlee, 46s. and 41s. 6d.; Calder, 47s. and 41s. 6d.; Carnbroe, 43s. and 40s. 6d.; Clyde, 43s. and 40s.; Monkland, 39s. and 36s. 3d.; Quarter, 38s. 6d. and 36s.; Govan, at Broomielaw, 39s. and 36s. 3d.; Shotts, at Leith, 45s. and 44s. 6d.; Carron, at Grangemouth, 48s. 6d. and 46s. 6d.; Kinneil, at Bo'ness, 43s. and 42s.; Glengarnock, at Ardrossan, 43s. 3d. and 40s. 3d.; Eglinton, 39s. and 36s. 6d.; Dalmellington, 41s. and 38s.

The shipments of pig iron from Scotch ports in the past week amounted to 7683 tons, as compared with 7031 in the preceding week, and 10,820 tons in the corresponding week of 1885. The arrivals of Cleveland pigs at Grangemouth for the week were 6981 tons against 9381 tons in the same week last year, and there is a total decrease in these arrivals since 1st January last of 15,234 tons.

The malleable iron trade is quiet, but there have been good shipments of iron and steel goods from the Clyde in the past week. They embraced locomotives to the value of £12,250 for Bombay; steamer fittings for Sebastopol, £7500; sewing machines, £9751; steel goods, £6100; and general iron manufactures, £18,000.

The Scotch makers of Siemens steel have had several meetings in Glasgow to consider the question of meeting the opposition of several North of England firms, who are reported to be selling plates to Clyde shipbuilders and engineers at lower prices than that agreed on by the Scotch Association. The probability is that sooner or later the prices will be reduced to cope with this opposition, which might well become formidable, seeing that builders are at present more than ever under the necessity of purchasing in the very cheapest market.

Messrs. Dick, Kerr, and Co., of the Britannia Engineering Works, Kilmarnock, have contracted to build ten engines on Morrison's patent system for the North London and Suburban Tramways Company.

New shipbuilding orders placed on the Clyde have lately been few, but Messrs. Barclay, Curle, and Co., of Glasgow, have received an order from Messrs. William Thomson and Co., of Leith, to construct for their Ben Line a steamer of 318ft. in length and 38ft. in breadth, and about 3500 tons. The same builders have contracted to supply Mr. A. Guthrie, of Mull, with a steel steam yacht of 120 tons and 105ft. in length. At Dumbarton Messrs. Murray Brothers have secured an order for a screw steamer of 600 tons for passenger and goods traffic on the coast of New Zealand, the engines to be supplied by Messrs. Muir and Hurston, of Glasgow.

The coal shipments from the Scotch ports in the past week have amounted to 78,543 tons, as compared with 82,102 tons in the corresponding week of last year. They consisted of 22,056 tons from Glasgow; 2495 from Greenock; Ayr, 7084; Irvine, 2347; Troon, 6902; Leith, 1641; Grangemouth, 7436; Bo'ness, 4382; Port Glasgow, 1400; Burntisland, 22,600 tons. The demand is generally quiet.

A report to the Dumfermline Town Council shows that the income from the collieries belonging to the town in the past twelve months has been £3242, as compared with £4050 in the preceding year. Mr. David Landale, M.E., Edinburgh, has reported that several of the Dunfermline town seams of coal are nearly exhausted.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

THE iron and coal industries remain in the same dormant state as I have so long chronicled, and unless a reaction set in there must of necessity be a series of commercial disasters. As good a key to the state of things as can be obtained is that afforded by the railways. Taff Vale stock, which has been slightly over £300, touched £222 last week, and is now quoted at £224 to £226. Six months ago shares were bought somewhat eagerly for £270. Barry Docks and Railway are at 3½; Rhondda and Swansea Bay at 7½; Severn and Wye, issued at 100, are at 6, but Rhymneys are firm at £181. I shall fully expect that Rhymney shareholders will exact 8 per cent. if they consent to an amalgamation with the Taff Vale Railway—a thing still under discussion. There is a strong impression abroad that the next dividend of the Taff Vale will be only 10 per cent. Possibly an effort will be made to screw it to 12, but it will not be judicious.

I see that the auditor of the Ferndale sliding scale has declared a reduction of 2½ per cent. The Ocean will certainly be the same, if not more; in fact, it seems likely that both the Ocean and coalowners' scale will be 5 per cent. Prices keep low for steam and house coal, and demand insignificant. The thorough stagnation has now lasted with the great majority of collieries for thirteen weeks, and the full average work during this time has been but three days a week. In consequence distress begins to prevail amongst the colliers, and funds are being solicited in several quarters. It is difficult to find a colliery doing anything like full work. The Cyfarthfa colliers in particular are suffering from the bad times, and streets teem with colliers unemployed.

Cardiff seems to be doing as well as the best at the present, bad as that is. Last week some fine cargoes, few, unfortunately, in number, went out. One of these was 3400 tons to Salz, another 2350 to Genoa, and several ranging over 2000 tons.

In rails little is doing. Cyfarthfa is clearing off some of its rail stock, of which thousands of tons are held for Barry. Few new orders are coming in. It is reported that some of the Welsh works are going to share with Bolckow, Vaughan, and Co. the Metropolitan order for steel sleepers. Rumour says Cyfarthfa, but Cyfarthfa is not ready with its make. I am inclined to think that Dowlais is meant, as Dowlais was the first to supply the Metropolitan steel rail, and its fine section was always admired.

Dowlais is tolerably well employed on sleepers for India, and with tin bars, and these two specialities appear to be coming more into demand than rails.

I note that Bessemer pig is being stocked largely, and hope the venture will be a good one. Labour is as low in price now as it ever can be.

Other industries in Wales suffer in proportion with those of iron and coal, but there are exceptions. The Windsor Dry Dock is doing well. Tin-plate is in better form than it was last week, and makers are holding their own against the buyers' combination. It is encouraging to find makers refusing such prices as 13s. 3d. for ordinary coke, and at the same time are in full work. March statistics show that, even with all the gloom and despondency such as I noticed last week, the aggregate work has been good. France, for example, took 113 tons more in March than in February, and the gross total exports show a larger quantity than has been sent for some considerable period.

Coke plates this week are quoted at 14s.; Bessemers, 14s. 3d.; Siemens', 14s. 9d.; charcoals, as high as 18s. Tin wasters are being picked up at a low price; I have seen some as low as 12s.

Swansea is doing a better trade in tin-plate than Monmouthshire, and some of its industries are moderately brisk. Gadlys' tin-plate is, I fear, a long way off a restart, and this is a misfortune, as the management included good men.

Nettlefolds Newport, Mon., promise well for the port. I see that Newport has a fair trade in iron pipes, but Glasgow gained the large contract for thirty miles given out by Cardiff Waterworks. These pipes are now being laid, and appear excellent.

NEW COMPANIES.

THE following companies have just been registered:—

Fairwood Tin-plate Company, Limited.

This company was registered on the 13th inst. with a capital of £20,000, in £100 shares, to erect works at Gower-road, Glamorgan, for the manufacture of tin, terne, and Canada plates. The subscribers are:—

	Shares.
R. Harries, Pontardulais, merchant	1
W. Bright, Pontardulais, works manager	1
W. Williams, Pontardulais, foreman	1
F. G. Gough, Llanelly, auctioneer	1
G. Bright, Llanelly, engineer	1
G. T. Bright, Llanelly, mariner	1
W. R. Booth, Liverpool, metal broker	1

Until the directors are appointed the subscribers will be deemed to be directors. The number of directors is not to exceed five; qualification, five shares; the company in general meeting will determine remuneration.

G. E. Frodsham and Co., Limited.

This company proposes to take over the business of chronometer, watch and clockmaker, and jeweller, carried on by Frederick Luard, under style of Frodsham and Co., at 31, Gracechurch-street. It was registered on the 13th inst. with a capital of £100,000, in £5 shares. The subscribers are:—

	Shares.
Hilliard Wool, 101, Malmesbury-road, Bow, secretary	1
A. A. Cubitt, 59, Mercer's-road, Upper Holloway, clerk	1
Walter Grey, 11, Tissington-street, Rotherhithe, clerk	1
F. R. Duff, Thornton Heath, clerk	1
C. Heap, 124, New North-road, watchmaker	1
D. Channon, Victoria-road, Peckham	1
F. J. Culver, 4, Lonsdale-square, Islington, clockmaker	1

The number of directors is not to be less than three nor more than seven; the subscribers appoint the first and act *ad interim*; qualification, 20 shares; remuneration, £250 per annum, with an additional £100 in respect of each 1 per cent. dividend in excess of 10 per cent. per annum.

Hampshire Ice and Cold Storage Company, Limited.

In the borough of Portsmouth or elsewhere this company proposes to manufacture and deal in ice, and to provide stores for preserving perishable goods and products. It was registered on the 13th inst. with a capital of £20,000, in £1 shares. The subscribers are:—

	Shares.
E. W. Parson, J.P., Portsmouth	1
Lieut.-General T. N. Howard, Portsmouth	1
G. S. Lancaster, J.P., Portsmouth	1
Lieut.-Colonel N. W. G. Walkard, Portsmouth	1
C. E. McCheaur, Portsmouth	1
W. Pink, J.P., Landport	1
A. W. White, Portsmouth, contractor	1

The number of directors is not to be less than three nor more than seven; qualification, 100 shares or £100 stock. After the first general meeting the remuneration of the board will be at the rate of £100 per annum, and a further £50 for each 1 per cent. dividend in excess of 5 per cent. per annum.

J. G. Fay and Co., Limited.

This is the conversion to a company of the business of yacht, ship, and boat builders and engineers, carried on at Northam, Southampton, by Mr. John Goodman Fay. It was registered on the 14th inst. with a capital of £50,000, in £5 shares. The subscribers are:—

	Shares.
*Marquis of Ailsa, Maybole, N.B., and 12, Charles-street, Berkeley-square	200
J. B. Campbell, 31, Powis-square, shipbroker	100
A. Thomson, 44, Penywern-road, S.W.	100
*J. G. Fay, 90, High-street, Southampton, yacht builder	1000
*E. Bance, Southampton, estate agent	50
W. Fielder, Southampton, shipwright	100
S. J. Sutton, Southampton, ship chandler	50

The number of directors is not to be less than three nor more than six; the first are the subscribers denoted by an asterisk, and Mr. John Duncuft, of Werneth, Bolton; qualification, £250 in shares or stock. The company in general meeting will determine remuneration.

Rhone Land and Water Power Company, Limited.

This company proposes to carry on at Bellegarde, Department of Ain, France, or elsewhere, such businesses as may be thought desirable, and to undertake works of public and general utility, and to acquire the real and personal estates, assets, and effects, of the Bangue des Travaux Public, at Bellegarde. It was registered on the 12th inst. with a capital of £160,000, in £10 shares, 7000 of which are preference shares. The subscribers are:—

	Shares.
E. Compton Sinkler, 14, Belmont-hill, Lee, secretary to a company	1
J. A. H. Drought, 15, Kensington-gardens-terrace	1
J. H. Burt, 1A, Laurence Pountney-hill, merchant	1
R. Leake, M.P., Whitefield, Manchester	1
F. S. Hunt, M.P., 7, Cromwell-road	1
F. Power, 11, Hyde Park-gardens	1
E. M. Harwar, 27, Offerton-road, Clapham-common	1

The number of directors is not to be less than three nor more than ten; the subscribers are to appoint the first; qualification for subsequent directors, 50 shares. The company in general meeting will determine the remuneration of the board.

North Mexican Foundry, Limited.

This company was registered on the 8th inst. with a capital of £50,000, in £5 shares, to acquire and work a foundry in the State of Chihuahua, in Mexico. An unusual feature in the constitution of the company is that whilst the liability of the members is limited, that of its managing director is unlimited. This peculiarity is provided for by Section 4 of the Companies' Act, 1867, which enacts "That the liability of directors and managers or of the managing director may, if so provided, be unlimited." The subscribers are:—

	Shares.
Francis Tallack, Windsor-chambers, Great St. Helen's, shipbroker	1
G. R. Logie, 14, Queen's-road, Dalston, accountant	1
C. R. Jones, 39, Ellturon-road, Fulham, secretary to a company	1
A. Wilkin, 34, Great St. Helen's	1
J. Ball Ball, 1, Gresham-buildings, chartered accountant	1
J. Milne, 3, Newman's court, Cornhill, merchant	1
J. Stevens, 109, St. John's-hill, Clapham Junction, wine merchant	1

Mr. Anthony Pulbrooke, of 20, St. Helen's-place, is appointed managing director, and after the members have received dividends in excess of 5 per cent. on the paid-up capital to the extent of double the amount of the paid-up capital, he will be entitled to require the company to issue to him ordinary fully-paid shares to the extent of capital that his interest in the profits would represent if divided as dividends. Mr. Pulbrooke is entitled to retain office until prevented by lunacy, death, or other incapacity. The first trustees of the company are the Hon. Henry George Roper Curzon, Colonel Henry Ayshford Sanford, and L. H. Scott and J. N. Sperryn.

Patents Purchase Company, Limited.

This company was registered on the 10th inst. with a capital of £15,000, in £10 shares, to acquire patent rights, and to form subsidiary companies for the working of the same. The subscribers are:—

	Shares.
E. A. Nelson, 18, Bennett's-hill, Doctor's-commons, solicitor	1
W. R. Penwell, 18, Bennet's-hill, Doctor's-commons, clerk	1
W. G. Colebeck, 1, Parkhurst-road, Bowes Park, N.	1
W. Francis, 2, Loumla-street, Haggerstone	1
W. J. Seddon, 29, St. Thomas-road, Finsbury Park, clerk	1
B. R. Richardson, 20, Torrington-square, W.C.	1
A. Ross, 7, York-buildings, Adelphi, solicitor	1

Registered without special articles.

Self-Acting Air Suction Fuel Economiser Syndicate, Limited.

This company proposes to purchase and work a certain patent referred to in an unregistered agreement of 1st September, 1885, between J. Nepomne Moerath, Charles Skinner, and Robert J. George of the first part, the London Founders' Association, Limited, of the second part, and Frederick Grant (for this company) of the third part, of which no particulars are given in the registered documents. It was incorporated on the 9th inst. with a capital of £10,000, in £5 shares, with the following as first subscribers:—

	Shares.
J. N. Moerath, C.E., 152, Kilburn Park-road	1
C. Tehofee, A.E., 40, Grange-road, S.E,	1
R. J. George, C.E., 7, Little Queen-street, Westminster	1
L. Hertz, 79, Priory-road, Kilburn	1
Col. C. Steel, Southampton	1
G. Smith, 16, Kitto-road, Nunhead, secretary to a company	1
D. N. Arnold, Sheffield, engineer	1

Registered without special articles.

Sonora Silver Mining Company, Limited.

Upon terms of an agreement of the 10th inst., this company proposes to purchase from Mr. Cole Saunders, of Leadenhall-street, the San Miguel Silver Mine, in the district of Ures, State of Sonora, Mexico. It was registered on the 13th inst. with a capital of £365,000, in £1 shares, 65,000 of which are 10 per cent. preference shares. The purchase consideration is £299,993 in fully-paid ordinary shares. Mr. Charles E. Harrison, of 9, Pall-mall, is to receive £20,250 in payment of advances for keeping up the mine and other charges, and for the cost of promoting the company and preliminary expenses. £12,500 is to be paid to Messrs. José Ortez and Co., of San Francisco, in satisfaction of an existing charge upon the mine, held by them. The subscribers are:—

	Ordinary Shares.
G. W. Taylor, 27, St. Maur-road. Fulham, solicitor	1
*Col. W. W. Knollys, Brooks' Club	1
*G. H. Teniswood, 89, Edith-road, Kensington, barrister	1
J. Ward, 23, Albemarle-street	1
F. C. Penfield, 4, Hanover-square, journalist	1
C. B. G. Cole, 96, Philbeach-gardens, S.W., analytical chemist	1
A. Espinosa, 2A, Hanover-street, naval officer	1

The number of directors is not to be less than three nor more than seven; qualification, £100 in shares, stock, or debentures. The first are Col. Hughes Hallett, D. A. Onslow, R. F. Webb, and the subscribers denoted by an asterisk. Remuneration, £300 per annum to the chairman, and £200 per annum to each other director.

T. Carr and Sons, Limited.

This is the conversion to a company of the business of T. Carr and Sons, of Scotswood-on-Tyne, brick and tile manufacturers and colliery owners. It was registered on the 8th inst. with a capital of £100,000, in £5 shares. The purchase consideration is £60,000, of which £10,000 is payable in fully-paid shares. The subscribers are:—

	Shares.
J. D. Hill, Osbaldiston-road, Clapton	20
G. H. Furmidge, 10, New Broad-street, engineer	20
Herbert Copeland, 10, New Broad-street, contractor	20
H. W. Adams, 10, New Broad-street, secretary	5
W. J. Coogan, 44, Manaton-road, Peckham	5
W. R. Carr, Corbridge-on-Tyne, manufacturer	300
J. Urwin, Scotswood-on-Tyne, engineer	300

The number of directors is not to be less than three nor more than ten; the subscribers are to appoint the first and are to determine their remuneration; qualification for subsequent directors, 200 shares. The vendor, Mr. John Urwin, is appointed managing director, at such salary as the subscribers may determine.

Signalling Equipment Company, Limited.

This company proposes to purchase the English letters patent No. 13,173 of 1884, and the French patent No. 167,935, granted to Sergeant James Logan Walker, of the St. George's Rifle Volunteer Corps, for an improved lamp for military night signalling. It was registered on the 13th inst. with a capital of £10,000, in £1 shares, power being taken to acquire other inventions relating to naval, military, railway, or other signalling. The subscribers are:—

	Shares.
E. M. Chubb, 11, Pancras-lane, solicitor	1
H. C. Turner, 80, Salcott-street, Wandsworth-common	1
H. Shoppee, 22, John-street, Bedford-row, architect, &c.	1
H. J. J. Price, Ongar, Essex	1
C. E. Soames, 2, Chapel-place, South Audley-street	1
J. O. Cooper, 12, Elford-road, Drayton Park	1
J. W. Ockenden, 152, Ebury-street	1

Registered without special articles.

James Price and Co., Limited.

This is the conversion to a company of the business of James Price and Co., varnish and japan manufacturers and merchants. It was registered on the 12th inst. with a capital of £40,000, in £5 shares. The subscribers are:—

	Shares.
H. W. Price, 17, Mincing-lane, broker	1
J. Price, 42, New Broad-street, merchant	1
H. H. Elder, 50, City-road, merchant	1
Rev. A. R. Price, Aberdare, Wales	1
*L. Webb, Edmonton, commercial traveller	1
Edgar Price, 42, New Broad-street, merchant	1
G. H. Price, 17, Mincing-lane, broker	1

The number of directors is not to be less than two nor more than four; the first are Messrs. James Price, Lewis Webb, and William Blimson, of Northampton; the qualification for a director other than Messrs. L. Webb and William Blimson will be the holding of £500 share capital; the company in general meeting will determine remuneration. Mr. James Price is appointed managing director at a salary of £600 per annum, and after provision has been made for the payment of 5 per cent. per annum dividend, Mr. Price will be further entitled to a commission at the rate of £2 10s. per cent. upon the annual net profits.

London and Lancashire Paper Mills Company, Limited.

The company proposes to acquire the paper mills and other property at Stalybridge, near Manchester, formerly known as the Higher Mills, and situate on the River Tame, belonging to Mr. Henry Balshaw. It was registered on the 10th inst. with a capital of £70,000, in £10 shares. The subscribers are:—

	Shares.
A. Taylor, Upton, Essex	1
H. Clark Lewis, 25, Church-road, Homerton	1
T. J. Curtis, 17, Triangle, Ruby-street, Old Kent-road, cashier	1
Cyril B. Audain, 4, Barmeston-road, Catford	1
J. Harmer, 89, Sewardstone-road, E., book-keeper	1
A. J. Blunden, Basingstoke, wine merchant	1
W. Dawson, 25, Budge-row, secretary to a company	1

The number of directors is not to be less than three nor more than seven; qualification, £100 in shares or stock; the subscribers are to appoint the first; remuneration, £600 per annum.

THE PATENT JOURNAL.

Condensed from the Journal of the Commissioners of Patents.

Applications for Letters Patent.

*** When patents have been "communicated" the name and address of the communicating party are printed in italics.

13*th April*, 1886.

5101. Sheep Shears, H. J. Allison.—(*A. J. Lytle, United States.*)
5102. Helical or Coiled Springs, H. J. Allison.—(*J. G. Shaw, United States.*)
5103. Ladies' Waterproof, &c., Cloaks, E. S. Wilks, Uttoxeter.
5104. Dental Artificial Palate, J. W. Halliwell, Wakefield.
5105. Castors, F. R. Baker, Birmingham.
5106. Loom Shuttles, R. H. Shand and D. S. Preston, Manchester.
5107. Bottles, A. De Ratti, Bradford.
5108. Gas Anti-fluctuator, J. Dougill, Manchester.
5109. Pin and Fastener for Scarves, L. Turnock, Stockport.
5110. Sash Window Fastener, W. A. Batsford, Birmingham.
5111. Purifying Saccharine Liquids, &c., J. D. and A. Scott, Glasgow.
5112. Bottle for Effervescing Drinks, L. B. and G. V. Bethell, London.
5113. Burl Dyeing Machines, M. Oldroyd and J. W. Hepworth, Halifax.
5114. Steam and Water Taps, J. Wright, Sheffield.
5115. Raising the Wheels of Vehicles over Obstacles, W. Lockwood, Sheffield.
5116. Electrical Toy, R. Dipple, London.
5117. Tool Holders, E. E. Lauson, Leeds.
5118. Gas, H. Johnson, Dudley.
5119. Road Sweeping Machines, R. W. Tayler, Bury St. Edmunds, and L. L. Simpson, Derby.
5120. Device for Drawing Objects, T. R. Ablett, Blackheath.
5121. Aerating Water, E. G. B. Barlow, Beckenham.
5122. Reply Postal, &c., Cards, W. Homan, London.
5123. Gas Lamp, R. W. Pugh, Manchester.
5124. Ladders, W. A. Allen, London.
5125. Electric Railways, P. M. Justice.—(*S. H. Short and J. W. Nesmith, United States.*)
5126. Bending Spring Plates, J. Mitchell and W. Codington, Sheffield.
5127. Stench Traps and Street Gullies, R. Cardwell, London.
5128. Spring Bending Machines, G. Norwood, London.
5129. Automatic Felt and Wire Guide, R. Smith, London.
5130. Knitting Machines, L. A. Groth.—(*R. Drescher, Germany.*)
5131. Domestic Grates, C. Gordon, London.
5132. Multitubular Boilers, J. C. Mewburn.—(*La Société Anonyme Co-operative pour la Construction de Chaudières Inexplosibles, France.*)
5133. Lock-nut and Bolt, P. S. Warren, London.
5134. Weighing Machines, R. Haddan.—(*Torsion Balance and Scale Company, United States.*)
5135. Safety Guards for Wheels, H. J. Haddan.—(*E. Neumann, Austria.*)
5136. Rendering Collars, &c., Waterproof, C. E. Mey, London.
5137. School Slates, C. Debusmann, London.
5138. Box for String, &c., A. Steer and A. E. Kennard, London.
5139. Show Cases, T. Cooper, London.
5140. Motive Power, R. G. Laird and H. Selby-Davison, Basingstoke.
5141. Spanner or Wrench, F. Stone, London.
5142. Coating Metal Plates with Tin, &c., H. Hall, London.
5143. Regulating the Supply of Gas to Gas Motor Engines, H. P. Holt, London.
5144. Frictional Coupling for Shafting, &c., A. Mechwart, London.
5145. Advertising by Means of Balloons, C. Wells, London.
5146. Machine or Battery Guns, C. F. H. Hayes, Stratford.
5147. Automatic Fire-extinguishing Apparatus, J. Wainwright and H. Briggs, London.
5148. Toy, G. F. Lütticke, London.
5149. Obtaining Motive Power, W. H. Hall, London.
5150. Grain Driers, L. Gathmann, Chicago, U.S.
5151. Disinfecting Compounds, H. H. Lake.—(*F. L. Sarmiento, W. G. Grimm, S. P. Sadtler, F. J. Sarmiento, and J. A. Wiedersheim, United States.*)
5152. Ale, Beer, and Porter, N. Pigeon and W. L. Flanagan, London.
5153. Spindle Steps, H. H. Lake.—(*J. W. Hobart, United States.*)
5154. Water Tube Boilers, M. Theobald, London.
5155. Washing and Cleaning Currants, &c., F. Vinten, London.
5156. Combined Umbrella and Walking-stick, &c., P. Furse and A. Fougeadoire, Paris.

14*th April*, 1886.

5157. Seat Rods of Tricycles, C. Church, London.
5158. Taps and Rimers, &c., W. Brierley.—(*J. Berg, Germany.*)
5159. Pins for Connecting Cornice Pole Rings, H. Munslow, Birmingham.
5160. Safety Bicycles, W. Golding, Lancashire.
5161. Stop Cock, J. W. O'Toole, Dublin.
5162. Baking Powder, H. Watkins, London.
5163. Tell-tale for Cabs, &c., J. S. W. Edmunds, Birmingham.
5164. Cutters and Cutter-bars, C. H. Brigg and T. Ainley, Elland.
5165. Restoring the Hair, M. Nicolson, Gateshead-on-Tyne.
5166. Conical Split Bush, J. Pritchards and W. C. Smith, Kidderminster.
5167. Preventing Down Draughts in Chimneys, J. Smalley, Liverpool.
5168. Electric Lighting of Trains, R. E. B. Crompton and J. Swinburne, Chelmsford.
5169. Automatic Waste Preventing Valve, J. A. McNaughton, Glasgow.
5170. Manufacture of Hydrates of Strontia, J. Mactear, Glasgow.
5171. Safety Stirrups, F. V. Nicholls, London.
5172. Apparatus for Extinguishing Fires, W. Gledhill, Manchester.
5173. Water Gauges, J. Graham, Salford.
5174. Testing Gas, &c., J. T. Marriott and W. Bagshaw, Batley.
5175. Cupboard Turns, S. Bott, Birmingham.
5176. Dynamo-electric Machines, &c., C. L. Baker, Manchester.
5177. Fastening Tubular Handles, &c., M. Swain, Manchester.
5178. Cushion Knee-cap for Horses, T. W. Lovatt, London.
5179. Machinery for the Manufacture of Mats, J. Wilson, Halifax.
5180. Regulating the Supply of Liquid Food, J. Carter, Birmingham.
5181. Photographic Dark Slide, W. Tylar, Birmingham.
5182. Close Stoves, C. Portway, London.
5183. Lessening Vibration in the Handles of Bicycles, W. Temple, Newcastle-on-Tyne.
5184. Draw-springs, J. H. Goodwin, Sheffield.
5185. Measuring Gauges, J. Kirk, Sheffield.
5186. Combined Cinder Sifter and Shovel, G. Lamb, London.
5187. Ornamenting Glass, W. Walker, Stoneycroft.
5188. Leaves of Albums, J. Laur, London.
5189. Imparting Surface Designs or Patterns to Bricks, &c., W. Benson and L. Gunning, London.
5190. Sewing Machines, A. Anderson.—(*The Singer Manufacturing Company, United States.*)
5191. Cooking Apparatus, T. H. P. Dennis, Chelmsford.
5192. Holder for Displaying Finger Rings, &c., W. Potter, London.
5193. Automatic Lock Hook for Holding Window Tickets, &c., W. Potter, London.
5194. Shelf Hook for Displaying Bracelets, &c., W. Potter, London.
5195. Self-acting Doors for Hoists, W. Young, Glasgow.
5196. Heating Water by Gas or Spirits, J. Winterflood, London.
5197. Heating Apparatus for Buildings, F. Powell, London.
5198. Boot and Shoe Stretchers, A. M. Clark.—(*M. S. Driggs, United States.*)
5199. Preventing Accidents in Mines, C. E. Hardy, London.
5200. Candlesticks and Candle Holders, E. de Pass.—(*E. Pulsford, France.*)
5201. Valve Gear of Steam Engines, H. Kühne.—(*W. R. Proell, Germany.*)
5202. Setting of the Cylinders of Barrel Organs, E. G. Brewer.—(*J. F. F. Grabau Germany.*)
5203. Leather Straps, &c., H. J. Haddan.—(*G. Garde-Roux, France.*)
5204. Draw-bars for Railway Vehicles, W. Davison and H. Bolton, London.
5205. Photographic Engraving, E. W. Foxlee, London.
5206. Bridges, W. P. Thompson.—(*J. Tomlinson, United States.*)
5207. Utilisation of Coke Dust, H. Bumby and N. L. Wieputte, Liverpool.
5208. Feathering Screw Propellers, R. T. Bells and W. P. Thompson, Liverpool.
5209. Sustaining Under-pants, &c., A. E. Adams, London.
5210. Closing Apertures in the Hulls of Vessels, A. M. Clark.—(*J. Spiers, United States.*)
5211. Patterns for Marking Materials, G. F. Redfern.—(*—— Frankfurther and —— Abraham, Germany.*)
5212. Wooden Fencing, &c., F. C. Nutter, London.
5213. Glass Bottles, W. B. Fitch, London.
5214. Raising Beer, &c., J. Hill, London.
5215. Electrical Batteries, A. Campbell, London.
5216. Centrifugal Governors, F. W. Crossley, London.
5217. Drawing-in Gear for the Carriages of Mules, E. Tanzler, London.
5218. Electrometer, B. Pell, London.
5219. Warming Air, M. Shillito and W. W. Wardle, London.
5220. Instrument for Indicating Pressures, B. Pell, London.
5221. Apparatus for Driving Tunnels, J. H. Greathead, London.
5222. Blasting Mines, &c., J. Heath and W. Frost, London.
5223. Insulating Materials, P. Ward and S. Blane, London.

15*th April*, 1886.

5224. Condensing Nicotine in Pipes, R. A. Moon, Galway.
5225. Needles for Sewing with Wire, T. Fletcher, Redditch.
5226. Boat-lowering Apparatus, W. Horseman, West Hartlepool.
5227. Glass Sleepers, D. Rylands and H. Lindsay-Bucknall, Barnsley.
5228. Brick-making Machinery, J. A. Matthews, Halifax.
5229. Tea, H. H. N. Martin, London.
5230. Handles for Bags, W. L. C. Brown, Manchester.
5231. Spoke-grips, S. Snell.—(*J. Bousfield, Yorkshire.*)
5232. Woven Fabrics, R. Illingworth, Manchester.
5233. Fence, J. Muggoch, Glasgow.
5234. Mathematical Instrument, A. H. B. Sharpe, Gainsborough.
5235. Treble Ladder, W. O. Jenkins, Swansea.

5236. Muzzles, F. V. Nicholls, London.
5237. Brick - making Machinery, T. C. Fawcett, Halifax.
5238. Hot-water Apparatus, F. Milan, Halifax.
5239. Treating Fish Curers, E. Tucker, Stornoway.
4240. Valves, J. Slinn and W. W. Slack, Sheffield.
5241. Attaching Soil Pipes to Water-closets, W. Cheal, London.
5242. Electric Arc Lamp, J. L. Balbi and F. Tolley, London.
5243. Dog Kennels, J. A. Wix, London.
5244. Cinder Sifter, T. M. Hurrell and F. G. Hallett, London.
5245. Discharging Projectiles, T. Stead.—(*D. Moore, United States.*)
5246. Show-carboys, &c., J. C. Sawer, London.
5247. Lath Blinds, W. C. Morton, Birmingham.
5248. Buttons, S. E. Jackson and M. S. Morton, London.
5249. Making Packets of Cigarettes, &c., R. de M. Lawson, London.
5250. Couplings and Fastenings, H. Kingsford.—(*S. Trott and F. A. Hamilton, Nova Scotia.*)
5251. Mixing Liquids, C. E. Davis, London.
5252. Four Way Bye Pass Valves, E. B. Donkin, London.
5253. Automatic Brake, G. Clutterbuck, London.
5254. Fastenings for Stair Rods, E Compton, London.
5255. Causticising Alkaline Lyes, &c., A. Chantreuse and I. Farinaux, Liverpool.
5256. Weighing Machines, A. J. Boult.—(*D. Bacas, Spain.*)
5257. Digging Machine, R. Pompilj, Italy.
5258. Tubular Telegraph Poles, W. Bayliss and E. Jones, London.
5259. Hanging Up the Bodies of Hansom Cabs, F. Forder and C. Forder, London.
5260. Artificial Teeth, F. Roetter, London.
5261. Stopping Run-away Horses, E. de Pass.—(*H. Bourget, France.*)
5262. Frame, &c., for Saw Benches, J. Sims, London.
5263. Centreing Work, W. R. Olivey, London.
5264. Cloth Clamps for Button-hole Sewing Machines, A. Anderson.—(*The Singer Manufacturing Company, U.S.*)
5265. Needles, A. H. Reed.—(*J. K. Krieg, U.S.*)
5266. Heating Greenhouses, &c., A. Haley, London.
5267. Measuring Woven Fabrics, W. G. Sedgwick, Byfield.
5268. Cranks, J. F. Hall and J. Verity, London.
5269. Crape, H. H. Lake.—(*Messieurs Gillet et Fils, France.*)
5270. Resinous Compounds, J. B. Melvin, London.
5271. Coupling Apparatus, B. G. Martin and S. A. Kirkby, London.
5272. Safety Apparatus for Lowering, &c., Goods, A. Bonnet, London.
5273. Mounting, &c., Dynamo-electric Machines, H. P. Holt, London.
5274. Lags for Holding Pins used in Heald Machines, K. Jowett, Bradford.
5275. Fastener for Attaching Fabrics, M. R. Snowden, Bradford.
5276. Telephonic Apparatus, E. Berliner, London.
5277. Oil from Oil-yielding Substances, H. Lambert and G. Greenwood, London.
5278. Poly-chromatic Pictures, &c., L. Schaefer and C. T. Storck, London.
5279. Terrets for Harness, H. H. Lake.—(*V. L. Walter, France.*)
5280. Brakes for Perambulators, &c., W. K. Hillyard and G. Newnes, London.
5281. Tubes of Infant Feeding-bottles, J. P. Neumann, London.
5282. Rolling Mills, C. D. Abel.—(*C. Hessenbruch, Germany.*)
5283. Bottles, H. W. Stevens, Colchester.

16th April, 1886.

5284. Pedals for Bicycles, &c., G. Lewis, Kingston-on-Thames.
5285. Hydrant Stands, J. Fletcher, Ashton-under-Lyne.
5286. Attaching Door Knobs to Spindles, E. Staples, Birmingham.
5287. Handles for Doors, &c., H. A. Done, Sutton Coldfield.
5288. Coupling Railway Wagons, J. A. Hay, Radcliffe-on-Trent.
5289. Compound Locomotives, &c., S. Morley, Horsforth, near Leeds.
5290. Fastening Sliding Sashes, W. Howie and R. Henderson, Ecclefechan.
5291. Glass Melting Furnaces, D. Rylands and H. Lindsay-Bucknall, Barnsley.
5292. Covering for Pipes, Boilers, &c., C. Brader, Manchester.
5293. Collars, J. Cayard and T. Johnson, London.
5294. Plates for Artificial Teeth, J. S. Crapper, Hanley.
5295. Target, G. L. Jeffries, Birmingham.
5296. Mechanism for Carding Machines, E. Gaunt and W. Firth, Bradford.
5297. Painting, Glazing, and Window Cleaning Machine, D. Toye, Aldrington.
5298. Secondary Voltaic Battery, C. Moseley, Manchester.
5299. Perforating Cigars, J. Neal, Birmingham.
5300. Window Blind Apparatus, S. E. Howell, Sheffield.
5301. Saddle Springs for Bicycles, &c., T. M. Lowcock, Sheffield.
5302. Compound Spiral Spring, B. F. Cocker and J. Bishop, Sheffield.
5303. Beating Eggs, J. B. Ablewhite, Malmesbury.
5304. Clearing Railway Tunnels of Steam and Smoke, T. Gilmour, Glasgow.
5305. Feed Heating Apparatus for Boilers, T. Gilmour, Glasgow.
5306. Coupling and Uncoupling Wagons, E. Makin, West Leigh.
5307. Attaching Clothing to the Flat Bars of Carding Engines, G. and E. Ashworth, Manchester.
5308. Trueing Bars for Carding Engine Flats, G. and E. Ashworth, Manchester.
5309. Travelling Flat Carding Engines, G. and E. Ashworth, Manchester.
5310. Stove for Heating Tailors' Iron, J. Wilson, Halifax.
5311. Heating Gas Retorts, J. A. Drake, Halifax.
5312. Supporting List Healds in Looms, H. Brooke, Halifax.
5313. Step-cord Supercede, W. M. White, Birmingham.
5314. Cane Splitting Machine, H. Burdett, Leicester.
5315. Boats and Davits, W. V. Shaw, Glasgow.
5316. Automatic Syphon for Flushing Closets, W. T. Allen, Gravelly Hill.
5317. Ventilators, W. Westley and J. Peers, Birmingham.
5318. Travelling Cap, F. S. Alger, Diss.
5319. Combined Vapour Burner and Vapouriser, W. Wakefield, Dublin.
5320. Obtaining Power from Running Water, H. G. Blyth, London.
5321. Tiles, M. Hussey, London.
5322. Shaft Tugs, R. Macfarlane, Birmingham.
5323. Waterproof Bags for Sponges, &c., H. Spence, London.
5324. Syphon Cisterns for Flushing, G. Oulton, Liverpool.
5325. Tubes for Boilers, Condensers, &c., C. Wicksteed, London.
5326. Alkaline Carbonates and Hydrates, T. Twynam, London.
5327. Floating Breakwaters, F. W. Jones, London.
5328. Oils, &c., in the Manufacture of Tin, &c., Plates, H. Hall, London.
5329. Marking Strokes in the Game of Golf, R. M. Alexander, London.
5330. Explosive Compounds, H. E. Newton. —(*A. Nobel, France.*)
5331. Explosive Substances, H. E. Newton. —(*A. Nobel, France.*)
5332. Exhibiting Moving Figures, J. Maynes and C. L. Watchurst, London.
5333. Albumen and Colour and Dye, G. Epstein, London.
5334. Aerated Water or Liquid, G. Epstein, London.
5335. Detective Envelope, Thorburn, Bain, and Co., London.
5336. Forging Chains, J. Platt, London.
5337. Candle Moulding Machines, A. R. Cowles, London.
5338. Governing Dynamo, &c., Machines, W. T. Goolden, A. P. Trotter, and H. W. Ravenshaw, London.
5339. Machine for Cutting Leather, J. Silman, London.
5340. Triturating Cylinders, J. R. Alsing, London.
5341. Mechanical Telephones, E. P. Alexander. —(*H. Lamont, U.S.*)
5342. Game of Chance, R. H. D. Hart, London.
5343. Filters, C. E. Gittens, London.
5344. Putting-out Machines, J. W. Vaughan, U.S.
5345. Machines for Tongue and Groove Flooring, G. Johnson, jun., London.
5346. Bottle Stopper Fastenings, L. Kalling, Baltimore, U.S.
5347. Calendar, A. H. Deakin, London.
5348. Gas Retort Lids and Fastenings, W. W. Box, London.

17th April, 1886.

5349. Thrashing and Winnowing Machines, T. Adair, Comber, Down.
5340. Fittings for Lawn Tennis Poles, A. Millin, Belfast.
5351. Carrying-off Tables for Brick Machines, R. Bradshaw, Swinton.

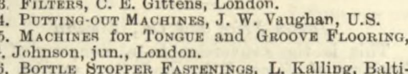
SELECTED AMERICAN PATENTS.

(From the United States' Patent Office official Gazette.)

336,129. Pipe Coupling, *Fred. L. McGahan, Indianapolis, Ind.—Filed May 16th, 1884.*

Claim.—In a pipe coupling, tubes *a* and *c*, joined by sliding one within the other, stuffing-box *e*, closing said joint, spiral spring *f*, arranged to abut against the gland of said stuffing-box, and against flange *d* on tube *c*, whereby said spring is compressed and the

336,129

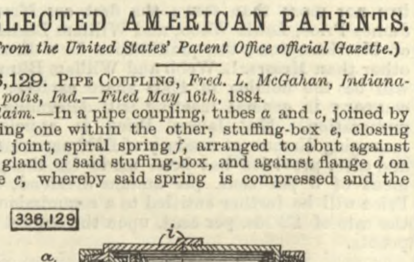


stuffing-box tightened by the sliding of the tubes together, and case *i*, inclosing said stuffing-box and spring, all combined and arranged to co-operate substantially as and for the purpose specified.

336,132. Electric Meter, *Samuel D. Mott, New York, N.Y.—Filed August 24th, 1883.*

Claim.—(1) The combination, for an electric meter, with an electric motor driven by the current to be measured, and having a magnetic field for its armature, maintained constant despite changes in the current, of a register train operated by said motor, and constituting by itself the load for said motor.

336,132

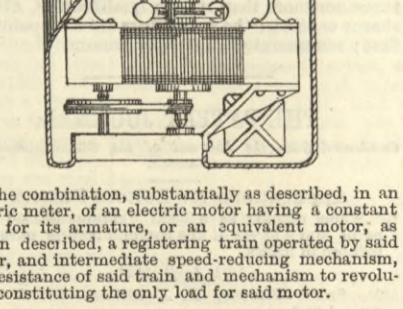


(2) The combination, substantially as described, in an electric meter, of an electric motor having a constant field for its armature, or an equivalent motor, as herein described, a registering train operated by said motor, and intermediate speed-reducing mechanism, the resistance of said train and mechanism to revolution constituting the only load for said motor.

336,140. Oscillating Water Meter, *Lewis H. Nash, Brooklyn.—Filed September 22nd, 1885.*

Claim.—The combination, in a water meter, of a case having two interior opposite wall abutments, suitable interior wall bearings, and inlet and outlet ports, and an abutment piston pivotted within the case chamber between the said abutments, with a

336,140

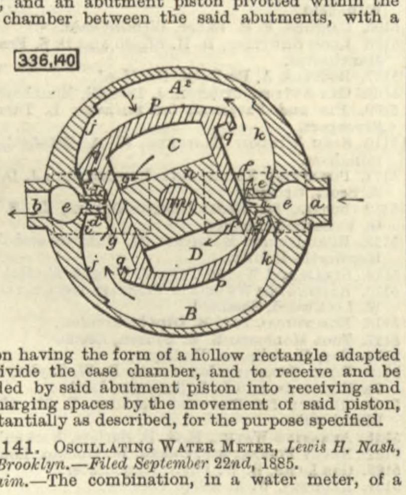


piston having the form of a hollow rectangle adapted to divide the case chamber, and to receive and be divided by said abutment piston into receiving and discharging spaces by the movement of said piston, substantially as described, for the purpose specified.

336,141. Oscillating Water Meter, *Lewis H. Nash, Brooklyn.—Filed September 22nd, 1885.*

Claim.—The combination, in a water meter, of a

336,141

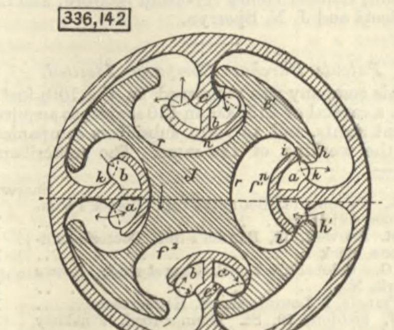


case having two or more radial abutments separating the inlet and the discharge ports with a piston having a revolving oscillating movement, adapted to operate to divide the case chamber into receiving and discharging spaces, and having an interior chamber open at the side and for each abutment which divides it into receiving and discharging spaces, the walls of said chamber openings having a form and relation to co-operate with case-wall bearings to make instant contact and separation, and thereby prevent the confining of the water within the measuring chambers and the consequent locking or retarding of the piston, substantially as described.

336,142. Water Meter with Revolving Piston, *Lewis H. Nash, Brooklyn.—Filed October 16th, 1885.*

Claim.—(1) The combination, in a water meter, of a revolving non-rotating piston having the bearing points $h\ h^1$, &c., and recesses $f^1\ f^2$, &c., with a case having an equal number of coacting bearing points and corresponding recesses, and the inlet and exhaust ports *a* and *b*, bounded by and having the edges *k k* and $i\ i^1$, &c., whereby the piston points are caused to open communication between the measuring spaces the instant communication is closed with the inlet ports *a*, to effect the free inlet and discharge of the water into and from the measuring spaces, substantially as described. (2) In a water meter, the combination of a revolving non-rotating piston having projections formed with bearing points $h\ h^1$, &c., connected by a convex surface c^1, &c., and having the concave bearing surfaces *r*, with a case having an equal number of projections having coacting bearing points $i\ i^1$, &c., connected by the convex bearing surface *n*, case recesses corresponding to the convex formation of the

336,142

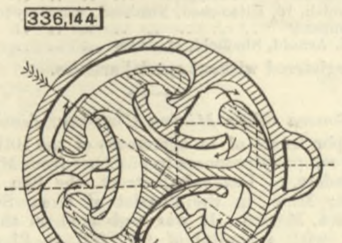


piston projections c^1, and suitable inlet and exhaust ports, substantially as described. (3) In a water meter, the combination of a revolving non-rotating piston having projections formed with bearing points $h\ h^1$, &c., connected by a convex surface c_1, &c., and having concave bearing surfaces *r*, with a case having an equal number of projections having coacting bearing points $i\ i^1$, connected by the convex bearing surfaces *n*, and inlet and exhaust ports *a* and *b*, bounded by and having the edges *k k* and $i\ i^1$, &c., and the case recesses corresponding to the convex formation of the piston projections c^1, &c., substantially as herein set forth. (4) The combination of a revolving non-rotating piston having bearing projections $h\ h^1$, &c., and $c\ c^1$, &c., and concave bearing surfaces *r*, with a case having bearing projections $i\ i^1$, &c., *n*, and *k k*, the inlet and exhaust ports *a* and *b*, the inlet bottom passage H, communicating with the ports *a*, and the outlet top passage E, communicating with the ports *b*, substantially as herein set forth.

336,144. Water Meter with Revolving Piston, *Lewis H. Nash, Brooklyn.—Filed November 3rd, 1885.*

Claim.—In a water meter, the case heads A^1 and C, each having the inlet ports $a^1\ a^2$ and the outlet ports $b^1\ b^2$ outside of the bearing points of the case projec-

336,144

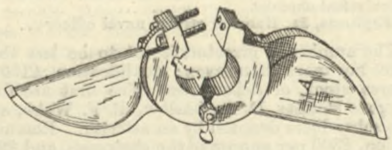


tions, in combination with a case and the piston having equal number of bearing projections making perpetual joint forming contact with corresponding recesses in both piston and case, whereby the piston and case projections operate to separate the inlet from the outlet ports in all positions of the piston.

336,447. Cam for Stamp Mills, *Carl A. Thies, Concord, N.C.—Filed September 17th, 1885.*

Claim.—A cam for the purpose set forth, having a hub made in two sections and adapted to embrace a shaft, said sections being permanently connected

336,447

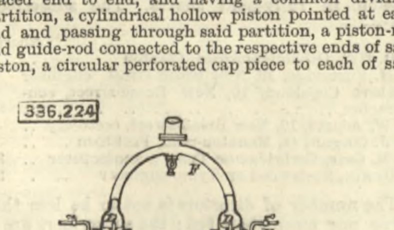


together at one side by a hinge joint C, and provided at the opposite side with parallel perforated portions, securing bolts passing through said perforations, a recess *f*, in one of said sections, and cam wings A, formed integral with said sections, substantially as set forth.

336,224. Apparatus for Compressing Air, *Claude M. Ferrot, Lyons, France.—Filed November 7th, 1884.*

Claim.—(1) The combination, in an apparatus for compressing air, of the water-holding vessels A A^1, placed end to end, and having a common dividing partition, a cylindrical hollow piston pointed at each end and passing through said partition, a piston-rod and guide-rod connected to the respective ends of said piston, a circular perforated cap piece to each of said

336,224



water vessels, a convex disc *e*, and pipe F, connected to each of said cap pieces, and the valves E and D, substantially as specified. (2) In an air compressing apparatus, two water-holding vessels, with an opening between them, a plunger in the said opening, with a rod by which it is reciprocated, an arched top to each vessel, with inlet air openings in said arched top, a flexible valve in such vessel beneath said openings and closing upwardly, a central discharge opening, a pipe above the same, and a valve closing downwardly over the said opening, whereby the inlet and discharge of the air are at the highest point of each vessel and agitation of the water is prevented, substantially as specified. (3) The combination, with a water-holding vessel and piston in an air compressing apparatus, of an arched top, a circular range of openings through the level portion of the top, a valve below the said openings closing upwardly, a rim around the openings, and a pipe for supplying water, whereby the water reaches all portions of the openings with uniformity, and a central opening, pipe, and valve for the discharge of the compressed air, substantially as specified.

336,619. Dredging Apparatus, *Gardner F. Badger, Brooklyn, N.Y.—Filed December 15th, 1884.*

Claim.—(1) A combined digger and strainer for excavating or dredging purposes, constructed substantially as herein shown and described, consisting of a hollow metallic shell adapted for attachment to a

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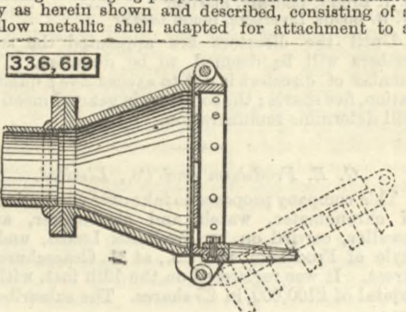
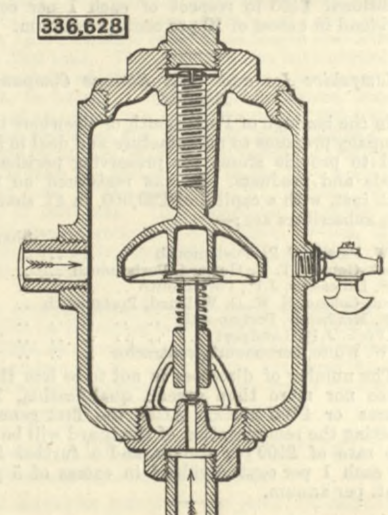


suction pipe, and having secured to its lower rim a flanged perforated plate carrying projecting teeth, as set forth. (2) In a dredging or excavating apparatus, the combination, with the suction pipe of a pump, of a perforated plate carrying removable projecting stirring or digging teeth, substantially as herein shown and described, said plate being secured on the lower end of the pipe, as set forth.

336,628. Steam Trap, *Nelson Curtis, Boston, Mass.—Filed November 27th, 1883.*

Claim.—(1) The combination, with a steam system, of a steam trap consisting of a steam-tight chamber provided with an open or free inlet passage communicating with said steam system, a valved outlet passage, and an interior expansion vessel, the said expansion vessel controlling the valve of the said valved outlet

336,628

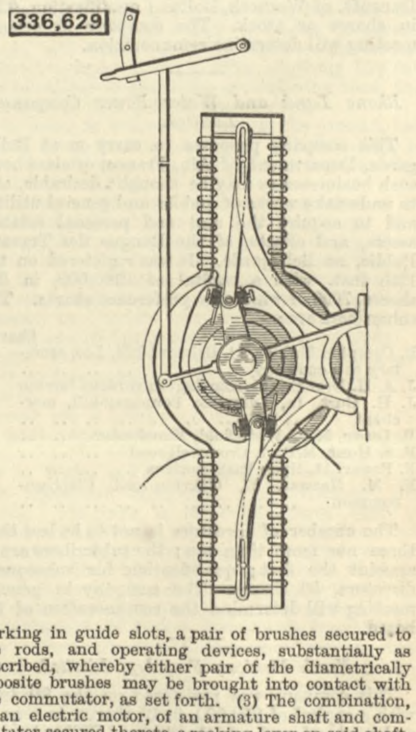


passage, substantially as described. (2) A hollow casting or chamber provided with a free inlet passage and a valved outlet passage, and containing an expansion vessel and spring, the said spring and said expansion vessel being arranged to work in opposition to each other and govern the valve in said valved outlet passage, substantially as described.

336,629. Electric Motor, *Leo Daft, Greenville, N.J.—Filed May 26th, 1885.*

Claim.—(1) In an electric motor, a rocking lever having a pair of brushes at each end arranged with their inner ends projecting from each other, one of the brushes of each pair having a common terminal, and mechanism, substantially as described, whereby each diametrically-opposite pair may be brought into contact with the commutator at an angle to the direction of rotation of the commutator, as set forth. (2) The combination, in an electric motor, of a rocking lever, guide levers secured to the ends of the lever and

336,629



working in guide slots, a pair of brushes secured to the rods, and operating devices, substantially as described, whereby either pair of the diametrically opposite brushes may be brought into contact with the commutator, as set forth. (3) The combination, in an electric motor, of an armature shaft and commutator secured thereto, a rocking lever on said shaft, guide levers secured to the ends of said lever and working in slots in the frame of the machine, a pair of brushes secured to the guide levers, having outwardly projecting rods, and one brush of each pair having a common terminal, and a hand lever for changing the position of the brushes, so that they will bear upon the commutator at an angle to the direction of rotation of the same, or so that none of the brushes will touch it, substantially as described.