INSTITUTION OF MECHANICAL ENGINEERS.

At the last general meeting of the Institution, which took place on the 18th ult., at Leeds, the proceedings commenced with the reading by Mr. Wyllie of a paper on

Triple Expansion Marine Engines.

This paper is too long and too important to be abstracted with advantage, and we therefore give it in full on page 363. The discussion was opened by Mr. W. Parker, who added to the importance of the paper by giving facts and figures concerning the superior results obtained at sea by ships fitted with triple-cylinder expansion as compared with the more ordinary two-cylinder expansion or compound engines. The facts he mentioned as obtained from shipowners and marine engine builders are among those which show conclusively that the ships in which the highest pressures are used are the most economical carriers. In these ships triple expansion engines are used, and the economy is generally credited to these engines, as without three-cylinder expansion the very high pressures cannot be thoroughly utilised. Some exception is, however, taken to this; and it is said that the ordinary compound engine might come out well if supplied with high pressure steam. We will not say this is not true with limitations, although years of experience and experiment have shown that more than a moderate range of expansion cannot be economically used per cylinder or per pair of cylinders, so that it would not seem that very excessive pressures could be utilised with two cylinders, and the fact remains that the triple engine has proved the most economical engine yet sent to sea, under existing conditions. Mr. Parker said it was acknowledged by nearly all steamship owners that the triple-expansion engine was the engine of the future, and that the compound engine was practically extinct. Steamers by its agency were now working under the conditions of quite 30 per cent. less in coal than was the case five years ago. Two large steamers had recently been built for the Peninsular and Oriental Company. They were of 6000 indicated horse-power, were exactly of the same dimensions, and on the same lines. One worked with a triple engine at a pressure of 145 lb. to the square inch, and the other with an ordinary compound engine, working at 90 lb. to the square inch. Both sailed to Australia at 12 knots per hour, and the vessel with the triple engines burned 1200 tons of coal less than the one with the compound engines. In another case of two ships, one carried 1200 tons of cargo more with triple engines than the other with compound, though the working expenditure was the same in both cases. As to steam jacketting, unfortunately in marine engineering they had not the same facilities for looking after things as they had on shore, and through this the jackets sometimes filled with water and were more harm than good. On Friday, while in London, he saw the secretary of one of our largest mail boat companies, and he announced that the engine altered by Messrs. Richardson, of Hartlepool, had given so much satisfaction that although they had just got four vessels completed they had determined upon having them altered, and had besides given an order for other six engines, as the consumption of coal under the new system was so much less as just to make a dividend. Mr. Parker also pointed out that the crank shaft stress diagrams could not be of any service if taken out without reference to the weights. This, however, was done, and we omit these diagrams.

Mr. Cochrane thought it was desirable that all figures relating to steam engine economy should be given in terms of feed-water used per indicated horse-power, so as to eliminate all influences of boiler efficiency or fuel quality. He also suggested that where, as mentioned in the paper, the velocity of the steam had really shown itself in the wire-drawn condition of the indicator diagram, there were the elements for ascertaining what ought to be the limit of velocity for the steam, in order to get the full expansion without wire-drawing. As the size of the ports which had failed to give perfect satisfaction was known, there was an opportunity for ascertaining under the varying conditions of pressure what the limit was. He thought the velocity should not exceed 40ft. per second. What lower velocities were necessary at the intermediate cylinder and the low-pressure cylinder were matters of actual experiment, which he thought were capable of being ascertained by means of indicator diagrams examined in connection with the known sizes of the ports.

Professor Alexander B. W. Kennedy said the three-cylinder engine was a three-cylinder compound, just as much as its predecessor was a two-cylinder compound. He supported Mr. Cochrane's request, that if possible Mr. Morrison should give the size of the ports in these engines, because a great point had been made of that matter in the paper; and this information would make engineers still more indebted to Mr. Wyllie. The triple-expansion engine had been a good deal discussed lately in papers by Mr. Parker and Mr. John. Mr. Wyllie's paper was at least as important as those which had preceded it, but there was one feeling of dissatisfaction that he had experienced in reading all, arising from the cause Mr. Cochrane had touched upon, namely, that there were no exact experiments in regard to marine engine economy. Statements of averages had been given, but they were statements which he would show could not be trusted entirely; and he hoped it might be possible to get some much more accurate data to go upon. Engineers had to take for their data figures derived from experiments which could only be called roughly approximate. That was recognised in Mr. Wyllie's paper, where it was said that, in order to get a correct estimate of an engine's performance, the quantity and temperature of the feed and circulating water ought to be considered. On the Para, if it had been possible to measure the feed-water, he was sure that some of the figures in the paper would not have appeared. He had worked out as accurately as he could, from small-scale copies of the indicator diagrams exhibited, the steam consumption per I.H.P. per hour in the Para, the Anglian, the Lusitania, the Shakespear, the African, and the Stella; he had grouped the results in the accompanying table. Steam quantities calculated from

Consumption of Steam in Compound and in Triple Expansion Cylinder Engines (Kennedy).

Name of steamer.	Number of cylinders.	Indicator diagrams.	Indicated horse-power.	Steam consumption per I.H.P. per hour, deduced from indicator diagrams. Actual weight of steam consumed.	Equivalent evaporation from and at 212 deg. Fah.	Ditto with 15 per cent. added for initial condensation.	Nominal coal consumption per I.H.P. per hour.	Equivalent evaporation from and at 212 deg. Fah. per lb. of coal.
	No.	Figs.	I.H.P.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Para	3	25	616	13·4	16·1	18·5	1·54	12·0
Anglian	2	28	1065	17·9	21·1	24·3	2·10	11·6
Anglian	3	29	1575	13·7	16·5	19·0	1·40	13·6
Lusitania	2	30	2330	18·0	21·2	24·4	2·08*	11·7
Lusitania	3	31	3632	14·9	17·8	20·5	1·28*	16·0
Shakespear ..	3	19	871	14·3	17·1	19·7	—	—
African ...	3	26	1086	14·9	17·8	20·5	—	—
Stella	3	32	932	13·7	16·4	18·9	1·36†	13·9

* Welsh coal. † North-country coal

indicator diagrams were always too small. In ordinary compound engines with 80 lb. boiler steam and with steam-jacketted cylinders, he thought the indicator diagrams did not usually show more than about 75 per cent. of the steam used. He thought that although in the triple-expansion engines a high initial steam pressure was very well carried out in the first cylinder, and the high-pressure clearance was very small, and everything had been done to render the condensation of the entering steam as small as possible, yet the fall of temperature in the steam on entering the first cylinder was about the same as in the two-cylinder compound engine, as would be seen from the figures given in Table II. in the paper; and there was no steam jacket on the high-pressure cylinder. The indicator diagrams he therefore believed did not show more than about 75 per cent. of the steam actually used. But to be quite safe in his calculations, he had assumed that the indicator diagrams showed as much as 85 per cent. of the steam used; and on that supposition he had calculated the consumption of steam per I.H.P. per hour, and the quantity of water evaporated from, and at 212 deg. Fah. per pound of fuel. The result so arrived at was that in the Para the evaporation was 12 lb. of water per pound of coal, in the Anglian 13·6 lb., in the Stella 13·9 lb., and in the Lusitania 16 lb. This was impossible. With ordinary coal such as was burnt in marine boilers, from 12 lb. to 14lb. of water evaporated per pound of coal was as much as could be got even in a calorimeter; while in a boiler furnace, imperfect combustion, uselessness of the hydrogen, and carbon not burnt into carbonic acid, made it impossible. Moreover heat was unavoidably lost in the escaping gases and heating the air, so that 10 lb. of water evaporated per pound of coal was very good practice. In view of these facts he thought it was high time that marine engineers should endeavour to carry out more exact measurements and to furnish more correct data than those from which such results were worked out as he had here arrived at. While disagreeing with the author upon this point, he did not disagree with the author's main contention, that three-cylinder engines were better than two-cylinder engines in particular cases. The reason of the advantage was clear. Comparing, for instance, the two-cylinder indicator diagram from the Anglian, shown in Fig. 28, with the three-cylinder diagram from the same vessel after conversion, shown in Fig. 29, it was seen that the high-pressure diagram in Fig. 28 would nearly cover the intermediate diagram in Fig. 29, and the two low-pressure diagrams would cover each other; because it would be seen that in Fig. 28 the initial pressure in the high-pressure cylinder was only 45 lb., or very much the same as the initial pressure in the intermediate cylinder in Fig. 29. The advantage had been obtained by using a higher boiler-pressure, and taking additional work out of the steam by expanding it from a pressure of about 150 lb. down to 45 lb., which had here been done by putting in a third cylinder as the high-pressure cylinder. There was no reason theoretically why this additional work should not be equally well obtained from the steam by two cylinders. It did not prove that three cylinders were better than two; but that it was far better to use 150 lb. pressure than only 50 lb. There were important practical reasons, however, connected with range of temperature and with initial condensation, which made it difficult to utilise so high a pressure as 150 lb. in only two cylinders. But it was very necessary to be clearly understood that it was not the three cylinders which in this case made the improvement, but the use of a very much higher pressure of steam. He did not agree that the low-pressure cylinder, as stated in the paper, was the source of the greatest inefficiency. He thought inefficiency in the low-pressure cylinder was caused mainly by defects of receiver and of passages, and that it could be remedied mainly by alterations outside the low-pressure cylinder itself; it was the high-pressure cylinder which was at present the most inefficient. It was in the high-pressure cylinder that there occurred the initial condensation which was the most serious of all the remediable causes of loss in any engine; and for any large economy he believed it was necessary at present to look to improvement in the high-pressure cylinder rather than in the low-pressure. If slag-glass liners to the cylinders could be used, or in some other way making them non-conducting, it would get rid of the present abomination of sending in 20 per cent. of the steam as water, or converting it into water as it entered the cylinder.

Mr. Mudd, of West Hartlepool, entered upon a full discussion of the paper, assisted by diagrams, but as his remarks were written, they had to be handed in to the Council, though what he did say proved them to be of importance.

Professor R. H. Smith thought they required further explanation with regard to some of the points raised by the author. His impression was that the greater efficiency of the triple expansion engines was chiefly due to the possibility of using a very much higher initial pressure. But then there was the question as to whether they were not bound to use three or more cylinders. It was necessary to use more than two cylinders if they were to be able to employ the high initial pressure without sacrificing other practical advantages in the engine.

Mr. David Greig thought that a good deal of the economy of the triple-cylinder engine was due to the high pressure used, and that the compound engine might do much higher duty if instead of say 90 lb., steam at the higher pressure were used on it. There was no difficulty about the high pressure. He was himself working engines every day at 180 lb., and sometimes at 200 lb., and had no trouble with them. Beyond 200 lb. he did indeed experience some trouble; and no doubt some means would be arrived at by which steam at 200 lb. pressure could be worked without difficulty. Possibly four or five cylinders would then be required instead of three. Another speaker remarked that in fairness to the author it should be borne in mind that marine engineers had to be guided as much by what the shipowners required as by what was to be learnt from the reading of indicator diagrams. What Professor Kennedy had said concerning the quantity of steam that might or might not be used as indicated by the diagrams was all perfectly true. But the steam shipowners did not care at all about what the diagrams showed; what they wanted to know was for how much coal they could carry a ton of cargo from one port to another. When the results were taken from a set of engines and boilers working day after day over many thousands of miles, and voyage after voyage, slight inaccuracies as to the quantity of coal might be entirely disregarded; whatever they were they applied equally to the two-cylinder compound engine ship and the lower pressures; and although for experimental and for comparative purposes and for questions of thermo-dynamics it would be very much better to know the number of pounds of water used per indicated horse-power, still after all the question was for how much coal could the cargo be carried; and it was this consideration by which marine engineers had to be guided in designing engines to satisfy the shipowners. The steam shipowners had found by the same examination as that which they applied in all cases, that triple engines had achieved results which the two-cylinder compound had not, and whether this was due to very high pressure, and whether three cylinders were necessary to the use of this pressure or not, the facts were the same.

VISITS IN THE PROVINCES.

THE MOSS BAY IRON AND STEEL COMPANY'S WORKS, WORKINGTON.

The extensive and important works belonging to the Moss Bay Iron and Steel Company are conveniently situated on the shores of the Solway Firth, and midway between the two sea ports of Workington and Harrington. Since the erection of these works, the former town has been greatly extended in that direction, house property has been built or is now being built, along the highway between the two towns. The site of the works forms a triangle, one side of which runs parallel with the line of railway belonging to the London and North-Western Company, for nearly half a mile. This railway company has formed a connection at both ends of the works. At the north end of the works, the Cleator and Workington Railway crosses over the London and North-Western on a higher level, and forms a junction with the rails of the Moss Bay Company in its own yard. The same railway company has formed a special line at the south end by which a connection has been formed, thus giving a direct railway connection with the hematite ore district, and also with the docks for the shipment of their produce. The Moss Bay Company has laid down in its own yard, at its own cost, for the successful working of its own traffic, between five and six miles of railway, on which it employs seven locomotive engines. Such an extent of railway and locomotive power will not be considered too large, the great amount of traffic being taken into account which has to pass in and out of the yard, as well as the amount of shunting rendered necessary inside the yard. In order to form some idea of the number of wagons and trucks which will have to be received into and dispatched from the works, it will be necessary to point out the quantity of raw material that is consumed inside these works. They receive annually about 100,000 tons of coke, mostly from the Durham district, 40,000 tons of limestone from the local quarries, and 160,000 tons of iron ore. When these, in connection with the stores for carrying on the works, are taken into consideration, it will be seen that the total amount received is considerably above 300,000 tons of raw material yearly. If we were to estimate each wagon and truck entering the yard to contain on an average 6 tons, it would require 50,000 wagons or trucks to bring in that amount. In considering the daily delivery we are not to suppose that would take place at one uniform rate per day; it is possible that this might vary from 100 to 200 wagons per day. It will be necessary to remark that none of the wagons or trucks employed to bring in the raw material would be suitable for carrying out the finished article. For this trucks of a different construction have to be employed, consequently the whole of the 50,000 wagons or trucks bringing in the raw material have to be despatched from the works empty, and in addition to these there are needed

10,000 trucks to send out the 100,000 tons of steel rails or other finished articles which are manufactured yearly by this company, making a total of 60,000 wagons or trucks passing in and out of the yard per annum. In addition to these there are 100,000 tons of slag and other refuse to remove.

On the side of the works which stretches along the shores of the Solway is situated the engine-house containing the four blowing engines supplying the four furnaces with the necessary blast; between the engine-house and furnaces are seated nine horizontal and eight vertical boilers for supplying steam to the blowing and some smaller engines employed for different purposes in the yard. At the opposite end of the row of furnaces are thirteen other horizontal boilers, made of mild steel by Messrs. Galloway, of Manchester; these boilers are chiefly employed to give steam to the engines working at the steel works. The total number of boilers employed is twenty-two horizontal and eight vertical. The eight vertical and seventeen of the horizontal boilers are worked by the waste gas from the blast furnaces; the other five are fired with coal, the waste gases not being sufficient to supply the whole of the boilers with fuel.

In the same line with the four furnaces already erected, space has been left for a fifth, when the directors may see it necessary to build another. The outer shells of the furnaces are made of the best rolled iron plates, resting upon cast iron pillars; these pillars have a solid foundation of the usual description, and being surmounted by a cast iron ring, on which the outer casing and furnace blocks rest. Inside the casing the furnaces are lined with fire-brick blocks, made of the best fire-resisting material, in order that they may, as far as possible, withstand the high temperature needed for smelting the ores. The furnaces are 60ft. high, the diameters at the bosh being 18ft. and 19ft.; on each side of the furnaces are arranged the heating stoves. The heating stoves are built to the designs of the late Mr. Thomas Whitwell, and are said to have, in their general working, given satisfaction. At the back of the furnaces, and on the shore of the Solway, are built the bunkers, on the top of which, at a considerable height above the ground level, is placed a line of rails, on which the wagons and trucks are run containing the coke, limestone, and ores; and from thence the various raw materials are discharged into the bunkers, and are filled by hand labour into double-wheeled barrows, which are raised on cages by a small steam engine to the top of the furnaces. The whole of the 300,000 tons of raw material has to be lifted 60ft. to the furnace top, but before doing so the whole has to be weighed, and the proper proportion of each ascertained before it is discharged into the furnace. Two small engines working two cages each, lift the material, which will average nearly 800 tons per day of twenty-four hours, the men working in two shifts, or night and day, twelve hours each shift. The company makes very little pig iron for sale, the managers acting on the idea that it is more profitable to work it up into the finished article before removing it from the works. It is considered that the finished article can be produced at a less cost than would be the case if the raw material were moved to another establishment to finish; not only the saving of the carriage, but both profits can be reaped by the one company.

On the extreme north side of the works is located the steel manufacturing plant. The Bessemer converters are erected on the end nearest the shore. The crane is swung round so as to bring the ladle under the agitator, which is formed by fixing arms to a vertical shaft. This is dipped into the molten steel, and a revolving motion is given to it by a small steam engine in such a way as thoroughly to mix the metal. It is afterwards brought over what is called the Bessemer pot—a large circular opening made below the level of the floor, in which are placed a number of iron moulds standing on end. The steel being brought over one of these moulds, a tap is opened in the bottom of the ladle, and the steel is allowed to run out until the mould is full; the hole is then closed and the ladle brought over another, and so on until the whole of the steel is run from the ladle into the moulds. While the steel is thus being run out the chemist takes small samples of it to ascertain its quality or constituent parts. As each mould is filled the men cover the top of the mould with sand, and put on a lid to prevent the ebullition of the steel, which would make it unsound. As soon as the metal has begun to set in the moulds, which it will do in from five to ten minutes, the covers and moulds are removed, and leave standing in the Bessemer pit blocks of steel 14in. square, slightly tapering to the top, and weighing from 20 cwt. to 24 cwt. each. The ingots of steel are taken in hand by another set of men, who remove them, while still hot, to the heating furnaces, where they remain until they are in a proper condition for passing through the rolls. The heating furnaces are built in batches varying in number, at the sides of the rolling mills, and heated by a method patented by Mr. Peter Kirk many years ago. It would be here necessary to point out that the ingot when taken out of the Bessemer pit may have had a hard shell of metal formed on the outside, while the inside may be in a semi-fluid state, in which condition it would be utterly unfit to pass through the rolls. To retain the heat given off by the ingot when solidifying and store it up for future service, and save the expense of re-heating, various methods have been devised, none of which are regarded by the Moss Bay Company as a complete success, and it has been thought more satisfactory by the managers of this company to re-heat the ingot in the manner described. A large range of furnaces of a new design is being constructed, in such a position, and of such dimensions as will, it is hoped, greatly reduce the cost of heating. Of these possibly we may at some future time give an enlarged description. When the ingot has acquired its proper state of consistency, it is removed from the heating furnaces, and entered into the rolls of the blooming mills, when it is passed through several grooves; each time it is diminished in thickness and increased in length; it is then transferred to the roughing mills, where the same process is gone through until it becomes a rough shaped rail. It is then removed to the finishing rolls, where it receives the form and finish of a rail of the shape and weight required. In passing through the last groove of these mills the rail receives the stamp of the firm, the date, and the name of the purchaser. The act of passing the bloom or rail through the grooves in the different rolls is effected by machinery, little or no manual labour being now employed.

The rail, having passed the finishing mills, is now on the opposite side of the rolls to that by which it at first entered, and at a convenient distance from these rolls. At this stage of its manufacture the rail is from 80ft. to 130ft. in length, according to section and weight per yard. It is moved forward on rollers, acted on by machinery, until in front of a small circular saw, where it becomes stationary; the saw is moved in the direction of the rail, revolving very rapidly, and cuts through the solid steel rail in an incredibly short time. The operation is again repeated, until the whole is cut into proper lengths by the same means. The rails are afterwards moved by machinery —first to the benches, where the workmen dress off the roughness left by the saw while the rail is still hot; and secondly, to the press where all bends are taken out, and the rail made perfectly straight; third, to the steam drills, where the holes for the bolts of the fish-plates are made, and then to the benches, from which they are loaded to send to their final destination. At this stage the inspector walks along each rail, closely examining each separately, and sees that they are properly finished, notes the defects, if any, and has the defective rails removed, allowing only those which are up to the specification to leave the yard.

In this description we have followed the raw material from the point where it first entered the yard until we leave it now a finished article, and in doing this we have arrived at the same place in the yard as that from which we commenced. Here we would wish to remind our readers that the quantity of material which has to pass through the rolls yearly is immense, and that this amount has been increased greatly of late years. According to the declaration of Mr. Valentine, one of the managing directors of the company, when before the House of Lords in 1882, the turn out of steel rails yearly was 70,000 tons, but the capacity of the works at the present time has increased to 100,000 tons of finished rails per annum. In this estimate allowance has been made for unavoidable stoppages, which in works like these with the best management cannot be avoided. When in full work upwards of 2000 tons of rails have to pass the rolls each week, or from 330 to 340 tons per day, which includes both the day and night shift, or the whole of the twenty-four hours. During the whole of this time nearly 15 tons per hour will have to be rolled, and if we take the ingots on an average of 22 cwt., there will need thirteen or fourteen ingots per hour to make the quantity of rails given above. For some years there has been a growing improvement in the amount of work which has been turned out by this company. In 1880 there were 62,329 tons of ingots, and 53,547 tons of steel rails manufactured. In 1881, 66,441 tons of ingots, and 56,616 tons of steel rails. In 1882, 88,112 tons of ingots, and 75,036 tons of steel rails. In 1883, 94,604 tons of ingots, and 80,870 tons of steel rails were turned out; the present capacity of the works is 100,000 tons of steel rails.

This improvement in the productive capacity of the works is not so much due to any extension that has been made in them, as to the labour-saving machinery which has been devised and erected under the superintendence of Mr. Peter Kirk, a managing director of the company. In immediate connection with the works the directors have had a large foundry built, and in this they have been for some time casting their own ingot moulds, which they make of the best Bessemer pig, and find them to answer their purpose well. Lately they have begun to cast their own rolls, making them either in iron or steel. By this means they save the carriage rate, while at the same time they insure a good article. Such rolls as these had to be brought from Staffordshire. At this foundry they have been able to cast rolls weighing eight tons and upwards, and to finish them to their own pattern in their own yard, a staff of suitable men being employed at the works.

It would not be necessary that we should here say anything in detail of the extensive pattern and fitting shops which have also been erected at the works, which have been liberally furnished with modern tools of the most approved description, by means of which nearly the whole of the repairs are done, as well as a large proportion of the new mechanical improvements now in use have been made.

The company has within its own works a large and commodious laboratory, with a staff of efficient chemists, who analyse the raw material received into the yard, as well as the manufactured goods sent out, a record of the analysis being kept in the office. This is done the better to insure both descriptions of material being correct and according to specification. It has extensive hematite ore mines of its own, from which it expects shortly to be able to supply its furnaces. The Wood End royalty has every appearance of being a success. The company has already at that place proved a large deposit of valuable hematite ore. It has also lately taken on lease a large and valuable limestone royalty at Tallentire, belonging to Mr. William Browne, of Tallentire Hall, from which it expects to bring, for the fluxing of its furnaces, about 70,000 tons of limestone annually. When in full work the company employs about 1000 workmen at the iron and steel works alone, and possesses a capital of £350,000 in shares, with £40,000 in debentures. It has been fortunate enough to make a profit in each year since the works were commenced as a private company in 1871. The limited company was formed and took over the works in the early part of 1881, the original surviving partners retaining their interest in the undertaking.

ON THE DESIGN OF SLIDE VALVES.

By Prof. R. H. Smith.

It is not intended here to say anything of the merits or demerits of the various kinds of slide valves. These differ greatly as to the frictional work spent in driving them, as to their steam tightness, as to their wearing qualities, and as to their more or less rapid opening and closing of the ports. The simple geometrical question alone of the relation between steam distribution and valve dimensions is to be dealt with, the valve being supposed driven by an ordinary excentric.

The diagram shown in the engraving is almost identical with one constructed by myself in 1870 or 1871. The elementary principle of the device was suggested to me by a German draughtsman. He had a small brass disc, about 2in. in diameter, on which was described a circle divided into equal parts, and a series of parallel, equidistant straight lines, perpendicular to a scribed diameter, which was taken as the piston-stroke and the valve-stroke. At the centre was pivotted a small arbor, on which were mounted two dial pointers, taken to represent crank and excentric. These could be clamped together at any angle, and the two could be rotated together by means of a small milled head. The instrument was a very rough one, incapable of accurate calculation; but its chief fault lay in the fact that no account was taken of the effect of the obliquity of the connecting-rod.

The convenience of the instrument consisted in its obviating the necessity of drawing any circles on paper, and of plotting off any angles with the dividers in working out slide-valve problems. It was an easy step to perceive that the same result could be obtained by a carefully drawn diagram on paper or cardboard, with various scales marked on it, and that in preparing such a diagram allowance could be made for the obliquity of the connecting-rod by projecting the equal divisions of the piston stroke on the crank-pin circle by means of circular arcs of connecting-rod radius, instead of by perpendicular straight lines. In the diagram attached to this article this is done for three standard ratios of connecting-rod length to crank throw. The connecting-rod lengths chosen are 2, $2\frac{1}{2}$, and 3 strokes. The stroke is divided into 100 equal parts, and the corresponding positions of the crank-pin are shown on the three outer circular scales for the above three connecting-rod lengths. The actual connecting-rod length in steam engines is never so much different from one or other of these as to make any appreciable difference in the slide-valve calculation.

The inner circle is taken as 5in. in diameter, and represents to different scales the paths of both crank-pin and excentric centre. The horizontal diameter represents to the same two scales the strokes of piston and of valve. It is divided into 100 parts, only every fifth division being indicated by a vertical cross line. Considering it as the valve stroke, the corresponding positions of the excentric centre are projected on the circle by vertical straight lines, because the obliquity of the eccentric-rod may be taken as practically *nil*. In slide valve design, all dimensions have to be considered in ratio to the half travel of the valve. Therefore the half travel is conveniently divided into ten parts, each of these being subdivided into five. The one-fiftieths of the half travel are large, and easily divisible by eye, so that there is no difficulty in reading off the ratios to 1 per cent. of half travel.

In using the diagram careful distinction must be made between the out and in-strokes. The upper semicircle must be used in dealing with the in-stroke; the lower with the out-stroke. The diagram must be so used whatever be the actual direction of rotation of the engine. The diagram can be used for the solution of two classes of converse problems—firstly, given the valve and port dimensions and the setting of the valve, to find the resulting steam distribution; secondly, given the desired steam distribution and the ratio of connecting-rod length to stroke, to find the required valve dimensions and excentric setting. In conjunction with the diagram two sets of rules are given—first, four for the first class of problems, and second, five for the converse problems. These rules are so easily proved to be correct by a little careful consideration that it is hardly worth while to give demonstrations of their truth here. It will be sufficient to make one or two explanations as to the phraseology used and as to the general mode of procedure.

In the rules the phrase "set off" such an angle is constantly used. This setting off is not to be performed with dividers. By help of the scale of angle-degrees all the angles used are obtained in degrees, and the simplest mental addition and subtraction of degrees are alone needed for the plotting off of the angles from any of the points mentioned in the rules. If the mental arithmetical faculty be not developed in the operator, he can make his additions and subtractions on paper, but he should not substitute the use of the dividers for this arithmetic, because the prickings of the divider points would rapidly destroy the diagram for all accurate purposes. The "angle of lead" is to be understood as the angle at which the crank stands before the dead point when steam admission takes place. The "angle of lap" is the angle beyond 90 deg. at which the excentric stands when steam admission takes place. The "angular advance" is the sum of these two angles.

It is to be distinctly understood that the diagram enables one to calculate only angles and ratios of the valve dimensions. Evidently any standard diagram could not give directly absolute dimensions. The port breadth has to be found from the required area of port. Call it b. Say that a ratio q has been calculated by help of the diagram for outside lap divided by half travel. Then from this we find the half travel $= \frac{b}{1-q}$, and therefore the outside lap $= b\,\frac{q}{1-q}$.

If we wish to make the cut-off the same on out and in-stroke, we find two different values of q for the two strokes, *i.e.*, for the two outside laps. That obtained for the out-stroke is always the larger of the two if the two

SLIDE VALVE DIAGRAM.

(For description see page 360.)

RULES TO FIND PROPER VALVE DIMENSIONS REQUIRED FOR GIVEN STEAM DISTRIBUTION.

1.—*Given Pre-admission to find* Angle of Lead:

Find the desired point of pre-admission on the proper-piston stroke scale, and the point opposite this on the scale of angle-degrees. The angle between this point and the end of the stroke is the Angle of Lead. The sum of the Angle of Lead and of Angle of Lap is the angular advance.

2.—*Given Pre-admission and Cut-off to find* Outside Lap:

Find Angle of Lead by Rule 1, and set it forward from point of cut-off found on proper piston-stroke scale. Half the remaining angle between the point so got and the end of the stroke is the Angle of Lap.

3.—*Given Pre-admission, Cut-off, and Release to find* Inside Lap:

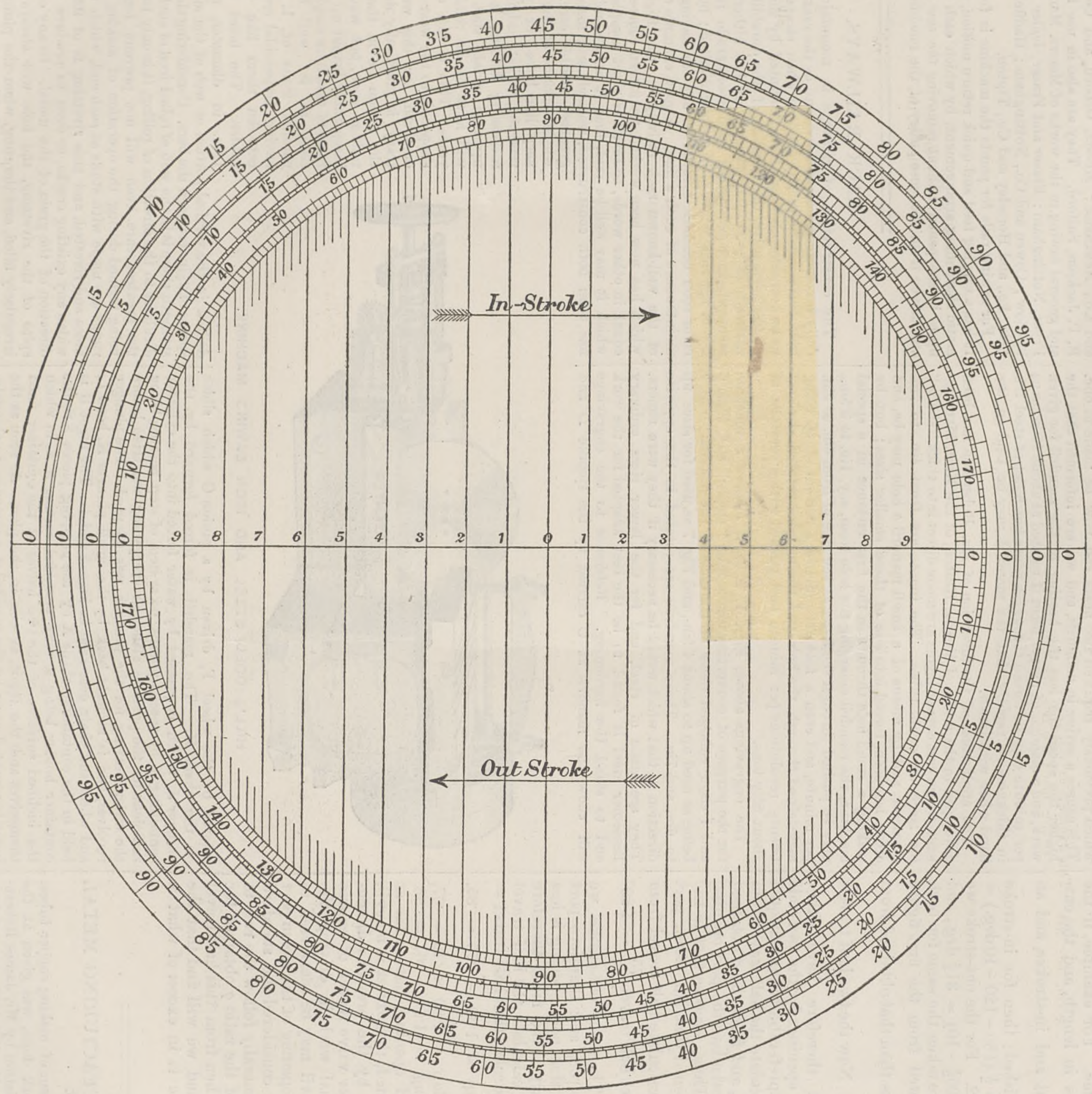
Find angular advance by Rules 1 and 2. Set the angular advance back from end of stroke. The angular difference between the point so got and the desired point of release as found on the proper piston-stroke scale is the Angle of Inside lap, or of *clearance if release is further back than point first got.*

4.—*Given Pre-admission, Cut-off, and Compression to find* Inside Lap:

Find angular advance by Rules 1 and 2. Set the angular advance back from the beginning of the stroke. The angular difference between the point so got and the desired point of compression as found on the proper piston-stroke scale, is the Angle of Inside Lap, or of *clearance if the point of compression is further forward than the point first got.*

5.—*Given Cut-off and Angular Advance to find* Outside Lap:

From point of cut-off as found on proper piston-stroke scale, set forward the angular advance. The angle from point so got to end of stroke is the Angle of Outside Lap.



Scale on Diameter.—Valve Travel; each half-travel divided into 50 equal parts. (These divisions being projected on 1st Circle.)

Scale on 1st Circle.—Equal degrees of Angle; each semicircle divided into 180 deg.

Scale on 2nd Circle.—Piston Stroke divided into 100 equal parts; Connecting-rod = 2 Strokes. (Showing positions of Crank Pin for simultaneous positions of Piston.)

Scale on 3rd Circle.—Piston Stroke divided into 100 equal parts; Connecting-rod = $2\frac{1}{2}$ Strokes.

Scale on 4th Circle.—Piston Stroke divided into 100 equal parts; Connecting-rod = 3 Strokes.

RULES TO FIND STEAM DISTRIBUTION DUE TO GIVEN VALVE DIMENSIONS.

1.—*Given Lap and Angular Advance to find* Pre-admission:

Subtract from Angle of Lap and Lead, *i.e.*, the angular advance, the Angle of Lap. Set the difference of these angles back from the beginning of the stroke. The point so got is the point of Pre-admission.

2.—*Given Lap and Angular Advance to find* Cut-off:

Add the angular advance to the Angle of Lap. Set the sum of these angles back from the end of the stroke. The point so obtained is the point of Cut-off.

3.—*Given Inside Lap and Angular Advance to find* Release or Exhaust:

Subtract from angular advance the Angle of Inside Lap. Set the difference of these angles back from the end of the stroke. The point so got is the point of Release.

4.—*Given Inside Lap and Angular Advance to find* Compression:

Add the angular advance to the Angle of Inside Lap. Set the sum of these angles back from the beginning of the stroke. The point so got is the point of Compression.

DEFINITIONS.

The "Angular Advance" is the angle between crank and excentric, less 90 deg.

The "Angle of Lap" is the angle whose sine is the outside lap divided by the half-travel.

MACHINERY FOR MANUFACTURING METAL TUBES.

MR. JAMES ROBERTSON, GLASGOW, ENGINEER.

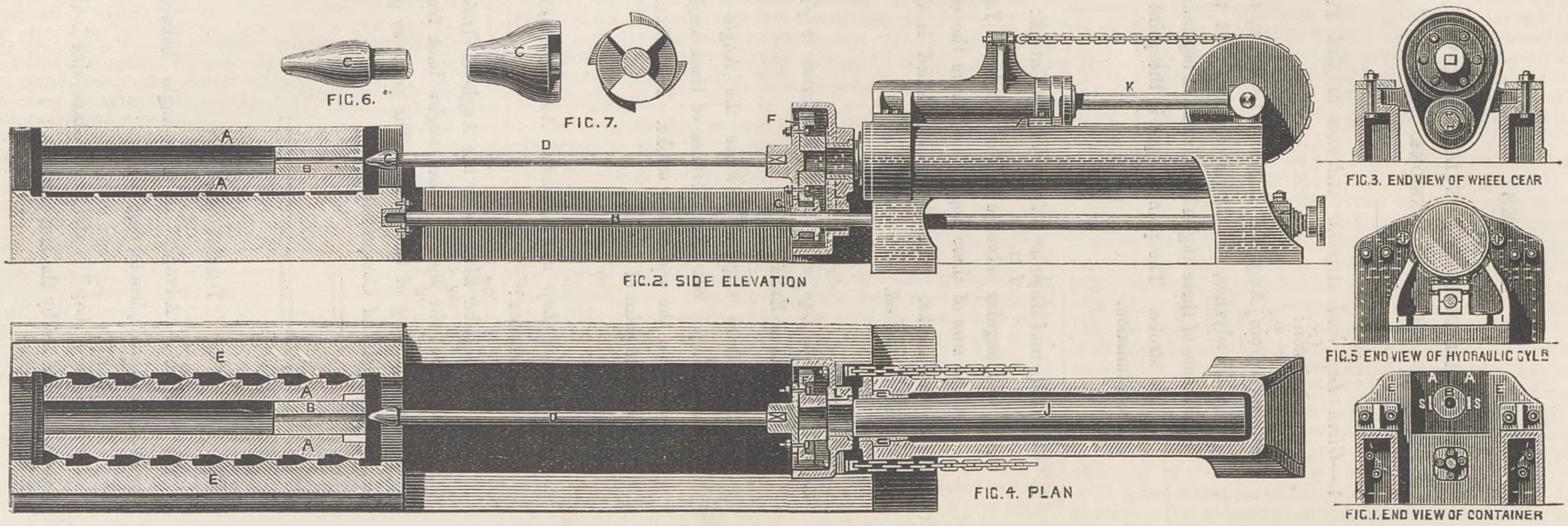


FIG. 6. FIG. 7. FIG. 2. SIDE ELEVATION. FIG. 3. END VIEW OF WHEEL GEAR. FIG. 5. END VIEW OF HYDRAULIC CYLR. FIG. 4. PLAN. FIG. 1. END VIEW OF CONTAINER.

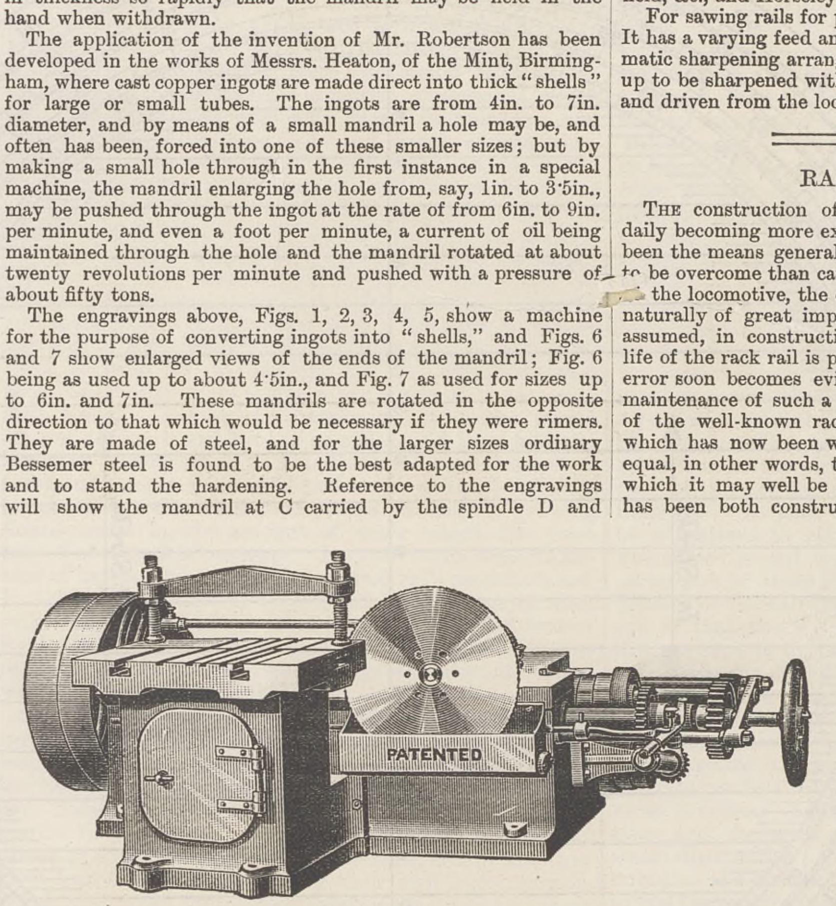
angles of lead be taken the same. For example, if the connecting-rod were two strokes in length, and the cut-off $\frac{7}{10}$ were desired for both out and in-strokes, and an angle of lead of 10 deg. were wished; then for in-stroke we would have "angle of lap" $= \frac{1}{2}(180 - 120 - 10 \text{ deg.}) =$ 25 deg., and consequently $q = {\cdot}42$. For the out-stroke we find "angle of lap" $= \frac{1}{2}(180 - 106\frac{1}{2} - 10) = 31\frac{3}{4}$ deg., and therefore $q = {\cdot}53$. If now b were taken the same for both ports, the half travel as calculated from the first figure ·42, $\left(\frac{b}{1 - {\cdot}42} = \frac{b}{{\cdot}58}\right)$ would be less than that obtained from the second ·53, $\left(\frac{b}{1 - {\cdot}53} = \frac{b}{{\cdot}47}\right)$. Now the two half travels cannot be unequal. We must therefore have either unequal cuts-off, or unequal port openings for the two ends of the cylinder. It will generally be preferable to have unequal port openings. We must then calculate the half travel from one of the two ratios q obtained, and from the q obtained for the other end of the valve calculate the port opening and lap from this half travel. Thus, suppose that in the above example it had been reckoned that $\frac{3}{4}$in. steam port opening was required. If we calculate half travel from the ·42 for in-stroke, we would have half travel $\frac{{\cdot}75}{{\cdot}58} = 1{\cdot}29''$ and lap. $= 1{\cdot}29 - {\cdot}75 = {\cdot}54$. Then for out-stroke we would have lap $= 1{\cdot}29 \times {\cdot}53 = {\cdot}68$, and therefore port opening $1{\cdot}29 - {\cdot}68 = {\cdot}61$. But this port opening is less than has been settled as necessary. We must therefore proceed in the other order, and calculate the half travel from the ·53 obtained for the out-stroke; thus half travel $= \frac{{\cdot}75}{1 - {\cdot}53} = 1{\cdot}60$, and therefore lap $= 1{\cdot}60 - {\cdot}75 = {\cdot}85$. For in-stroke, we then obtain lap $= 1{\cdot}60 \times {\cdot}42 = {\cdot}67$, and therefore steam port opening $= 1{\cdot}60 - {\cdot}67 = {\cdot}93$. This is in excess of the required opening, but so far as simple steam admission is concerned, this excess is no evil, whereas the deficiency obtained by the previous dimensions is a decided evil. The larger valve travel of course involves more waste of frictional work in driving the valves, and in some cases this evil may be considered to overbalance the evil of deficient opening of the steam port at one end. But this cannot be considered the standard case, and therefore we should generally follow the rule to design the half travel by help of the ratio q obtained for the cut-off on out-stroke. We then from this half travel calculate the lap for in-stroke, and we will find that the steam port opening for in-stroke is in excess of what is absolutely required.

A NEW SYSTEM OF MANUFACTURING METAL TUBES.

An account of a remarkable system of making copper tubes, illustrated by specimens of the work done, was given at the recent meeting of the British Association by Mr. James Robertson, of Glasgow, in a paper read by Mr. Ralph Heaton, of Birmingham, in whose works the system is adopted. Mr. Robertson calls the principle involved in his system the "cross surface motion frictional contact of solid bodies." We need not reproduce Mr. Robertson's paper, as having seen the machinery at work in carrying out the process we may, perhaps, describe more briefly what is meant by the above, and then leave our readers to employ their own nomenclature. The essential feature is the application to tube-drawing mandrils of the compound motion which anyone gives to a cork when it is pulled out by a slightly twisting movement, or of the partial rotative movement given to, say, a wheel, when it is being pushed on to a shaft upon which it fits tightly. The same principle had previously been employed by Mr. Robertson as a means of making pistons and piston and slide rods move more freely than when the pull or push imparted to them caused them to move only in the direction of their axes and not to rotate upon them. The same principle has recently been employed by Mr. Wicksteed for the rotating pistons in his autographic testing apparatus. The difference between the force necessary to slide a gland along a rod when the rod is fixed and when it is rotated at a hundred or so revolutions per minute, has been found by Mr. Robertson to be something like sixty times, and the force necessary to pull a bulb-ended mandril through a tube is said to be from sixty to eighty times more when pulled in the ordinary way than when rotated at the same time that it is pulled. According to Mr. Robertson, the greatest saving of power seems to be effected when the movement in a rotative sense of the surface concerned is about equal to its linear axial advance. The rotating mandril has been adopted for drawing welded tubes, and it is found that by rotation the mandril is at the same time prevented from heating to any material extent, and that a tube which previously required two heats can now be made in one. This causes a saving in mandrils, and we are informed that the higher the speed the less the heating of the mandril for given work, and a mandril of proper form if rotated at about 4500 turns per minute may be forced through a white hot billet of steel 1ft. in thickness so rapidly that the mandril may be held in the hand when withdrawn.

The application of the invention of Mr. Robertson has been developed in the works of Messrs. Heaton, of the Mint, Birmingham, where cast copper ingots are made direct into thick "shells" for large or small tubes. The ingots are from 4in. to 7in. diameter, and by means of a small mandril a hole may be, and often has been, forced into one of these smaller sizes; but by making a small hole through in the first instance in a special machine, the mandril enlarging the hole from, say, 1in. to 3·5in., may be pushed through the ingot at the rate of from 6in. to 9in. per minute, and even a foot per minute, a current of oil being maintained through the hole and the mandril rotated at about twenty revolutions per minute and pushed with a pressure of about fifty tons.

The engravings above, Figs. 1, 2, 3, 4, 5, show a machine for the purpose of converting ingots into "shells," and Figs. 6 and 7 show enlarged views of the ends of the mandril; Fig. 6 being as used up to about 4·5in., and Fig. 7 as used for sizes up to 6in. and 7in. These mandrils are rotated in the opposite direction to that which would be necessary if they were rimers. They are made of steel, and for the larger sizes ordinary Bessemer steel is found to be the best adapted for the work and to stand the hardening. Reference to the engravings will show the mandril at C carried by the spindle D and



HILL'S COLD STEEL AND IRON SAWING MACHINE.

rotated by the wheel F, driven by a pinion G which slides on the shaft H. The mandril is forced forward by the plunger J, which is pressed by water forced into the cylinder containing it by special pumps, no system of step bearing being sufficient for the purpose, although everything was tried before the water bearing for the plunger was adopted. The plunger revolves, and is brought back by the small plunger K, head L, and wheel and chain gear seen in Figs. 2 and 4. The ingot B is held in the containing shells A by the gripping pieces S S, the container holder being a very powerful casting A A, in which the inclined surfaces of the two halves of the container fixed themselves and the ingot, as seen in the plan. As soon as the ingot is operated upon by the mandril it commences to elongate, and a 2ft. ingot will come out of the container after it has had a 3·5 mandril forced through it, there previously being only a 1·25in. hole, as a 4ft. shell. When the shells come from this machine they pass to tube drawing rolls, in which they are drawn out upon a rotating mandril.

This process is in course of development, and will no doubt work some great changes in the present methods of tube making. It is exceedingly interesting as a metallurgical process, and would have delighted Tresca could he have seen it. As may be expected from what we have said as to the rate at which the copper ingot has to make up its mind to change its form, a hard and bad ingot will not stand the first process, but those which do stand it—and they are nearly all—have thereafter a comparatively comfortable time in the succeeding drawings which follow the annealing after the first. The surface sometimes shows that the ingot has been heavily dealt with, but a light cut is run over the shells in a lathe at a high speed, and this surface defect, when it exists, is removed at very low cost, and the result is that splendidly sound and strong copper tubes are the result, especially adapted, owing to the way in which the metal is compressed, for calico printing rolls, as well as for the purposes of large and medium size copper pipes for general steam purposes.

HILL'S COLD STEEL AND IRON SAWING MACHINE.

Amongst other special work for which the machine illustrated above is employed is cutting off risers and runners, or gates from steel castings. The machine is made by Mr. Isaac Hill, Derby, and several are employed in the works of Sir W. G. Armstrong and Co., Newcastle; Messrs. Osborn and Co., Sheffield; and R. P. Jackson, Salford. They are also in use for girder, angle, and general sawing in the works of Messrs. Manlove, Alliott, and Fryer, Nottingham; Fraser and Fraser, boiler works, Bromley-by-Bow; Cowen and Co., Nottingham; Hadfield and Co., Sheffield, &c., and Horseley and Co., Tipton.

For sawing rails for points the machine is found very useful. It has a varying feed and quick return motion, and with an automatic sharpening arrangement, by which each tooth is brought up to be sharpened without removing the saw from its spindle, and driven from the loose pulley of the machine.

RACK RAILWAYS.

The construction of railways in mountainous countries is daily becoming more extended, and as the rack rail has hitherto been the means generally adopted when steeper gradients have to be overcome than can be surmounted by the simple adhesion of the locomotive, the question of the durability of the rack is naturally of great importance. It has hitherto been generally assumed, in constructing such steep-grade railways, that the life of the rack rail is practically unlimited; but that this is an error soon becomes evident to any one having to do with the maintenance of such a line. A good example of this is the case of the well-known rack railway on the Rigi in Switzerland, which has now been worked for fifteen consecutive summers—equal, in other words, to seven or eight complete years—and of which it may well be said, that it is pre-eminently one which has been both constructed, worked, and maintained with the greatest possible care. Nevertheless, whole sections of the rack rail on this very line have for years had to be renewed, whilst, judging by the rapidly increasing defects, it may be looked upon as certain that the whole rack will have to be relaid within a few years. This is not due, as might be supposed, to the wear of the cross-bars or teeth, for this wear, on the contrary, is practically *nil*. Neither does the reason lie in the system of rack rails as such, but would appear to be inseparably bound up with the special form of rack here employed, which consists, as is well known, of two parallel irons of L or ⊏ sections, having trapezoidal cross bars rivetted between them like the rungs of a ladder. The holes for these rungs, $1\frac{3}{4}$in. in diameter, are punched or drilled in the vertical portion or web of the side irons, leaving spaces of $2\frac{1}{4}$in. between the bars. Considering therefore how little strength there is in the web of rolled iron of such sections perpendicularly to the direction of rolling, it is only to be expected that the greatest care even will not prevent longitudinal cracks being formed during the operation of making the holes. The rungs are made with studs at each end, which are placed in the holes and rivetted, and this rivetting is of itself calculated to widen any existing cracks, or even to produce new ones, in the direction of the grain of the metal. In any case, therefore, in spite of the rivetting, the hole will always be liable to be irregularly filled, and the rung, when the pinion passes over it, will thus tend to move excentrically, and so to split the web of the side iron from hole to hole. Various plans have been tried to remedy this excentric movement, such as, for instance, allowing the rungs to rest on horizontal longitudinal flanges or ribs on the side irons. Such a contrivance would certainly serve to increase the cost of the rail, but not, however, its durability, as, in practice, it is impossible for all the cross-bars to be made, in the first instance, to rest at the same time both in their holes and on the flange—or, should this be attained by increasing the size of the holes, then the bars would be loose—whilst, if the degree of rivetting were increased to counteract this looseness, there would then be the risk of splitting off the whole of the upper part of the side iron. On the other hand, if the rung does not rest properly on the flange, then this latter is useless, and becomes actually a disadvantage, owing to its necessitating an increased length of the rungs. Any one carefully examining the rack rails on existing lines will remark at once that a large number of the rivet-heads are covered with oil, owing to the rungs being no longer firm in their holes, and thus allowing room for the grease supplied for lubricating the toothed gearing to squeeze through. Portions of the line will even be found where every one of the rivets is in this condition. The next stage of this looseness is when it has reached such a pitch that the rungs can be visibly moved by the hand, and this can of itself prove a source of danger to the traffic, because, in consequence of the trapezoidal form of the section of the rungs, considerable irregularities in the distances between the rungs will be the result, and these are very likely to prevent the teeth of the pinion from gearing properly. It is also usual to lay the rack rail in lengths of about 10ft. in order to reduce the effect of the expansion and contraction due to changes of temperature; but it is evident that in spite of this precaution, this expansion and contraction must create, at every joint and at every change of temperature, a varying distance betwen the rungs on either side of each joint. This want of uniformity in the pitch of the rack will naturally, as in all forms of gearing, produce a lack of smoothness in the running of the train, increasing with the speed, which, for this and other reasons, can never be more than from three to four miles per hour.

The disadvantages of the form of rack rail hitherto chiefly employed can only be avoided, as will have been seen by a perusal of the above, by a complete change in the nature and construction of the rack itself, and we purpose to describe and illustrate in an early impression a system by which all the difficulties here referred to have been satisfactorily overcome.

ON TRIPLE-EXPANSION MARINE ENGINES.[1]

By the late Mr. Robert Wyllie.

The last few years may be regarded as a transition period in the history of marine engineering, as the high-pressure triple-expansion engine has now proved the successful rival of the double-expansion compound. The object of the present paper is to bring forward the results of experience with this new type of engine, and to consider briefly the various points which have a direct bearing on its efficiency, as well as the most suitable design for marine purposes.

Position of cylinders.—There has been great difference of opinion regarding the best method of placing the three cylinders in a triple-expansion engine of ordinary size; and some very crude plans have been adopted since the introduction of the system by Mr. Kirk in the Propontis. The high-pressure cylinder placed on the top of either the intermediate-pressure or the low-pressure has been tried, together with many schemes to lessen the difficulties of overhauling, whilst the main objections to this design appear to have been overlooked. With the exception of what was being done in the matter by Mr. Kirk, no further attempt seems to have been made to construct small power triple-expansion engines on three cranks until about three years ago, when the writer undertook to build one of 700 indicated horse-power which should fulfil the condition that no more space was to be occupied than would have been taken up with an ordinary compound. Engines of small power had previously been constructed on the tandem principle; but experience had shown the writer that, in order to take full advantage of the triple-expansion system, an engine must be built on three cranks placed at equal angles; and the best proof that this was the correct solution of the problem is the fact that the arrangement is now almost universally followed, although at the time it was considered by the advocates of the tandem engine and others to be a step entirely in the wrong direction.

General conditions of efficiency.—The most important conditions to be considered in order to obtain an efficient engine, are that there should be approximate equality—first, in the range of temperature in each cylinder; secondly, in the initial stress on each crank; and thirdly, in the indicated horse-power of each engine. What may be termed the complements to these three essentials are—(1) steam-jacketed cylinders; (2) cylinder ratios; (3) velocities of initial and exhaust steam; (4) clearance and compression; (5) receiver capacity; (6) piston speed; (7) order of sequence of cranks.

Steam-jackets.—The subject of steam-jacketing, and of fitting cylinders with working barrels cast separately, has undergone considerable discussion amongst engineers, although the theoretical advantages of the system have long since been admitted. Keen competition seems evidently to have been one of the reasons why this fitting in many instances has been discontinued, in order to meet the demand for a cheap engine. Thorough investigation of the subject is beyond the scope of this paper; but the action of the cylinder surface, producing as it does an influence on coal consumption, deserves more attention than it often receives. In a single-cylinder engine with a high ratio of expansion and a large range of temperature, it is well known that in each stroke there is excessive initial condensation, followed by partial re-evaporation. In triple-expansion engines, where attention is paid to the equal division of the total range of temperature amongst the cylinders in which the successive stages of expansion take place, the benefits arising from the use of jackets are naturally not so great as in a single-cylinder engine with a high ratio of expansion; but however carefully the triple engine may be designed, the jacketing of at least the intermediate and low-pressure cylinders is essential to maximum efficiency. Beyond the actual economy resulting from steam-jacketing, there are numerous practical advantages of a working barrel cast separately. The cylinder barrel being one of the most vital parts of an engine, it is essential that it should be of the finest material and of uniform quality, in order to prevent it from wearing unevenly, as an oval or uneven cylinder means a leaky piston and increased coal consumption. In the case of a cracked cylinder without an independent liner, the expense of renewal is very great, whilst a new liner costs but little; and the additional facility given for heating up cylinders fitted with independent liners is a safeguard against accidents of that description.

Cylinder ratios.—The ratio of cylinder capacities in a triple-expansion engine depends on the pressure of steam and the type of engine. In cargo steamers, where economy of fuel is of vital importance and a large range of reserve power is not necessary, the high-pressure cylinder should be of such a diameter that with a cut-off at from 56 to 60 per cent. the theoretical absolute terminal pressure in the low-pressure cylinder shall not exceed 10 lb. per square inch. In warships, where a large range of power is sometimes required and economy of fuel is not so important, the high-pressure cylinder should be larger in proportion, so that a higher mean pressure can be obtained. In triple expansion engines on three cranks, the intermediate cylinder should be so proportioned that, with 55 to 65 per cent. cut-off, the powers, the ranges of temperature, and the initial stresses in the three cylinders may approach equality.

Steam velocities.—To obtain even approximate equality in powers, temperatures, and stresses, requires the greatest care in designing the steam passages throughout the engine; and unless the velocities of the steam at the various points, and the degrees of cut-off by the valves, are carefully proportioned, it will be found that these three elements of economy and of efficient working are very far from being realised. The greater number of published results show that the subject is still inadequately appreciated. In Fig. 5 is shown an expanded high-pressure diagram taken from an engine with 135 lb. boiler-pressure, and drawn out in the manner described in the memorandum appended. The velocity in the passages was by no means high, but the pipes were indirect, and owing to specified requirements there were several altogether unnecessary valves; the result was a fall of pressure to 120 lb., or a loss of 15 lb. available initial pressure. When the objectionable bends were removed, the initial pressure in the diagram rose to 130 lb., as shown in Fig. 6, thus raising the ratio of expansion and increasing the general efficiency. The stroke of the engine was 3ft., and the revolutions 104 per minute. Fig. 7 is a high-pressure expanded diagram from a cylinder of the same diameter and stroke, the revolutions being 70 per minute. This shows how small the initial drop may be, when the sources of loss are thoroughly appreciated.

Piston valves.—The use of piston valves on the intermediate and low-pressure cylinders, especially in engines of moderate power, serves to illustrate how the indirectness of the valve passages impairs the efficiency of the steam, and in some cases more than balances the beneficial effect of reduced friction in the machinery. Fig. 8 is an expanded diagram taken from the intermediate cylinder of a triple engine fitted with a piston valve, and shows considerable wire drawing, which is to be attributed to the indirectness of the valve passages; for in Fig. 9, taken from a similar engine in every respect, with only a slightly lower speed of steam, but fitted with an ordinary slide, it is seen that the wire drawing is much less.[2]

Low-pressure cylinders.—The low-pressure cylinder is of course the source of the greatest inefficiency; and too much care cannot be taken in the design of the steam ports and exhaust passages. The ports should be as small as possible, so as to reduce the clearance to a minimum; and the speed of the entering steam should not be so high as to cause excessive frictional resistance, nor the speed of exhaust so high as to augment the back-pressure; consequently the greatest efficiency is obtained when the revolutions and indicated horse-power are not required to vary to any great extent. As an illustration, Fig. 10 is a diagram taken from a low-pressure cylinder which was designed for 60 to 65 revolutions per minute; on the light-ship trial the engines were run at 78 revolutions, and as shown in Fig. 11 the vacuum was then $1\frac{3}{4}$ lb. less than with the same cut-off at 68 revolutions, the loss being entirely due to the excessive exhaust velocity consequent on driving the engines at a greater speed than they were designed for. Contracted or indirect exhaust passages in the high-pressure and intermediate cylinders have the effect of causing a larger difference between the back-pressure on one piston and the initial pressure on the next, thus diminishing the efficiency of the steam. An illustration of this defect is

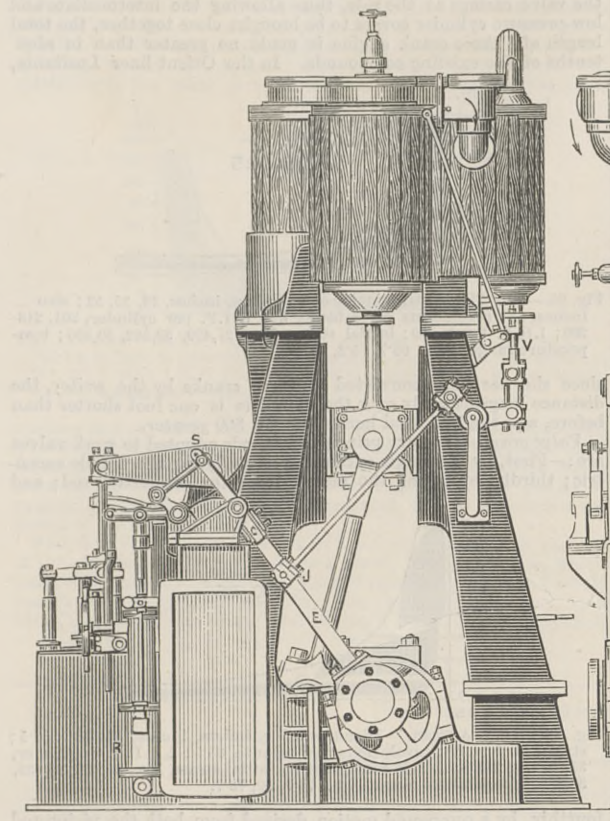


FIG. 1.

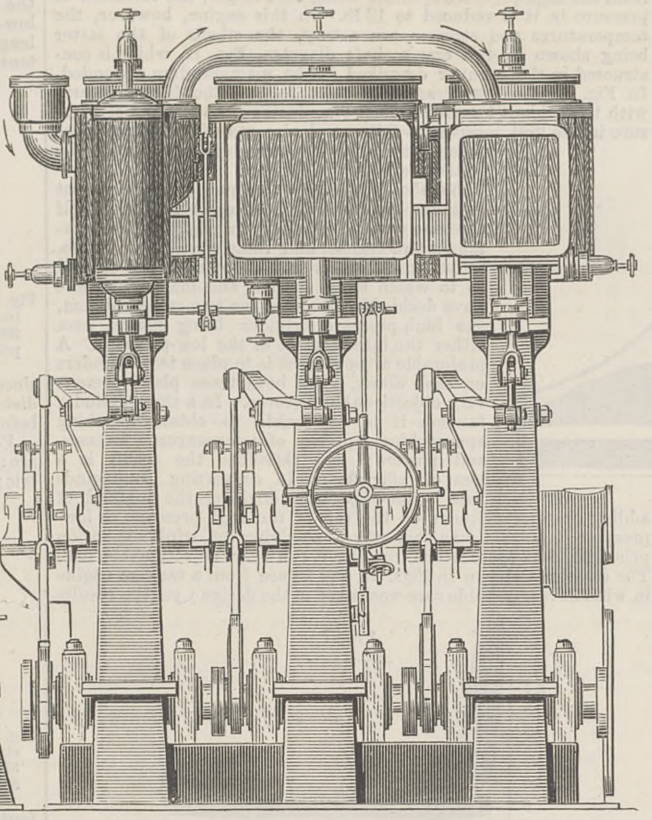


FIG. 2.

PARA AND JACATRA.

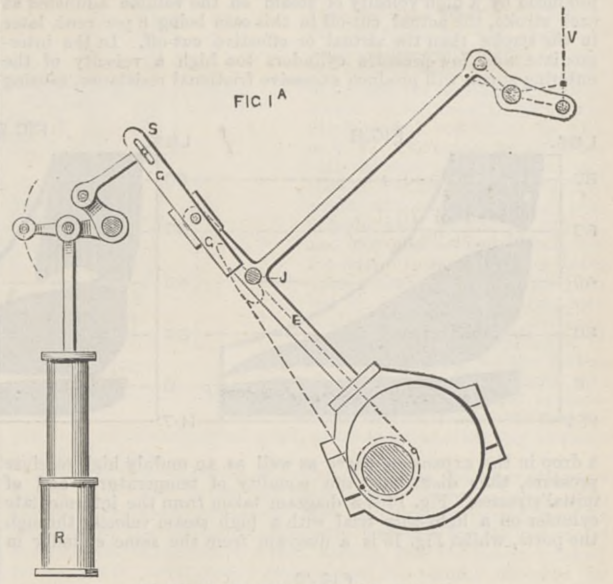


FIG. 1A

SLIDING BLOCK VALVE GEAR.

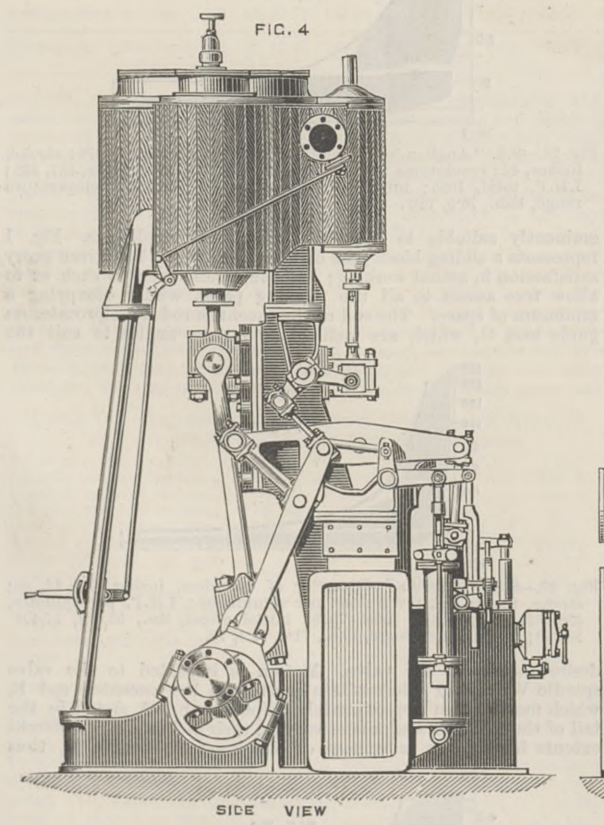


FIG. 4

SIDE VIEW

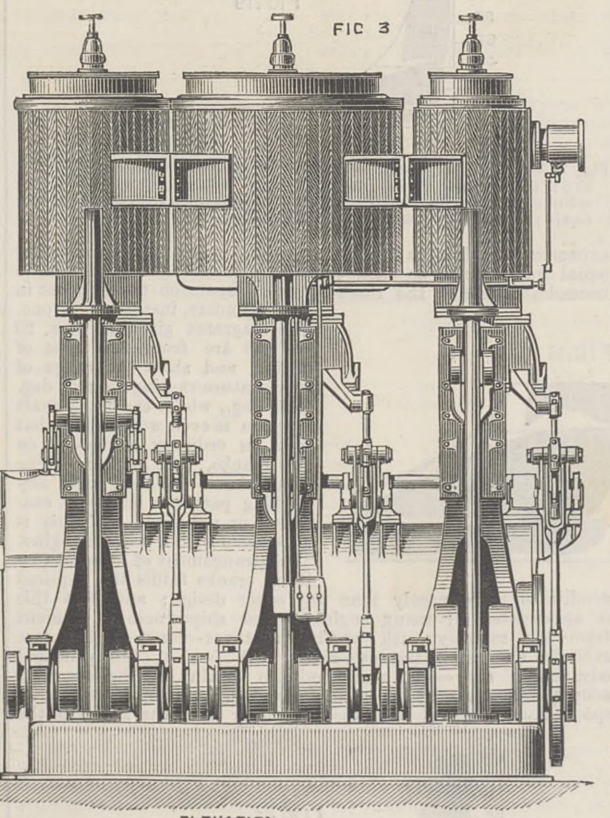


FIG. 3

ELEVATION

S.S. AFRICAN.

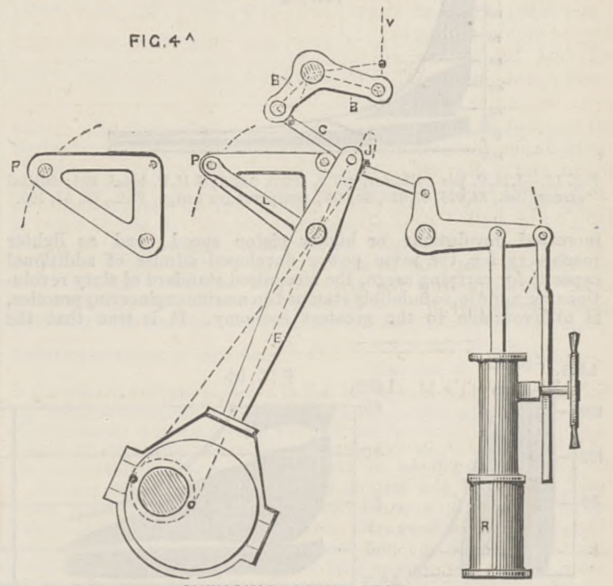


FIG. 4A

SWINGING LINK GEAR.

[1] Paper read before the Institution of Mechanical Engineers at Leeds.

[2] All the figures given under these diagrams from triple engines, give the high pressure cylinder first, intermediate second, and low-pressure cylinder last.

E

furnished by the diagrams shown in Fig. 12, which were taken from a triple-expansion engine built in the North of England.

Cut-off.—The cut-off necessary to maintain the equality of the three essentials for an efficient engine is governed to a great extent by the speed of the entering steam and the nature of the passages, inasmuch as the same amount of steam per stroke may enter the cylinder at the ordinary working number of revolutions per minute as at a higher speed with later cut-off and larger port-opening;

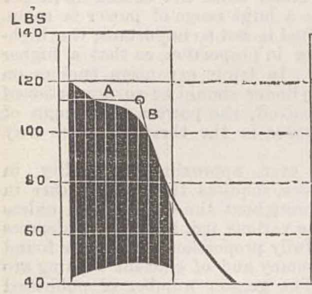


FIG. 5

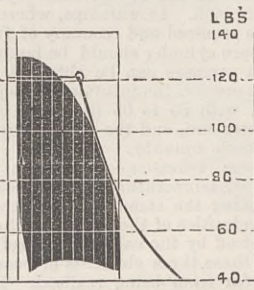


FIG. 6

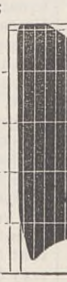


FIG. 7

and in the latter case the difference will be greater between the actual and the effective cut-off. Fig. 13 is an expanded high-pressure diagram taken on a light-ship trial, and shows the effect produced by a high velocity of steam on the volume admitted at each stroke, the actual cut-off in this case being 8 per cent. later in the stroke than the virtual or effective cut-off. In the intermediate and low-pressure cylinders too high a velocity of the entering steam will produce excessive frictional resistance, causing

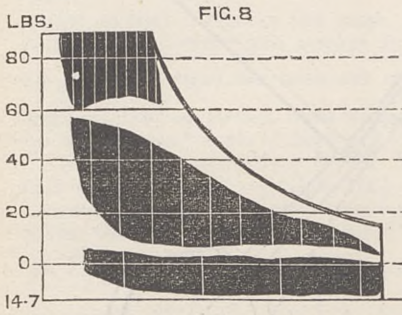


FIG. 8

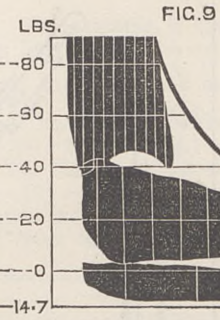


FIG. 9

a drop in the expansion curve as well as an unduly high receiver pressure, thus disturbing the equality of temperatures and of initial stresses. Fig. 14 is a diagram taken from the intermediate cylinder on a light-ship trial with a high steam velocity through the ports, whilst Fig. 15 is a diagram from the same cylinder in

FIG. 10

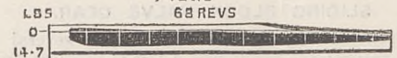


FIG. 11

he loaded ship; the cut-off was equal in both instances, yet in the latter case the receiver pressure is 7 lb. lower, and the drop in the expansion curve is very considerably reduced. A three-crank engine, with its more uniform twisting moment on the shaft, and its approximately equal initial loads, presents every facility for

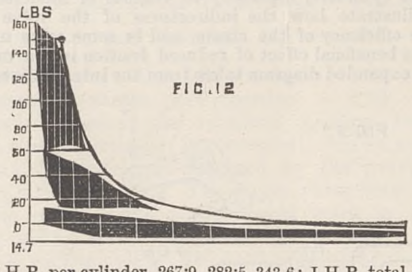


FIG. 12

Fig. 12.—I.H.P. per cylinder, 267·9, 282·5, 343 6; I.H.P. total, 894; initial stress, lbs., 34,976, 47,623, 60,605; temperature range, Fah., 63, 67, 100.

increased revolutions or higher piston speed; and as lighter machinery for the same power developed admits of additional capacity for carrying cargo, the recognised standard of sixty revolutions per minute, so indelibly stamped on marine engineering practice, is unfavourable to the greatest economy. It is true that the

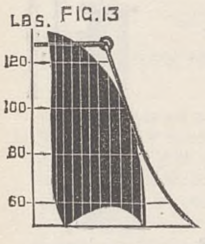


FIG. 13

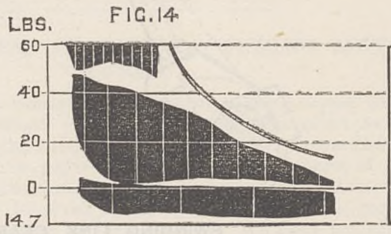


FIG. 14

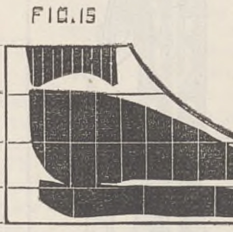


FIG. 15

absurdly bluff run aft, which is found in many steamers, interferes with a high number of revolutions; but there is no reason why a considerable advance should not be made. Engineers are often severely handicapped and sometimes utterly baffled by the design of the cargo receptacle which has to be propelled; and should the speed not reach the unreasonable expectations formed, the

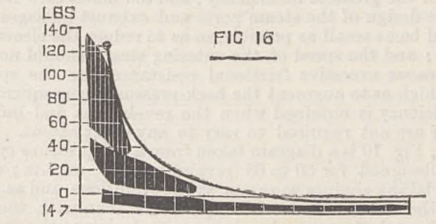


FIG 16

Fig. 16.—Diameter of cylinders, inches, 20, 31, 52; stroke, inches, 36; revolutions per minute, 68·93; I.H.P. per cylinder, 214, 205, 194; I.H.P. total, 613; initial stress, lbs., 30,938, 35,098, 31,855; temperature range, Fah., 76·2, 78, 80·8.

general inefficiency of the engines is at once set down as the cause, although the ship may have a displacement coefficient as high as 0·77 and may never run a straight course except by accident. That ships having a large cargo carrying capacity and travelling at a low speed are pecuniarily successful is not to be denied; but that beneficial results would follow from a slightly less box-like form is abundantly evident, though not yet universally appreciated in practice.

Sequence of cranks.—In a triple engine some diversity of opinion seems to have existed as to the order of sequence for the three cranks. Many engines are arranged with the high-pressure crank leading, followed by the intermediate crank, and the low-pressure crank last; which causes excessive variation in the receiver pressure, increased ranges of temperature in the cylinders, and considerable differences in initial stresses. The better sequence is high-pressure leading, low-pressure following, and intermediate last. Expanded diagrams are shown in Fig. 16 from an engine built on the Tyne with the common arrangement of cranks, namely—high, intermediate, and low; here the pressure in the receiver into which the high-pressure cylinder exhausts is seen to vary as much as 22½ lb., this large amount being probably due to the receiver being too small. The temperatures and stresses in the high-pressure and intermediate cylinders approach equality; but the amount in each case is much greater than it would have been had the low-pressure crank followed the high-pressure. The diagrams in Figs. 17 and 18 are from an engine built in Scotland with the same sequence of cranks as in Fig. 16, namely, high, intermediate, and low; but the receiver from the high-pressure cylinder being here larger, the variation of pressure in it is reduced to 12 lb. In this engine, however, the temperatures and stresses are astray, the effects of the latter being shown in the crank shaft diagram, Fig. 18, which is constructed in the manner described in the memorandum appended. In Fig. 19 the low-pressure cylinder follows the high-pressure, with the evident beneficial effect of reducing the variation of pressure in the first receiver to 6 lb., and also reducing the ranges of temperature in the cylinders, as well as the initial loads on the pistons.

Number oj cranks.—The question of the most suitable type of marine engine resolves itself into two general divisions, namely, engines working on two cranks, and those working on three. Considerable difference of opinion has existed as to which is the better, and many engineers have decided in favour of the two-crank tandem, the high-pressure cylinder being placed over either the intermediate or the low-pressure. A preferable arrangement is to place two cylinders on each crank. But both these plans present very objectionable features. In a three-cylinder tandem it is impossible to obtain anything approaching equality of temperatures, stresses, and powers; and therefore the result is a loss of efficiency. In converting compounds into triple-expansion engines, the method of adding another cylinder on the top of the high-pressure or low-pressure is certainly an easy way of applying the triple-expansion principle, but for obvious reasons it is a very objectionable one. The diagrams shown in Figs. 21 and 22 are from a tandem engine in which every possible care was taken in the design; yet the results

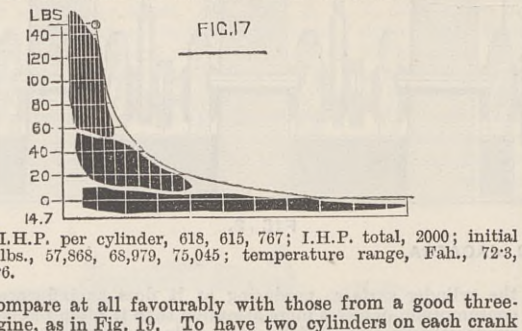


FIG. 17

Fig. 17.—I.H.P. per cylinder, 618, 615, 767; I.H.P. total, 2000; initial stress, lbs., 57,868, 68,979, 75,045; temperature range, Fah., 72·3, 67·2, 83·6.

do not compare at all favourably with those from a good three-crank engine, as in Fig. 19. To have two cylinders on each crank is undoubtedly the best design for a two-crank engine on the triple-

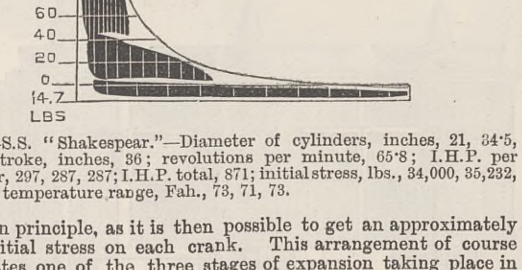


FIG. 19

Fig. 19.—S.S. "Shakespear."—Diameter of cylinders, inches, 21, 34·5, 55·5; stroke, inches, 36; revolutions per minute, 65·8; I.H.P. per cylinder, 297, 287, 287; I.H.P. total, 871; initial stress, lbs., 34,000, 35,232, 35,078; temperature range, Fah., 73, 71, 73.

expansion principle, as it is then possible to get an approximately equal initial stress on each crank. This arrangement of course necessitates one of the three stages of expansion taking place in two cylinders, instead of in one. The diagrams given in Figs. 23 and 24 are from this type of engine, and show the range of temperature varying from 59 deg. to 81 deg., whilst the crank-shaft diagram is even worse than that from an ordinary compound on two cranks. A marine engine should be so designed that any working part can be easily examined or removed; and this is impossible with a tandem engine. The arrangement of cylinders on three cranks fulfils the required conditions more nearly than any other design; and that this is appreciated by many engineers and shipowners is evident from the rapidity with which the three-crank engines are entirely displacing the two-crank. A few of the principal advantages are:—(1) more uniform strain on shafting; (2) adaptability for a higher rate of revolution and increased piston speed, thus obtaining increased efficiency from the steam in the

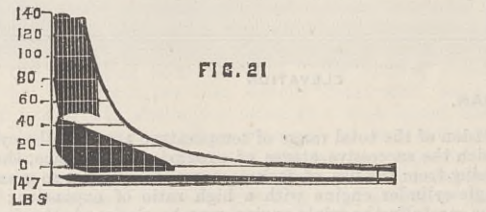


FIG. 21

Fig. 21.—Three cylinders on two cranks.—I.H.P. per crank, forward, 181; aft, 126; initial stress, lbs., 23,472, 22,862; I.H.P. per cylinder, 110, 126, 71; I.H.P. total, 307; initial stress, lbs., 14,235, 22,862, 9237; temperature range, Fah., 66·1, 92·8, 38·3.

engine, as well as lighter machinery in proportion to the power developed; (3) less wear and tear; (4) easier accessibility of working parts; (5) interchangeability of parts, thus minimising the consequences of a breakdown; (6) greater facility for repairs; (7) easier adjustment of temperatures, stresses, and powers. All these features are deserving of investigation. Regarding the more uniform twisting moment on the crank shaft of a three-crank engine, it is often advanced that the difference between crank shaft diagrams from a two-crank and a three-crank engine is not so great as to cause any appreciable effect. It must be remembered, however, that the variable twisting strains on the crank shaft are reflected to a greater or less extent throughout all the working parts of the engine; and it seems certain that the beneficial influence of three cranks is far beyond what is generally accepted.

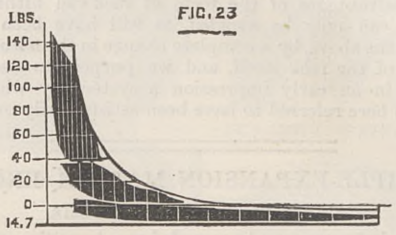


FIG. 23

Fig. 23.—Four cylinders on two cranks.—I.H.P. per crank, forward, 549; aft, 547; I.H.P. total, 1096; initial stress, lbs., 6?,486, 58,471; temperature range, Fah., 81, 59·1, 78.

There seems to be an impression that the length of an engine room is increased by the introduction of three cranks. But by placing the valve casings at the side, thus allowing the intermediate and low-pressure cylinder covers to be brought close together, the total length of a three crank engine is made no greater than in nine tenths of the existing compounds. In the Orient liner Lusitania,

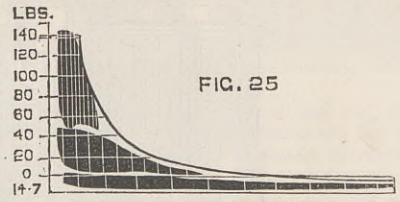


FIG. 25

Fig. 25.—S.S. "Para."—Diameter of cylinders, inches, 19, 35, 53; stro inches, 33; revolutions per minute, 62; I.H.P. per cylinder, 201, 213 206; I.H.P. total, 620; initial stress, lbs., 27,499, 39,582, 30,886; temperature range, Fah., 68·7, 75·8, 84.

since she has been converted to three cranks by the writer, the distance longitudinally over the cylinders is one foot shorter than before, and the indicated horse-power is 800 greater.

Valve gear.—The four principal methods adopted to work valves are:—First, by the single excentric; secondly, by the double excentric; thirdly, by taking the motion from the connecting rod; and

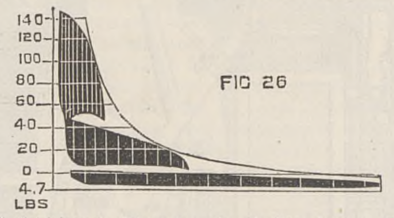


FIG 26

Fig. 26.—S.S. "African."—Diameter of cylinders, inches, 21, 34·5, 55·5; stroke, inches, 36; revolutions per minute, 85·5; I.H.P. per cylinder, 377·9, 364, 344 8; I.H.P. total, 1086·7; initial stress, lbs., 35,322, 36,635, 33,868; temperature range, Fah., 71·7, 69, 73·7.

fourthly, by a compound motion derived from both the piston-rod and the connecting-rod. All four of these have their advantages and defects, and vary considerably in complexity and in multiplicity of parts. The single excentric valve gear, shown in Figs. 1 and 4, giving almost perfect steam distribution, having few working parts, and being independent of the connecting-rod or piston-rod, seems

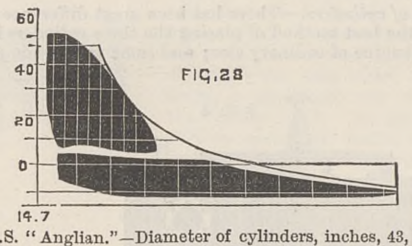


FIG. 28

Fig. 28.—S.S. "Anglian."—Diameter of cylinders, inches, 43, 76; stroke, inches, 42; revolutions per minute, 58; I.H.P. per cylinder, 537, 528; I.H.P. total, 1065; initial stress, lbs., 66,075, 69,181; temperature range, Fah., 70·5, 75·1.

eminently suitable to fulfil all the desired conditions. Fig. 1 represents a sliding-block gear of this kind, which has given every satisfaction in actual working; and the arrangement is such as to allow free access to all the working parts, whilst occupying a minimum of space. The end of the excentric rod E reciprocates on guide bars G, which are inclined at various angles to suit the

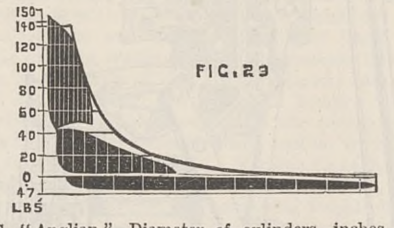


FIG. 29

Fig. 29.—S.S. "Anglian."—Diameter of cylinders, inches, 26, 42, 69; stroke, inches, 42; revolutions per minute, 69; I.H.P. per cylinder, 538, 523, 514; I.H.P. total, 1575; initial stress, lbs., 52,824, 57,494 50,480; temperature range, Fah., 71·4, 71·4, 79.

desired action of the valve. Motion is imparted to the valve spindle V from an intermediate joint J in the excentric rod E, which moves in an approximately elliptic path. A slot S in the tail of the guide bars admits of varying their inclination to different extents for a given movement of the reversing engine R, thus

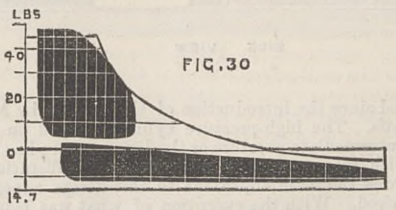


FIG. 30

Fig. 30.—S.S. "Lusitania."—Diameter of cylinders, inches, 58, 103; stroke, inches, 48; revolutions per minute, 56; I.H.P. per cylinder, 1230, 1100; I.H.P. total, 2330; initial stress, lbs., 114,931, 116,652; temperature range, Fah., 71·9, 78.

altering independently the cut-off in each cylinder. The long leverage and easy motion reduce the wear and tear to a minimum, as results in actual practice have proved. An objectionable feature, however, in an engine fitted with this sliding-block gear is that the valves are at the front, over the starting platform; and the exhaust has to be led by a belt round the low-pressure cylinder to the condenser. To overcome this objection of the sliding-block gear, the swinging-link gear shown in Fig. 4 was designed. The excentric rod E, as in the last case, is placed diagonally over the condenser, but is here guided in an arc of a circle, by suspending it by a swinging link L centred on a pin P, which pin is adjustable by the

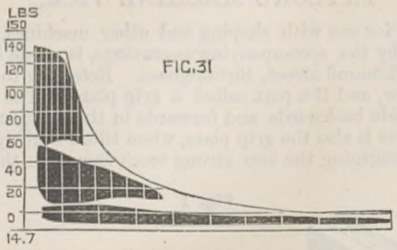


Fig. 31.—S.S. "Lusitania."—Diameter of cylinders, inches, 36, 60, 96; stroke, inches, 48; revolutions per minute, 76; I H.P. per cylinder, 1113, 1352, 1167; I.H.P. total, 3632; initial stress, lbs., 83,976, 124,405, 95,906; temperature range, Fah., 59·2, 69 6, 62·1.

reversing engine R into various positions for varying the grade of expansion either ahead or astern. The movements for working the valve are transmitted from a joint J at the end of the excentric rod E, by a compensating link C connecting the joint with one arm of an oblique lever B, of which the other arm is jointed to the valve spindle V. The compensating link C is an essential and distinguishing feature of this gear; it is so placed and proportioned relatively to the other parts as to produce practically equal port-

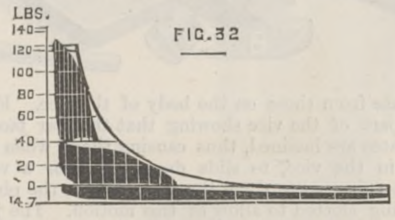


Fig. 32.—S.S. "Stella."—Diameter of cylinders, inches, 22, 37 5, 60; stroke, inches, 39; revolutions per minute, 61·5; I.H.P. per cylinder, 291, 331·5, 310; I.H.P. total, 932·5; initial stress, lbs., 32,498, 39,275, 37,463; temperature range, Fah., 70, 70·7, 78.

opening and cut-off at each end of the stroke. There is a quick and a slow movement of the valve at each end of its travel: the slow movement being at the maximum port-opening, and a quick movement at the cut-off. The lead is also constant at all grades of expansion. These features are illustrated by the accompanying model of the swinging-link gear.

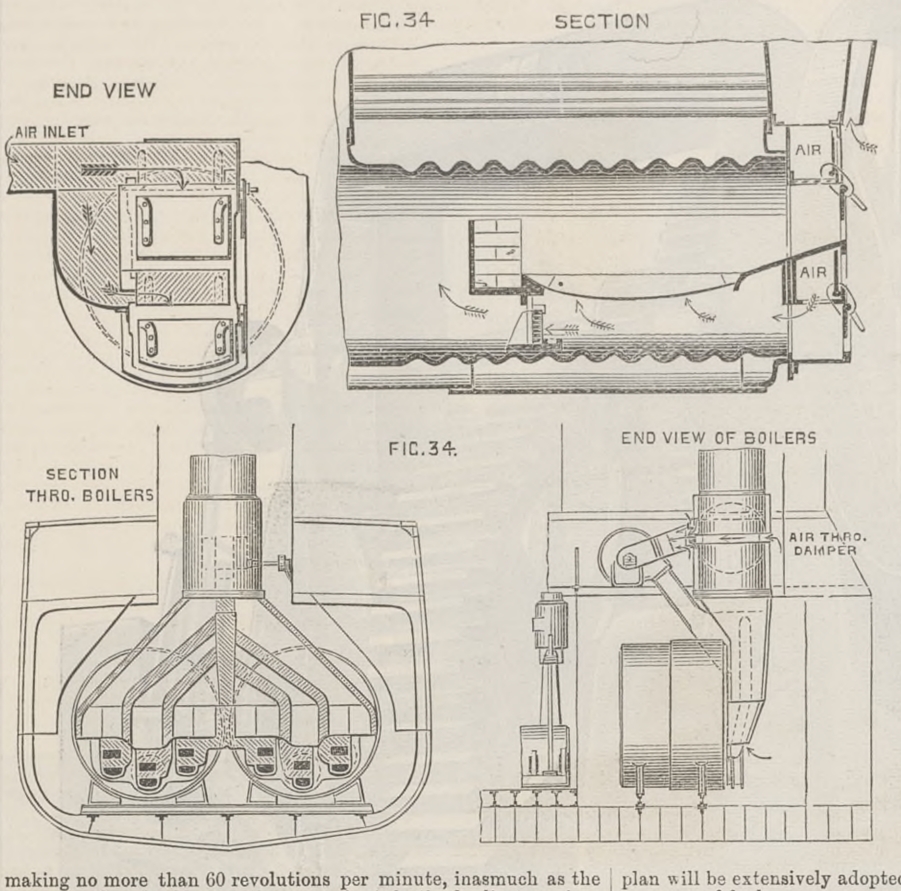
Practical results.—In Figs. 1 and 2 are represented the engines of the s.s. Para, belonging to Messrs. Steel, Young, and Co., which made her maiden voyage to the River Plate about three and a-half years ago. The cylinders are 19in., 35in., and 53in. diameter, with 33in. stroke. These being the writer's first triple expansion engines, special arrangements were made for ascertaining the actual coal consumption per indicated horse-power; and Table I appended is a log of the results obtained during a three days' trial between Liverpool and Madeira. Although, in order to get a correct estimate of an engine's performance, the quantity and temperature of the feed and circulating water ought, of course, to be considered, yet there are so many practical difficulties in the way of getting these particulars on board ship that it has been found impossible to obtain any reliable data on these points. This steamer still continues on the same run, averaging 9 knots an hour on 10¼ tons of coal; and has not yet cost anything beyond the usual overhaul for repairs. The great saving in coal consumption with the triple engines is apparent when comparison is made with two sister ships fitted with compound engines, the Ingram and the Wandle, belonging to the same company, and built by the same builders; the comparison is shown in Table II., which gives the

TABLE II.—*Comparative Results from three similar Steamers with Compound and Triple Expansion Engines.*

Name of screw steamer	Ingram	Wandle	Para
Length, feet and inches	257 6	257 6	257 6
Breadth, feet and inches	34 6	34 6	34 6
Draught, feet and inches	18 10½	18 6½	19 4
Dead weight carried, tons	2310	2203	2398
Type of engines	Compound	Compound	Triple
Boiler pressure, lbs. per square inch	75	75	150
Speed, knots per hour	8½	8½	9
Indicated horse-power, total	570	₤80	620
Coal consumption per day, tons	13¾	14	10¼

average working over a period of three years. The diagrams in Fig. 25 are an expanded set taken during the three days' trial of the Para; but owing to the intermediate cylinder being rather too large, the equalities of temperatures and of initial stresses are disturbed, and the drop of the steam pressure in the intermediate cylinder is excessive, in consequence of the steam velocity being too great. In Table III. is given a comparative statement of results from an approximately similar trio of boats in the same trade and under the same management on a round voyage to Java under average conditions. The triple engines in the Jacatra are of the same general design as those in the Para, but of greater power; the compounds in the two other boats are of the ordinary type.

In Figs. 3 and 4 are represented the triple engines of the Union Company's s.s. African and Messrs. Glover Brothers' s.s. Shakespear. The design differs from that in the Para and Jacatra in having the valves situated over the condenser, thus doing away with the exhaust belt round the low-pressure cylinder, and giving a free open front to the engines. All the working parts are thereby rendered easily accessible, with every facility for overhauling. Expanded diagrams taken from the Shakespear under average working conditions are shown in Figs. 19 and 20, which have already been referred to. The equalities of temperature, initial stresses, and powers are as near as it is practically possible to get them, and this result has been obtained by carefully considering the various points which influence the efficiency of the engine. The expanded diagrams in Figs. 26 and 27 are a set taken on the trial trip of the African in Stokes Bay, showing 1086-horse power developed at 85½ revolutions per minute. They thus prove that there is a sacrifice of weight in triple engines when



making no more than 60 revolutions per minute, inasmuch as the power developed at 66 revolutions per minute by the duplicate engines of the Shakespear, Fig. 19, is much less, namely, 871-horse power. The expanded diagrams in Fig. 28 are from the original compound engines of the Union Company's s.s. Anglian, taken under average conditions on a voyage to the Cape. The mean consumption of coal per day over eight voyages was 24 tons, or about 2·1 lb. per indicated horse-power per hour. The compound engines were of the ordinary two-cylinder type, the valves being directly over the screw shaft, and driven by the usual link motion. The diagrams in Fig. 29 were taken on a trial trip after the engines had been converted to triple expansion; and on her voyage to the Cape, the average speed being exactly the same as in the eight voyages above referred to, the coal consumption was one-third less, namely, 16 tons; and as she is placed on a foreign station where the cost of fuel is about £2 per ton, the economy of the conversion is obvious.

TABLE III.—*Comparative Results from three Steamers with Compound and with Triple Expansion Engines.*

Name of screw steamer	Fellinger	Padang	Jacatra
Length, feet and inches	286 2	300 0	314 0
Breadth, feet and inches	35 0	37 0	37 9
Draught, feet and inches	20 3	21 9	21 6
Dead weight carried, tons	2600	3000	3300
Type of engines	Compound	Compound	Triple
Boiler pressure, lbs. per square inch	70	76	140
Speed, knots per hour	9	9½	10
Indicated horse-power, total	660	790	890
Coal consumption per day, tons	15½	18	13½
Ditto per I.H.P. per hour, lbs.	2·19	2·13	1·41
Quality of coal used	German	Cardiff	Mixed

The method of converting consisted in replacing the old high-pressure cylinder by a new intermediate cylinder, and adding a new high-pressure engine complete on the forward end of the screw shaft, the high-pressure and intermediate valves being driven by sliding-block gear similar to that shown in Fig. 1. By arranging the valve casings at the side of the high-pressure and intermediate cylinders, the distance fore and aft over the present engines is very little more than before, although the power is now sufficient to drive the vessel one knot an hour faster than her former maximum speed. Diagrams from the Orient Company's s.s. Lusitania are shown in Figs. 30 and 31. The original compound engines were of the two-cylinder type, with an expansion valve on the high-pressure cylinder. The diameters of the cylinders were 58in. and 103in., with a stroke of 4ft.; and the boiler pressure was 55 lb. per square inch. The diagrams in Fig. 30 were taken under ordinary working conditions on a voyage from London to Sydney, the average daily consumption being 52 tons of Welsh coal. The old cylinders were afterwards replaced by new ones, and a high-pressure engine was added complete, its valve being worked by swinging-link gear like that shown in Fig. 4. By arranging the intermediate and low-pressure slide valves between the intermediate and low-pressure cylinders, the old gear was utilised; and by reducing the valve casings to modern proportions the distance lengthways over all the three new cylinders is one foot less than before. The diagrams in Fig. 31 represent the present average working conditions of the engines, the increased power propelling the vessel at a much higher speed. The coal consumption at this power is about 50 tons per day; but travelling at the former speed the consumption is reduced from 52 tons to 37 tons; so that, allowing eighty steaming days for a return voyage to Australia, the saving of coal is 1200 tons, while the cargo carrying capacity is largely increased. The foregoing results represent a fair average of those obtained from thirty triple expansion engines, all of the three crank type, which have been designed by the writer during the last three years; and are sufficient to prove that this kind of engine is most efficient, and is undoubtedly the engine of the future.

Artificial draught for boilers.—The next step in marine engineering is probably the application of artificial draught to boiler furnaces. The expanded diagrams in Figs. 32 and 33 were taken from the engines of the s.s. Stella, belonging to Messrs. Herskind and Woods, between Hartlepool and Dover on her voyage to Bombay; and as a steady boiler-pressure is always maintained, the engine power may be considered as constant. The average speed between port and port from Hartlepool to Bombay was fully nine knots per hour, the dead weight carried was 3680 tons, and the daily consumption of north-country coal was 13·6 tons. This performance is very remarkable when the dimensions of the ship are considered, namely, length 302ft., breadth 38ft., and displacement coefficient as high as 0·77. The arrangement of the plan is shown in Figs. 34; the special features are the method employed for heating the air both outside and inside the uptake, and the application of balanced fire-doors D D, which on being opened shut off automatically the hot air supplied by the fan, both above and below the fire-bars. This is the first application of artificial draught to the boilers of triple-expansion engines, and should the results fulfil expectations, there is little doubt that the plan will be extensively adopted, as being yet another step towards economy of fuel.

Memorandum respecting diagrams.—All the indicator diagrams shown have been drawn out from actual indicator cards. The theoretical adiabatic expansion curve has been constructed from the formula for the relation between the pressure and the volume in the adiabatic expansion of steam, namely, that the pressure raised to the ninth power varies inversely as the volume raised to the tenth. The theoretical curve is in all cases drawn tangential to the high-pressure indicator line. The virtual or effective cut-off is obtained by drawing a horizontal line across the top of the high-pressure diagram, at such a level that the area of the corner A of the diagram above the line is equal to the area of the vacant corner B below it, Fig. 5. Temperatures are given in degrees Fah., and denote the total range in each cylinder. Initial stresses are given in lbs., and denote the product of the initial steam pressure in each cylinder multiplied by the area of that cylinder. The twisting moments on the crank shaft have been calculated by the following formula, the weight of the moving parts being neglected:

Twisting moment in inch-tons $= \frac{p \times a \times l \times \sin.(\theta + \phi)}{2243 \cos. \phi}$, where p

is the effective steam pressure in lbs. per square inch, measured on the indicator diagram at the point corresponding with the angle θ of the crank; a is the area of the cylinder in square inches; l is the length of the crank in inches; and ϕ is the angle of obliquity of the connecting-rod, corresponding with the angle θ of the crank.

All the coal used was measured in half-tons, three measures being weighed during each twenty-four hours, and the mean weight taken at the end of the trial. The quality was soft North-country coal, yielding 10 per cent. of ash. A heavy beam swell running throughout the secondary trial caused the ship to steer badly. Each fire was cleaned once in twenty-four hours; and no appreciable difference in steam pressure was observed during cleaning. The following are the dimensions of the Para:—Length, 257ft. 6in.; extreme breadth, 34ft. 6in.; draught on leaving Hartlepool, 19ft. 4in.; dead weight carried, 2398 tons.

TABLE I.—*Three Days' Log of Triple Expansion Engines, S.S. Para.*

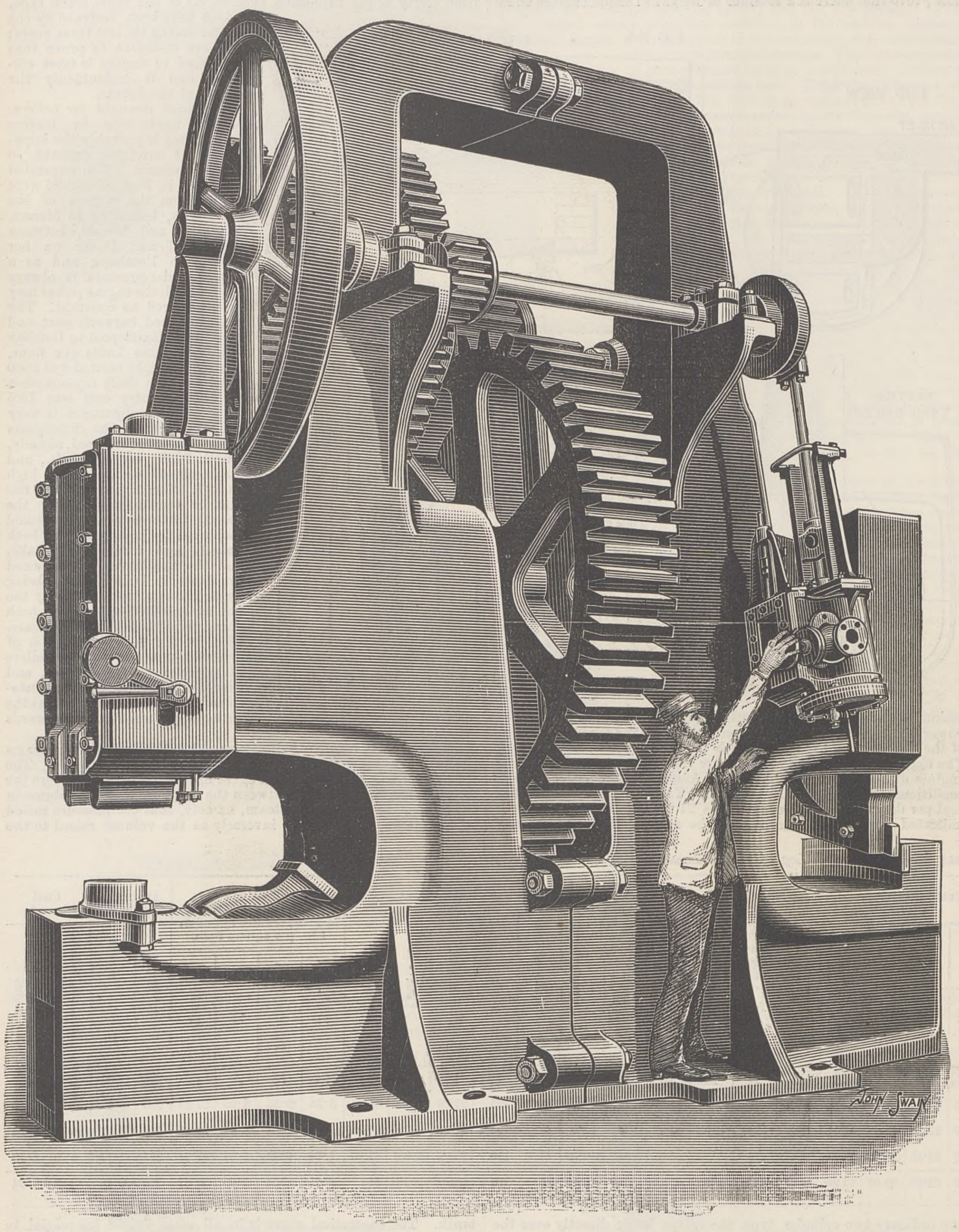
1883. April. Watch.	Length of watch. H. M.	Vacuum gauge. Inches of mercury.	Steam gauge. Lbs. per square inch.	Revolutions. Total per watch.	Revolutions. Average per minute.	Mean effective steam pressures. Lbs. per square inch. (See Fig. 25.) High-pressure cylinder, 19in. diameter × 33in. stroke. Top.	High-pressure Bottom.	High-pressure Mean.	Intermediate cylinder, 35in. diameter × 33in. stroke. Top.	Intermediate Bottom.	Intermediate Mean.	Low-pressure cylinder, 53in. diameter × 33in. stroke. Top.	Low-pressure Bottom.	Low-pressure Mean.	Mean back pressures. Lbs. per square inch. High.	Mean back pressures. Intermediate.	Mean back pressures. Low. Vacuum.	Revolutions per minute.	Indicated horse-power. High.	Indicated horse-power. Intermediate.	Indicated horse-power. Low.	Indicated horse-power. Total.	Mean effective steam pressures reduced to area of low-pressure cylinder. Lbs. per square inch. High.	Reduced. Intermediate.	Reduced. Low.	Reduced. Total.	Distance run. Total. Knots.	Distance run. Per hour. Knots.	Coal burnt. Total per day. Tons.	Coal burnt. Total I.H.P. per hour.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Average for first day	24 9	27·25	146·3	89112	61·5	66·1	67 01	66·55	22·61	21·1	21·85	8·6	9·3	8·95	48·75	2·87	12·5	61·9	195	216·6	202·8	614·4	8·55	9·53	8·95	27 04	220	9·1	10·38	1·56
Average for second day	24 9	27·25	145·7	89461	61·74	67·24	67·75	67·49	22 82	21 04	21·93	8·64	9·18	8·91	49·42	2·6	12·32	62·1	198·4	218·5	203·4	620·3	8·68	9·57	8·91	27·16	224	9·27	10·58	1·58
Average for third day	23 42	27·12	145·7	87006	61·18	67 72	68·72	68·22	22·45	20·82	21·63	8·68	9·0	8·84	50·37	2·59	12·28	61·6	199	214·1	200·6	613·7	8·76	9·44	8·84	27·04	216	9·11	9·79	1·50
Average for three days	72 0	27·20	145·9	265579	61·47	67·02	67·82	67·42	22·62	20 98	21·80	8·64	9·16	8·90	49·51	2·68	12·36	61·86	197·4	216·4	202·2	616	8·66	9·51	8·90	27·07	220	9·16	10·25	1·54

THE TOTAL PRODUCTION OF PETROLEUM in the United States was 21,842,041 barrels of forty-two gallons, of which the Pennsylvania and New York fields produced 20,776,041 barrels. The total value, at an average price of 87⅞c. per barrel, was 19,193,694 dols. The production showed a decrease of 2,247,717 barrels and 1,282,600 dols. in value from 1884.

THE INTERNATIONAL EXHIBITION AT ADELAIDE.—A Royal Commission has been named to obtain and distribute full information as to the best mode by which the products of the manufacturing and agricultural industries and the fine arts of the United Kingdom, the Colonies, and dependencies may be procured and forwarded to the capital of South Australia for exhibition next year. The Commissioners appointed are the Duke of Cambridge, the Duke of Manchester, the Marquis of Normanby, the Earl of Rosebery, the Earl of Carnarvon, the Earl of Dunraven, Earl Granville, Viscount Cross, Lord Thring, the Right Hon. Edward Stanhope, M.P., Sir James Fergusson, M.P., Sir Henry Holland, M.P., Sir John Rose, the Hon. C. W. Fremantle, Sir F. Leighton, P.R.A., Sir Richard Owen, Sir Philip Cunliffe-Owen, Sir J. D. Hooker, Sir John Gilbert, Sir J. D. Linton, and Sir J. F. D. Donnelly. Colonel Sir Herbert Bruce Sandford is appointed secretary to the Commission.

PUNCHING AND SHEARING MACHINE.

MESSRS. J. BENNIE AND CO., GLASGOW, ENGINEERS.



LARGE PUNCHING AND SHEARING MACHINE.

THE magnitude and thickness of steel plates with which shipbuilders have now to deal, particularly in the construction of ships-of-war, have necessitated machines of corresponding strength and power for shearing, punching, and other operations on such plates. We illustrate above an exceptionally large punching and shearing machine which has been built by Messrs. James Bennie and Co., Glasgow, for Messrs. Sir W. G. Armstrong, Mitchell, and Co., and is now at work in the Elswick shipyard. This machine is constructed to punch and shear steel plates 2in. in thickness at 33in. from the edge of the plate. It is driven by a 12in. cylinder engine attached to its side, and it has two sets of gear, so that it can be worked at varying speeds to suit light or heavy work, as may be desired. The change from one speed to another is effected simply by a clutch. The main shaft is of forged steel, 14in. diameter, and the main spur wheel is of 5in. pitch and 14in. broad on face. The total weight of this machine is about 54 tons. This and other machines in construction provide the Elswick Works with the most powerful plant in the world.

THE SEVERN TUNNEL.

THIS tunnel has been opened since September 1st for goods traffic, and will shortly be opened for the conveyance of passengers, which will add to the convenience of the travelling public, especially between the West of England and South Wales. The Great Western Railway Company has adopted Mr. C. E. Spagnoletti's new system of electric-locking for working the traffic through the tunnel. The system of working is that the starting signal lever in the signalman's box shall be kept locked until it is unlocked by a current of electricity sent by the signalman from the station in advance; and that when he has unlocked the lever for a train to leave the station in the rear, he cannot again unlock it for a second train to follow until the first train has arrived at his station and passed the clearing-point selected by the traffic authority. On single lines of railway this system is arranged so that not only one train cannot follow another until the first has arrived at the given clearing-point, but that a train cannot be started in an opposite direction until the train occupying the section has arrived, no matter in which direction a train may be running. The arrival of the train does not unlock the signals, but simply resets the instruments so that the signalman can again work them. By this means the care and responsibility which at present has to be exercised by a signalman is not removed from him; but should he inadvertently attempt to commit an error, then this system checks him at once from doing so. This is a very important feature, for in all systems where the work of the signalman is done automatically he, trusting to this mode of working, is liable to neglect doing what he ought to do, and if at any time the system should fail, then serious results might arise.

The instrument consists of a case with two circular holes in it, one above the other; the upper hole shows indications for trains departing, and the lower hole shows indications for trains approaching. Below the holes is a plunger, and on each side is a key, one red, one white. The normal condition of the instrument shows in the upper hole "lock on"—a red signal—and in the lower hole "train arrived"—a green signal. When a signalman is asked "Is line clear?" by the ordinary bell signal given on the instrument describing the train, should the line be clear for the train to come on, he will press the plunger, which will bring up the "white" disc in the lower hole of his instrument, showing "Line clear," indicating to him that he has given "Line clear" to the station in the rear for a train to come on. The effect of this at the station in the rear is that in the upper hole of his instrument is shown the white disc, "Line clear," and the lever of the starting signal is unlocked; he pulls the signal down to let the train start, and on putting the lever back again to protect the train it is again locked. The man at the station in advance is unable to unlock this lever again until the train has arrived at his station and passed over the contact threadle, which resets the instrument and renders it in a condition for sending another signal. The lock on the lever renders it impossible for a signalman to move it until it has been unlocked by the station in advance.

The indications shown on the instrument for "double" line working are in the upper hole; "Lock on"—red—"Train on line"—red—"Line clear"—white; in the lower hole, "Line clear"—white—"Train on line"—red—and "Train arrived"—green. The single line instruments show in the upper hole "Lock on"—red—"Line clear"—white"—and "Train on line going"—red; in the lower hole, "Train arrived"—green—"Line clear"—white—and "Train on line coming"—red. One line wire only is required for working these instruments, for giving these various signals, both on the instrument and the bell, and for unlocking the levers at each end. The bell signals can be given without any interference with the working of the indicators and locks.

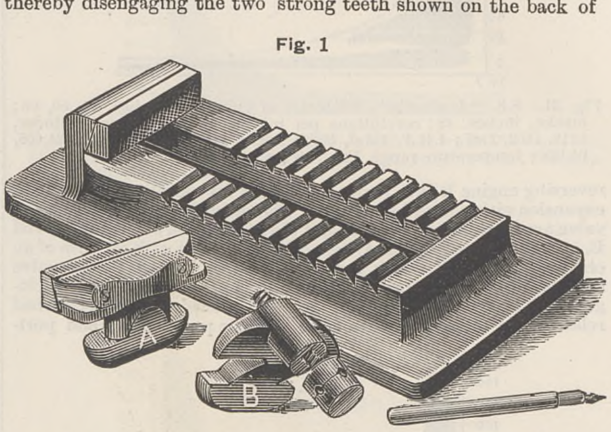
In order to provide against delays to traffic, in case of the wire breaking, or accidents from any cause, an arrangement is made by which the instrument may be reset by hand under proper authority, so as to prevent any delay to trains. Should any breakdown occur, it is always on the side of safety.

This system is now being tried on several lines of railway very successfully, and can be seen at work at Mr. Spagnoletti's office, Paddington Station.

TAYLOR'S MACHINE VICE.

THE vice for use with shaping and other machines, which is illustrated by the accompanying engravings, is made by Mr. C. Taylor, of Edmund-street, Birmingham. Referring to Fig. 1, A is a loose jaw, and B a part called a grip plate. The loose jaw is free to slide backwards and forwards in the longitudinal slot of the vice, as is also the grip plate, when tilted slightly forward, thereby disengaging the two strong teeth shown on the back of

Fig. 1



the grip plate from those on the body of the vice. Fig. 2 is a section of part of the vice showing that the rear faces of the steel jaw plates are inclined, thus causing them, when an article is gripped in the vice, to slide downwards for a very short distance, carrying with them the article held, the pin holes in the jaws being slotted to allow of this motion. The jaw plates are raised again, when the article held is released by a simple spring working in the recess shown at the bottom of each plate.

Fig. 2

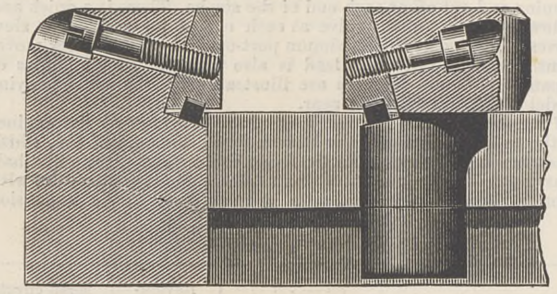
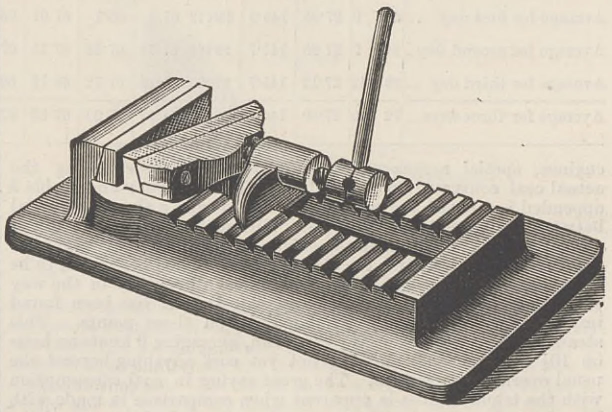


Fig. 3 shows the vice as it appears when holding a piece of taper work. To hold the work the loose jaw and plate are placed against it, the screw in the grip plate tightened against the back of the loose jaw, and the work is tightly held, and at the same time pressed down upon the surface of the vice. The article held being, by the action of the sliding jaw plates, pressed firmly and uniformly down upon the surface of the vice, any work done upon the upper surface of the article may be depended upon

Fig. 3



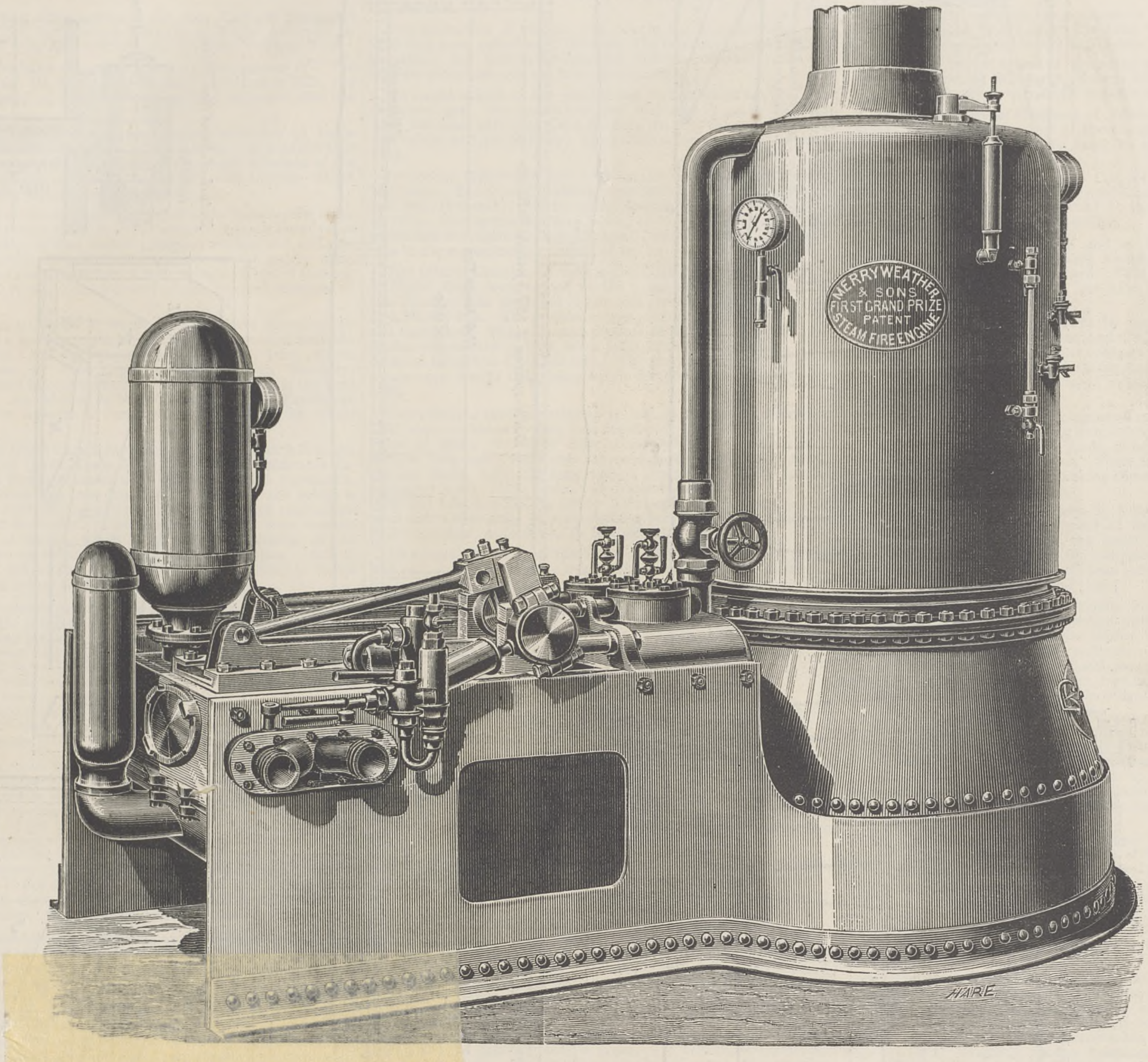
to be true with its under surface, and there is no necessity for hammering down the article held in the vice. The direct action of the screw enables the necessary degree of tightness to be obtained with the expenditure of much less force than is required with an ordinary vice, and work, when required, may be placed down between the ribs of the vice in the space usually occupied by the main screw.

NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty:—Bryant G. Little, engineer, to the Invincible; Edwin J. Jeffery, engineer, to the Indus, additional, as instructor in the working of machinery in torpedo boats; Thomas Morris, engineer, to the Prince Albert; John J. G. G. Percey, assistant engineer, to the Invincible.

DEATH OF A VETERAN ENGINEER.—We announce with regret the death, last week at Putney, of Lieutenant-General William Arden Crommelin, C.B. He came from a well-known Huguenot family, and was born about the year 1823, and obtained his first commission as second lieutenant in the Bengal Engineers in 1841. He took part in the Sutlej campaign, for which he got the medal, and also in the Punjaub campaigns of 1848 and 1849, including the battles of Sadoolapore, Chilianwallah, and Goojerat. He served as chief engineer with Havelock's force on both passages of the Ganges, and at the actions leading to and ending in the Relief of Lucknow, and at the subsequent defence of the Residency. He was mentioned in the home despatches for the skill with which he bridged the Ganges, with slender means and in the face of an enemy far superior in numbers, and with which he directed the extraordinary counter-mining operations at Lucknow. For these exploits he was made a Companion of the Bath, and further rewarded with the brevet rank of major, and with the Lucknow medal and clasp. In 1869 he was appointed Inspector-General of Military Works, and deputy secretary to the Government of India, in the Department of Roads and Public Buildings. The deceased officer was promoted to the rank of Major-General in 1868, and to that of Lieutenant-General on retirement from active service in 1879.

"GREENWICH" FIXED FIRE ENGINE.

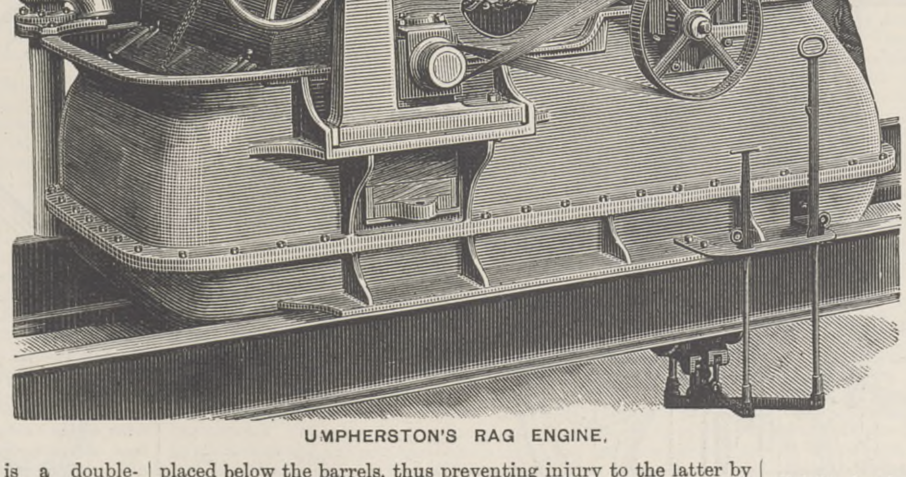
MESSRS. MERRYWEATHER AND CO., LONDON, ENGINEERS.



ADDITIONAL FLOATING FIRE ENGINES FOR LONDON.

THE Metropolitan Board of Works, under the advice of Captain Shaw, are fully alive to the importance of the protection of the river side against fire, and they are about to add another floatraft steam fire engine to the plant. The engine is to be of the new "Greenwich" pattern, designed and patented by Messrs. Merryweather and Sons. It has been increasing in popularity since its introduction last year; one may now be seen at the Colonial Exhibition, in a glass house in the grounds. It takes its water from the ordinary water mains at about 30 lb. pressure, and delivers it at about 120 lb. into the fire mains. Ten powerful jets may thus be concentrated on any part of the building with such force as to tear the roof off. The engine for the Board of Works will be of a capacity of 1000 gallons per minute and upwards, and capable of working through four 1¼in. jets with force sufficient to top any river-side factory or wharf; and steam may be raised in the boiler to 100 lb. pressure from cold water in about seven minutes. One great advantage of this engine is its light weight, in proportion to its great power and the comparatively small space occupied. The pump is of gun-metal and of entirely novel construction, all the valves are placed below the barrels, and any grit or deleterious substance finding its way into the pump falls to the bottom of the suction box without doing any damage. We may mention that two portable engines of this type have been supplied to the Manchester Corporation, each capable of delivering 750 gallons per minute; and one has recently been tested at Montreal, being selected in preference to eight engines tendered for by the leading Canadian and American makers, and its capabilities exceeded the most sanguine expectations of the authorities.

Messrs. Merryweather received the gold medal—the highest award—for their "Greenwich" engine at the Inventions Exhibition, 1885, and also the only gold medal at the Liverpool Exhibition. We illustrate above a metropolitan fire engine of this pattern. It is a double-cylinder return connecting-rod engine. The framework of the engine consists of wrought-iron plate, stiffened with angle-iron, and carrying the engine and the boiler. The machinery is so arranged that the line of pressure is contained within the engine independent of the framework. The steam cylinders drive two pumps placed horizontally, and the steam and water pistons are connected by steel rods, so that the power is transmitted direct without the intervention of a crank-shaft. A crank is, however, provided, placed above the piston-rods, merely for the purpose of actuating the slide-valves and determining the stroke. The crosshead works in guides over the pumps, and, owing to its special form, permits the use of long connecting-rods, thereby facilitating the easy running of the engine. The pumps are entirely of gun-metal, and are of a novel construction. Both suction and delivery valves are contained in one valve-chamber placed below the barrels, thus preventing injury to the latter by stones, grit, &c. The pump piston-rods are cased with brass tube to avoid rust. The collective area of the valves is large, so that at however high a speed the engine may be running, the barrels are always filled at each stroke, preventing the thumping and severe shocks to the machinery so common in high-speed engines. The valves may easily be examined by removing a few bolts and nuts. Both the suction and delivery ways of the pump are fitted with capacious copper air-vessels.



UMPHERSTON'S RAG ENGINE.

UMPHERSTON'S RAG ENGINE.

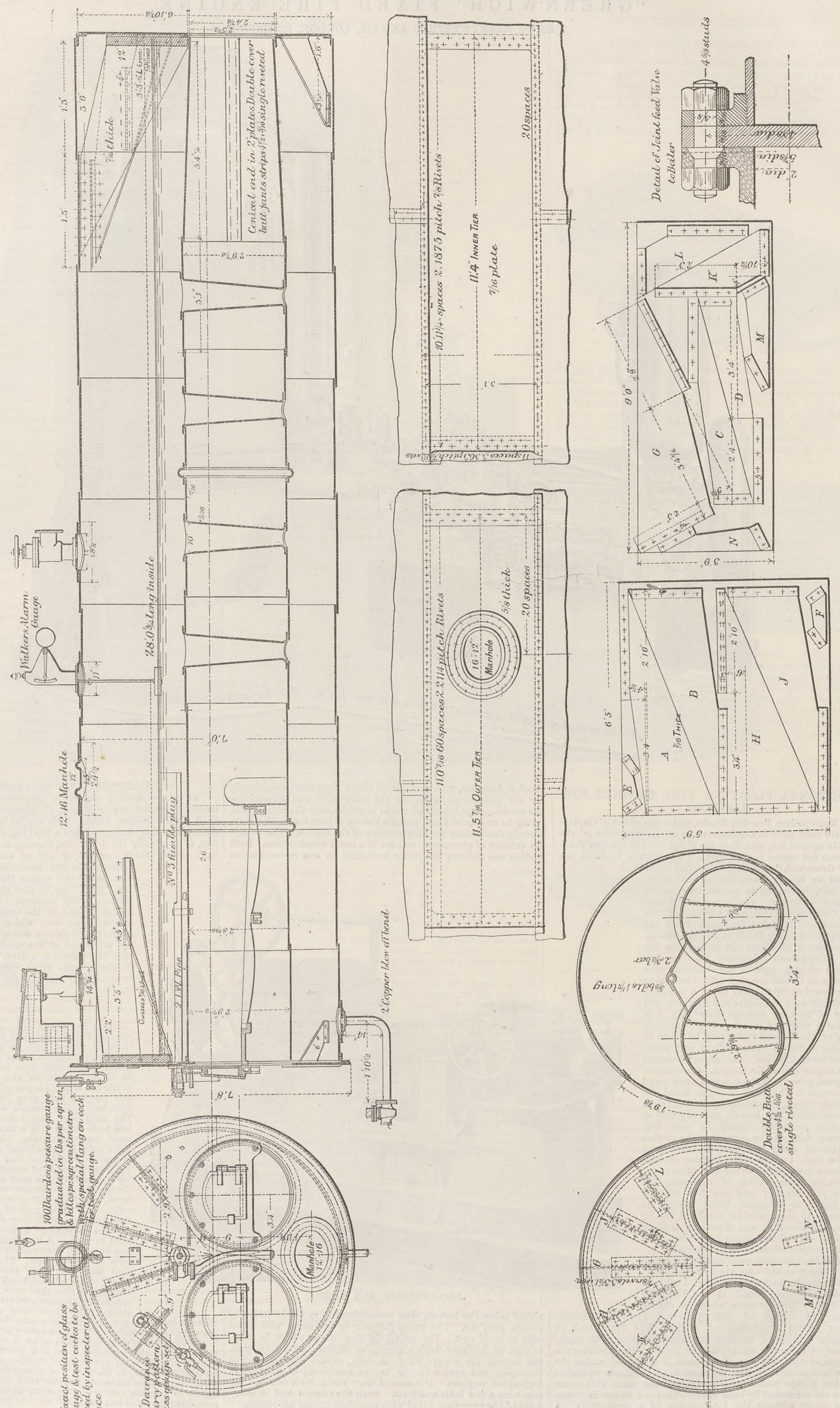
THE accompanying engraving illustrates an improved rag engine, manufactured by Messrs. Umpherston and Co., Bowershall Engine Works, Leith. This engine is one of the smaller sizes which they make, and has a working capacity of 93 cubic feet, or nominally the 3 cwt. size, working as a beater; but they have already made upwards of 100 of various sizes, varying from 60 to 300 cubic feet capacity. It is claimed for this engine that every portion of the "stuff" has to pass through the same distance, a result attained by the use of a horizontal instead of the usual vertical partition, and a breast over which it is driven by the beaters, falling down which it returns quietly to the other end of the machine. It is claimed that the pulp has a freer circulation than is obtained with other machines, and that it occupies only one half the ordinary amount of floor space.

EARLY ROLLER MILLS.—The American *Millstone* says that "Probably the first use that was made of smooth rolls in a burr mill was for slightly mashing the wheat before it went to the burrs. These rolls were crude indeed, both as to their composition and adjustments. The writer has in mind a pair of rolls constructed for this purpose that were 18in. in diameter and 40in. long. The journals were 3in. in diameter. The rolls were cast hollow, and adjustments had to be made with a monkey-wrench. There were no hand-wheels. The roll surface was quite soft, being ordinary cast iron, which soon became so pitted that they were next to useless. The next use made of smooth rolls in this country was in making a germ separation, which has always been legitimate in a burr mill. In truth, no burr mill should be without germ rolls. This thing may be said of their operation, however, that they should not be set so close as to squeeze or flatten everything that went to them. A legitimate use of germ rolls in a burr mill corresponds to the use of sizing rolls in a roller mill. They should be set so that they will break rather than mash the stock. They should break the middlings, and slightly flatten the germ. In this case the separation is made without softening the germ stock. The germ may appear to be only slightly touched, yet the operation may be sufficient to make the separation complete. Where the stock is flattened it is almost impossible to purify the middlings which were with the germ. If they are properly handled they are of a most excellent quality and easily purified. This operation of flattening and squeezing the germ stock is largely the result of thoughtlessness and carelessness. It has been assumed that this stock should be squeezed as tightly as possible, and a small portion of the burr millers have recognised that this was wrong."

CORNISH BOILERS, AMSTERDAM WATERWORKS.

MESSRS. EASTON AND ANDERSON, ERITH, ENGINEERS.

(For description see page 375.)



RAILWAY MATTERS.

The Severn Tunnel having now been opened two months for goods traffic, will shortly be opened for the conveyance of passengers.

During the first eight months of the year 2,291,726 passengers travelled over the Government railways of South Australia, of whom 1,996,187 were conveyed over the Port and Northern lines.

The Rev. Frederick Smeeton Williams, the author of "The Midland Railway: Its Rise and Progress," published in 1878, and "Our Iron Roads," of which two editions have appeared, died last week.

The North-Western of Uruguay Railway extension to Zanja Honda was opened to the public 1st November. It is added that Zanja Honda is about 20 miles from the previous terminus of the line. The completion of the line to the Brazilian frontier—about 22 miles—is being rapidly pushed forward.

The opening of the Selangor Railway, Straits Settlements, is one of the greatest events which have yet occurred to mark the advance of British prestige in the native protected States, and will, the *Colonies and India* remarks, clearly indicate to the native mind the advantages to be gained from a well-ordered system of Government having in view the development of the internal resources of the country.

The Legislative Council of South Australia have almost unanimously carried a motion to the effect that it is expedient that the Transcontinental Railway should be continued from South Australia proper to Pine Creek in the Northern Territory, and that it should be constructed by private enterprise on the land grant system. An address is to be presented to his Excellency praying him to appoint a Commission to consider the whole question.

The reported travel of rails eastward which have been laid in the railway tracks of the St. Louis Bridge has led to considerable discussion among local mechanics as to the cause of the movement. One says the travelling east from the west end of the bridge is natually to be expected, on account of expansion and contraction and the swag of the bridge. The rails cannot travel west, because of half-a-mile of tunnel, which keeps those laid therein at one temperature, no contraction or expansion taking place. But if there were no tunnel the rails would have a tendency to travel west equally with that to travel east.

The total number of persons killed on our railways during the first six months of the present year was 449, as compared with 435 for the corresponding period in 1885. There is also an increase in the number of persons injured, which this year amounts to 1686, as opposed to 1532 in the same period of the former year. Of the killed 51 were passengers and 202 were servants of companies. The remainder were persons not included in these two classes, such as trespassers and persons crossing railways at level crossings. Of the injured, 627 were passengers and 958 were servants of the company. Reports upon certain accidents are appended.

The net receipts on the railways in India for the year 1885 show an increase as compared with those for 1884 of Rs. 1,19,66,430, and the percentage on the capital expenditure, excluding that on steamboat services, suspense items, and indirect charges, gives a return equivalent to 5·84 per cent., against 5·27 per cent. in the previous year. The summary of merchandise carried on the several Indian railways supports the favourable view of the general traffic taken in last year's report. The total tonnage has increased by 1,887,378 tons, or nearly 15 per cent., and thirty-nine out of the forty-seven items tabulated show increases, the most marked being that of "grains and pulses," with a rise of 1,159,386 tons.

The coal which has been discovered at the Indwe, South Africa, might be turned to account were it not that it is handicapped by at least sixty miles when coming into competition with the Stormberg mines, which supply the north-east, where the chief consumption of coal must be for some time to come. The railway carriage being 2d. per ton per mile on Colonial coal, or 10s. on sixty miles, Indwe coal would have to be sold for 3s. at the pit's mouth to compete. The small differential value of 10 per cent. which formerly existed between the Indwe and Stormberg Mines, the *Colonies and India* says, has practically ceased, since the latter have worked away from the out-crop, and have reached 25ft. of roof, and, therefore, abandonment of the mine would be inevitable, and suggests that should, however, a demand arise for the supply of Colonial coal to ocean-route steamers, there would be a reasonable prospect of success for a tram line constructed from Indwe to the Imvani, seventeen miles south of Queenstown, and, if this should happen, then both coal and tram line might pay.

A correspondent of the Philadelphia *Ledger*, writing from Norristown, Pa., Oct. 19th, says:—"A singular accident occurred this evening on the Stony Creek Branch of the Reading Railroad, north of West Point station. As engine 456, drawing ninety-three freight cars, was rounding a curve, the axle of the middle drivers broke. The left wheel immediately left the engine and ran parallel with the train for some distance. Frank McKernan, the conductor, was sitting on the platform of the tender. As the tender passed the wheel the latter, which was still travelling along the track, struck McKernan's legs, and knocked him from his perch to the road-bed. By this time the connecting-rods were broken, and were tearing the machinery and cab to pieces with every revolution. The engineer, David Jones, stepped out upon the foot-board, when one of the rods struck him on the sole of his foot, and knocked him headlong into a heap of ashes along the tracks. The fireman was scalded by escaping steam. No one remained to man the engine, and the train thundered by West Point, the broken axle and connecting-rods thumping and bumping the locomotive to pieces. After running about two miles, the train came to a standstill, the locomotive standing on the rails, and her machinery ruined. The injured men were made as comfortable as possible, and brought to Norristown. None of them are hurt fatally. The road, being a single track, remained closed to travel for about four hours."

A circular issued by the A. French Spring Company, of Chicago, says: "Owing to the growing disposition on the part of consumers to procure material of all kinds at lower prices, manufacturers have been compelled to look for cheaper grades of material. In view of this fact, we have decided to manufacture springs from two qualities of steel. While we have always used and advocated crucible cast steel in the manufacture of railway locomotive and car springs, and experience proves that in the end it is the most durable, and hence the most economical, some railroad companies, however, have adopted an analytical, as well as physical, standard of their own, for the guidance of manufacturers, and which permits the use of steel manufactured in bulk, and therefore much cheaper than that quality of steel known as crucible. These railroad companies ask no guarantee, and assume the responsibility of the springs giving good service, insisting only that the springs pass the physical and analytical tests to which they are subjected at the time they are furnished. But as a comparison of value it may be stated that crucible cast-steel springs are now in service and in good condition that have been in constant use for over sixteen years to our knowledge. It is our aim now, as ever, to produce the best and most serviceable springs at a fair and reasonable price. We shall use the highest quality of crucible cast steel, as heretofore, and the best grade of special steel; and our patrons can always depend upon obtaining from us just what they order, and the best of its kind, leaving it optional with them as to what quality they desire to use. The difference in the cost of the springs will only be the difference in the cost of the material used, as our method of manufacture will be exactly the same in both cases. We shall use nothing but the best quality of crucible cast steel in the manufacture of our locomotive springs." This is a circular that cannot be said to be ambiguous.

NOTES AND MEMORANDA.

The production of manganese ores in the United States last year was 23,258 long tons, valued at 190,281 dols. Manganiferous iron ore, 3237 long tons, valued at 17,318 dols. Total value, 207,599 dols.

The production of chrome iron ore in the United States was 2700 long tons, valued at 40,000 dols. The consumption for making potassium and sodium bichromates increased markedly, due to imports of chrome iron ore from Asia Minor.

No record is kept of the yield in the United States in cubic feet of natural gas. The amount of coal displaced by gas in 1885 was 3,161,600 tons, valued at 4,854,200 dols. In 1884 the coal displaced was valued at 1,460,000 dols. The yield has increased tenfold since 1883.

In London 2685 births and 1380 deaths were registered during last week. The annual death-rate per 1000 from all causes, which had been 16·0 and 17·7 in the two preceding weeks, declined again to 17·4. During the first four weeks of the current quarter the death-rate averaged 17·1 per 1000, and was 2·3 below the mean rate in the corresponding periods of the ten years 1876-85.

The total production of coke in the United States in 1885 was 5,106,696 short tons, valued at the ovens at 7,629,118 dols. Of this Pennsylvania produced 78 per cent., or 3,991,805 tons, valued at 4,981,656 dols. The remainder was produced by fourteen States and territories. The maximum production of coke in the United States was reached in 1883, when 5,464,721 tons were made. This declined in 1884 to 4,873,805 tons. The production of 1885 shows a gain upon that of 1884, being within 360,000 tons of the make in 1883.

The principal statistics relating to iron in the United States for 1885 were:—Domestic iron ore consumed, 7,600,000 long tons; value at mine, 19,000,000 dols. Imported iron ore consumed, 390,786 long tons; total iron ore consumed, 7,990,786 long tons; pig iron made, 4,044,526 long tons, a decrease of 53,343 tons as compared with 1884; value at furnace, 64,712,400 dols., or 9,049,224 dols. less than in 1884. Total spot value of all iron and steel in the first stage of manufacture, excluding all duplications, 93,000,000 dols., a decline of 14,000,000 dols. from 1884.

At a recent meeting of the Paris Academy of Sciences a paper was read on a theory of the unequal flow of gases, by M. Haton de la Goupilliere. Although geometricians have already solved a few questions relating to the unequal movement of fluids, no general theory appears to have yet been applied to the subject so far as regards the gases. The object of the present paper is to make good this want, and to present a complete solution of the problem in connection with the receptacles of compressed air for locomotives or tramways filled from reservoirs maintained by the compressing engines at a constant tension.

Ryland's blast furnace returns for September give particulars of furnaces built and in blast on September 30th as follows:—Total number of furnaces built September 30th, 1886, 859; total number of furnaces in blast September 30th, 1886, 366; no alteration in the number of furnaces built since June 30th, 1886, 0; decrease in the number of furnaces in blast since June 30th, 1886, 20. Furnaces blown-out since June 30th, 1886, 32; furnaces blown-in since June 30th, 1886, 12; furnaces built since June 30th, 1886, 1; furnaces pulled down since June 30th, 1886, 1; furnaces being built at present time, 6 furnaces being re-built at present time, 5.

Messrs. Walter T. Glover and Co., Salford, Manchester, have devised a plan whereby the various sized cables required in the circuit of every electrical installation can be produced without visible joints. Their method is to unite the various lengths of cable required, such as, say, first—19 strand No. 14, then may come a 19 strand No. 16, then a 19 strand No. 18, or anything else fitting the installation, the various sizes being known. All are united in the bare core, and after this has been neatly and firmly done the insulating material is put on without break or joint from end to end of the whole. In this way no joints or bulky protuberances are seen, and the insulation is the same throughout.

In the *Photographische Mitarbeiter* the following recipe for preparing silk for printing from is given:—(1) Tannin, 40 grammes; water, 1000 c. cm. (2) Salt, 40 grammes; arrowroot, 40 grammes; acetic acid, 150 c. cm.; water, 1000. No. 1 is mixed with No. 2, well shaken, and filtered. The older the mixture the better it is for use. In this bath the silk is thoroughly immersed and allowed to remain for three minutes, when it is taken out and hung up to dry. Sensitising solution is composed of silver 1 to 10, acidified with nitric acid. For a toning bath is given:—(1) Chloride of gold, 1 gramme; water, 200 c. cm. (2) Sulphocyanide of ammonium, 20 grammes; water, 500 c. cm. No. 1, after shaking, is mixed with No. 2. In a few days the mixture will become clear, when it is ready for use. It is preferable to dilute with from two to four times the quantity of water. Fixing and washing as usual.

Clausius supposes that the molecules of all bodies are in a state of constant agitation, and that in fluids a molecule, after moving a certain distance from its original position, is just as likely to move still farther from it as to move back again. This process Clausius supposes to go on in the liquid at all times; but when an electro-motive force acts on the liquid, the motions of the molecules, which before were indifferently in all directions, are now influenced by the electro-motive force, so that the positively charged molecules have a greater tendency towards the cathode than towards the anode, and the negatively charged molecules have a greater tendency to move in the opposite direction. Hence the molecules of the cation will, during their intervals of freedom, struggle towards the cathode, but will continually be checked in their course by pairing for a time with molecules of the anion which are also struggling through the crowd, but in the opposite direction.

It has for some time been stated that electricity may be used in soap and bleaching works, and now the *Electrical World* says:—M. Rotondi has discovered that by the employment of suitable vessels it is possible to effect the saponification of oils by the electrolysis of an emulsion of the oil in a concentrated solution of sodic chloride. This, at least, is the nature of the process so far as can be gathered from a not very lucid description in one of the French technical journals. During the process it is said that caustic soda, free chlorine, and glycerine are formed, and it is suggested that at bleaching works it would be found economical to prepare chlorine by this process in order to obtain the soap and the glycerine as bye-products. It is also suggested that as the process requires practically no supervision, it would be practicable to employ in this way at night steam power already in use during the daytime for other purposes.

The use of intermittent light to indicate the speed of engines or other moving bodies has been proposed by M. Gustave Hermite. His plan is to illumine a Geissler tube by the sparks of an induction bobbin giving a constant and known rate of vibration per second, say from thirty to forty, each vibration giving a corresponding flash of the Geissler tube. By optically arresting the moving objects at different points of their course he proposes to obtain their speed. For example, if a disc of cardboard be made to revolve by clockwork at a uniform and known speed, say one turn per second, and if it be lighted by the Geissler tube giving thirty flashes per second, we shall see the disc thirty times during one second, or, in other words, while it makes one revolution; and if there be a visible spot on its surface, thirty spots will be seen. If the disc turn ten times per second, the succession of images will disappear, owing to the persistence of impressions on the retina, the disc will appear to be immovable, and we shall see three spots on its circumference occupying fixed positions. If the number of turns of the disc is equal to the number of flashes of the tube, the disc will be seen to be immovable. A printed page revolved in this way could be read as if it were fixed.

MISCELLANEA.

At the Edinburgh Exhibition, the Frictionless Engine Packing Company, Exchange-buildings, Manchester, has been awarded a silver medal.

The amount of cobalt oxide produced in America last year was 8423 lb., valued at 19,373 dols. The total value of cobalt in ore, matte, and the above oxide was 65,373 dols.

For their exhibit of mixed or compound oils for lubrication and jute batching oil, at Edinburgh, Messrs. MacArthur and Jackson have been awarded the only medal granted in their section.

The Noiseless Tread Company of Withey Grove, Manchester, has sent us a specimen piece of their noiseless treads for stairs, made of a cast iron grating, the holes in the grating being filled with india-rubber.

Messrs. Shand, Mason, and Co., of London, have been awarded two gold medals for the excellence in design and workmanship of the fire engines exhibited by them and lent for use in case of fire at the Edinburgh Exhibition.

At the Edinburgh Exhibition and at Liverpool, Mr. Joseph Hamblet, West Bromwich, has been awarded the highest awards for blue bricks, &c., exhibited there. This makes thirteen international exhibitions at which he has taken the highest awards for his manufactures.

From the official list of awards by the Edinburgh jury, we observe that Messrs. W. Simons and Co., Renfrew, have been awarded the gold medal for hopper dredgers with patent traversing gear; this firm received one of the three medals that were awarded to the Clyde shipbuilders for naval exhibits at Liverpool Exhibition.

The Cleveland Ironmasters' Association return shows the following as the month's makes of pig iron:—109,000 tons of Cleveland iron, and 83,000 tons of other kinds, a total of 192,000 tons, or 1600 tons less than in September. There are eighty-four furnaces blowing, fifty-one of which are making Cleveland pig iron. Stocks decreased 29,600 tons in October.

The breakdown of the Anchoria is a practical argument, the *Shipping World* says, "in favour of the duplication of the machinery, or, in other words, the use of twin screws, in large passenger ships." How will the shipping world get over the difficulty of getting long ships with twin screws in and out of docks without breaking screws now and then?

On Saturday last, at the Brymbo New Steel Works, near Wrexham, the fly-wheel of the roller mill, while revolving at a great speed, burst into fragments, killing two men and injuring eight others, some of them very seriously. The fragments of the wheel flew in all directions. A local paper says the accident was caused by the sticking of the steam regulator valve of the engine which prevented the driver from shutting off steam.

The National Agricultural Hall Company is inviting application for the unallotted shares in the company by which this hall has been constructed, and will be opened next month. The hall is the largest in the kingdom, being 250ft. wide and 450ft. in length, the width including an outer parade 40ft. in width. The building covers altogether about four acres, and gardens adjoin it comprising over five acres. These gardens and the hall are to be known as Olympia.

The Conservators of the river Thames have decided to bring forward a Bill in the coming session of Parliament, the main object of which will be to seek to increase the amount at present payable by the water companies for extracting water from the river Thames. The companies which will be affected by this proposal are the Southwark and Vauxhall, the Grand Junction, the Lambeth, the East London, the West Middlesex, and the Chelsea Waterworks. Could not the companies reduce their rents by using waste-preventing meters?

The Government of the Cape of Good Hope have issued a notice to the effect that, under the Customs Tariff Amendment Act, No. 13 of 1884, mining, agricultural, and sawing machinery, and railway material are free of Customs duty when imported into the Colony. The Railway Department has decided that from and after the 1st of November mining machinery in transit to places beyond the limits of the colony shall be conveyed to the several railway termini in the colony at third-class rates, instead of second class as at present.

A recent number of the *Cambrian News*, speaking of a twelve-head gold mill, constructed in the foundry of Mr. G. Green, at Aberystwith, for the Punjom and Sunghie Dua Samantan Gold Mining Company, Hong Kong, says, the order was given by wire on the 22nd September, the contract to be completed by the 2nd October, this only giving nine days in which to make the patterns, do all casting, construct all fittings, pack and deliver on board the s.s. Gleneagles in the West India Dock, London. Mr. Green was able to complete the contract.

The Chinese Ambassador and suite paid a visit to Messrs. Green's shipbuilding yard on Thursday, the 28th ult. After inspecting the general work, including a large caisson building for the Chinese Government, they lunched on board the steamship Glengyle, where they were entertained by Mr. M'Gregor, the head of the Glen line of steamers. The party then paid a visit to the works of Messrs. John and Henry Gwynne, at Hammersmith, where they inspected the large engines and pumping plant this firm is at present constructing for the same Government to empty the new graving docks at Port Arthur.

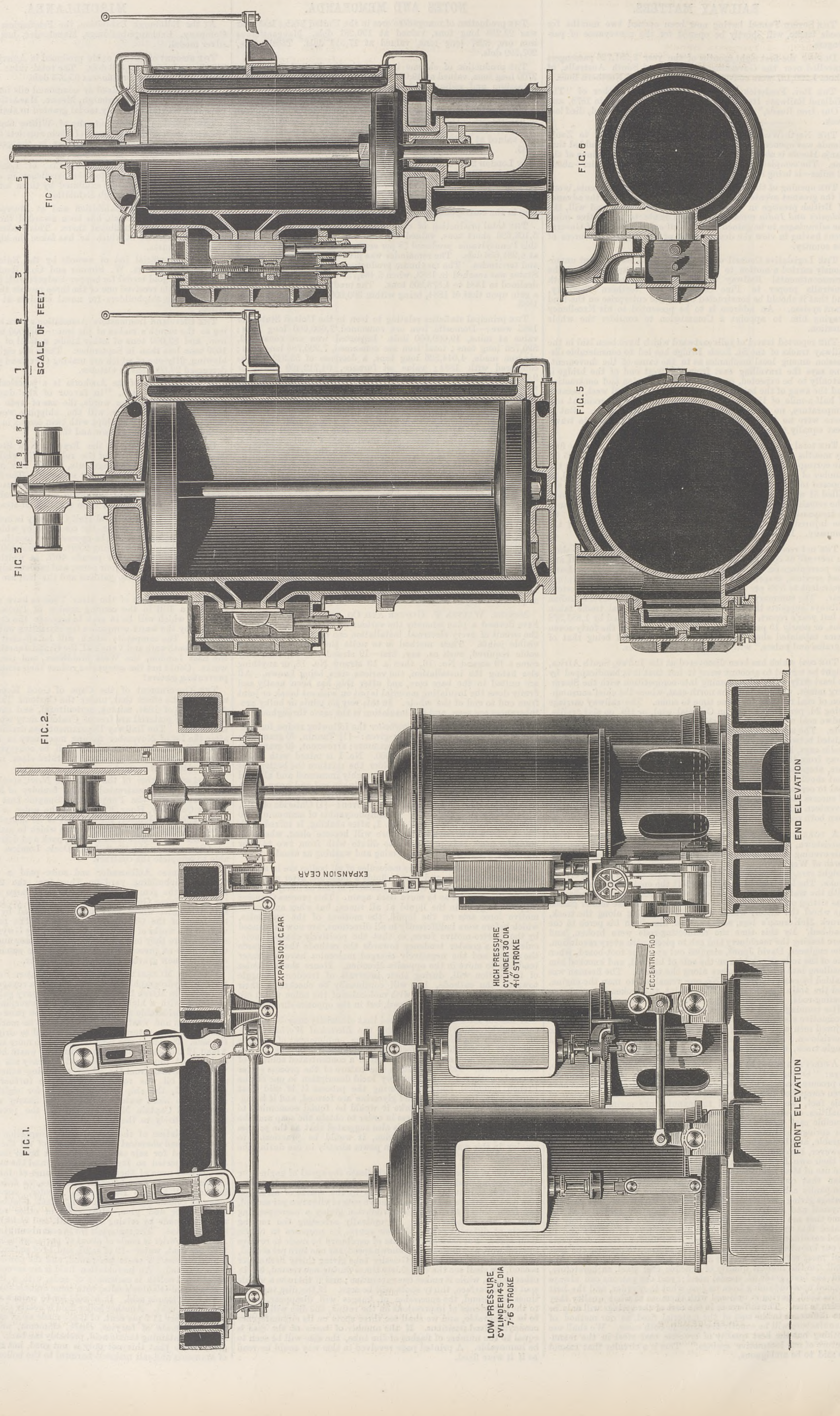
Captain Murrell, of the English steamer Surrey, reports to the U.S. Hydrographic Office that while on a voyage from Baltimore to London in March last he experienced heavy gales from N.N.W. attended with a high and confused sea, sweeping the decks and causing considerable damage. He filled the pans of the closets aft with oakum and waste and then poured in machine oil till the waste was fully saturated, allowing the oil to drip gradually over the side. The effect was remarkable, as no more seas came aboard. About 12 o'clock at night the oil in the waste became exhausted and almost immediately afterward a heavy sea swept the deck, washing the man from the wheel and doing other damage. The supply of oil was replenished and no further difficulty was experienced, the ship running easily for eighteen hours and shipping no more water on deck. The Surrey was loaded with cattle, and Captain Murrell attributes the preservation of the animals entirely to the use of oil.

An association of the several boiler inspection societies of Germany has had chemical analyses made of all the secret compositions offered for sale as specifics against boiler incrustation. The number reported so far is thirty-two, and the association recommends that none of them be used. Some of these compositions the American *Railroad Gazette* publishes, as follows:—At Berlin is offered "Albert's Incrustation Powder," composed of chalk, common caustic lime, slacked lime, potash, Glauber's salts, a little sand, water and glue, with traces of other substances. It is evidently made by mixing chalk, salt, and quicklime with caustic soda and glue. The materials for it cost about 2½ cents per pound. Another powder is made of about 67 parts crystallised soda—which is 63 per cent. water—19 of sand, and 14 of pulverised lignite. The materials cost 4·4 cents per pound, and the powder is sold for 17½ cents a pound. An incrustation fluid is six-sevenths water, while about one-twelfth is carbonate of soda, with a little caustic soda and salt and Glauber's salts, with some organic substances containing a little tannic acid. It is sold for 6¼ cents a quart, and costs less than 1 cent. Another boiler fluid is nearly eight-ninths water, and the other 11·6 per cent. of it are made up of carbonate of lime, salt, carbonate of barytes, chalk, ammonia, and some organic matters containing tannic acid, probably tan bark. The association gives notice that this not only is not good, but that the presence of ammonia and salt makes it harmful to the boiler plates.

DETAILS OF PUMPING ENGINES, AMSTERDAM WATERWORKS.

MESSRS. EASTON AND ANDERSON, ERITH, ENGINEERS.

(For description see page 375.)



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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.*

J. K. S. (Colchester).—*A letter awaits application by this correspondent.*

E. B.—*That which you quote probably refers to a book by the late John Anderson, on "Strength of Materials."*

Smoke.—*Only the best smokeless Welsh coal is used on the Underground Railway. Bwlfa coal gives excellent results.*

Manufacturer.—*There are a great many paddle boats in use. They are employed in Channel service, carrying mails, passengers, and cargo.*

J. F. (Pollockshields).—*If you do not find what you want in our advertising pages, write again.*

J. K.—*So far as we understand your question, it would not make the least difference whether the vacuum box was mounted on a carriage or not. The pressure of the air would be the same all over the vacuum box—back, front, top, bottom, and sides.*

W. H. T. (Leicester).—*You have quite missed the point. The setting of the excentric by a governor in the fly-wheel is not claimed as new. What does appear to us to be novel in the Proell engine we illustrated is the mounting of the excentric, not on the shaft, but on a second excentric, so that both the lead and the throw are under the control of the governor.*

CLAY TOBACCO PIPE MACHINERY.

(*To the Editor of The Engineer.*)

Sir,—Will any reader be so kind as to inform me who are the makers of apparatus required in the manufacture of clay tobacco pipes?

Manchester, October 21st. R. L. K.

FERRO SILICON.

(*To the Editor of The Engineer.*)

Sir,—In your last issue, page 322, on "Silicon in Foundry Iron," it states, "More than a hundred foundries in France are now using ferro-silicon." Can any reader inform me where this is to be obtained in England? Go Ahead.

Weymouth, October 28th.

PLOUGH SHARE IRON.

(*To the Editor of The Engineer.*)

Sir,—Can any of your readers inform me where I can procure the pig iron used for making chilled plough shares? When broken, the soft or upper part of these shares has a close, dark blue appearance, almost resembling what is known in America as "black-heart" iron.

Northampton, October 29th. T. C. S.

HORSESHOE MACHINERY.

(*To the Editor of The Engineer.*)

Sir,—I shall be much obliged if any of your readers can give me any information concerning horseshoes, either machine or hand-made. What is the usual process of making horseshoes by machinery? Are they as good as hand-made shoes? If not, why not? Are there any machines which make shoes by bending cold or hot? Would bending cold be detrimental to durability? What is the process by which the United Horseshoe and Nail Company, Limited, make their shoes? Any other information concerning horseshoes and their manufacture would be thankfully received by A. N. B.

November 3rd.

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MEETINGS NEXT WEEK.

The Institution of Civil Engineers, 25, Great George-street, Westminster, S.W.—First ordinary meeting, Tuesday, November 9th, at 8 p.m. Inaugural address of the President, Mr. Edward Woods, and presentation of the medals, premiums, and prizes awarded during the last session.

Society of Telegraph Engineers and Electricians.—Meeting at the Institution of Civil Engineers, 25, Great George-street, S.W., on Thursday, November 11th, at 8 p.m.; "The Predetermination of the Characteristics of a Dynamo," by Gisbert Kapp, Associate.

DEATH.

On the 30th ult., at Shanghai, Alexander, youngest son of the Rev. T. C. Cane, of Brackenhurst, Southwell, Notts, aged 37.

THE ENGINEER.

NOVEMBER 5, 1886.

TRIPLE EXPANSION MARINE ENGINES.

During the last meeting of the Institution of Mechanical Engineers at Leeds, only a single paper was read—namely, that by the late Mr. Robert Wyllie, of Hartlepool—on triple expansion marine engines. This paper will be found in another page. The discussion on it was opened and adjourned to the next meeting of the Institution, to be held in London next January. It is an important contribution to the literature of the subject. We do not agree with some of the statements made by the author, but this in no way precludes us from bearing testimony to its general excellence. We propose here to consider it step by step.

The first point which appears to us to be open to criticism is that concerning the general arrangement of the cylinders. Mr. Wyllie advocates the three-crank three cylinder arrangement. We grant at once that is, in certain points, the best form that the engine can assume, but we cannot admit "that in order to take full advantage of the triple expansion system an engine must be built with three cranks placed at equal angles." There are several tandem triple engines at work, and it has yet to be proved that they are not as economical and satisfactory in every respect as three-crank engines. The objection to this last type is that it gives too long an engine. Mr. Wyllie shows that this may be got over by arranging the valves on the sides of the cylinders, instead of disposing them fore and aft; but it is clear that this argument will cut both ways, in that the same thing can be done with a tandem engine, which will then be shorter than the three-crank engine by at least one cylinder. Mr. Wyllie holds that it is practically impossible to get the same equable distribution of power on the two cranks with the tandem as with the three crank engine. But this is simply a matter of calculation. We can cite at least one tandem engine working at 120 lb. in which the power given out by the single low-pressure cylinder is almost precisely identical with that given out by the two other cylinders; and furthermore, it is really a matter of little or no practical importance that this identity of energy should exist. Engines are running with great success and economy in which there is a very considerable difference between the horse-powers developed in the three cylinders, and Mr. Wyllie has made no attempt to show that the result should be different.

Turning next to the question of jacketting, we find that Mr. Wyllie holds that, even if the high-pressure cylinder is left unjacketted, the intermediate and low-pressure must be provided with this appendage. Now it is pretty well known, though Mr. Wyllie does not allude to the fact, that the widest diversity of opinion exists among engineers concerning the value of steam jackets at sea; and, so far as we are aware, there is no definite information available to prove that they have there any economic value whatever. Theoretically they are right, but practice is silent concerning their merits. Mr. Wyllie himself admits, it is fair to say, that in triple expansion engines, in which the range of temperature is small, "the benefits arising from the use of jackets are naturally not so great as in a single cylinder engine with a high rate of expansion." When he proceeds to argue in favour of the practical advantages of a working barrel cast separately and forced into the cylinder, we cordially agree with him; but this is a different matter. In any case, we hold that Mr. Wyllie is distinctly wrong in his selection of cylinders to be jacketted. Experience with triple expansion goes to show that there is little or no condensation taking place in the third cylinder. On the contrary, re-evaporation proceeds rapidly because of the great reduction in pressure. When we come to the first cylinder we find different facts, and we are presented with one of the numerous puzzles which the working of steam engines always presents. The initial condensation in the first cylinder is enormous under all circumstances, and appears to be quite uninfluenced by the use of a jacket. Sir F. Bramwell mentions one instance in which it amounted to no less than 47 per cent. of the whole admission, and probably in no case is it under 33 per cent. No rational explanation of this circumstance has as yet been supplied. A small portion of this enormous quantity of water is re-evaporated in the high-pressure cylinder. A much larger quantity is converted into steam in No. 2 cylinder; and in No. 3, as we have said, but a small proportion of water is to be found. Our own experience in this matter is confirmed by inquiries which we have made. According to the heat trap theory the initial condensation ought to be very small; practically, so far as we have data to go on, the initial condensation is very much larger in the triple than in any other form of engine. The experience of other engineers on this point may be different from ours; if so, we think it highly desirable that the facts should be made public. Why it is that even with such a drawback the triple engine is extremely economical, we have already more than once explained. It may not be out of place to say here briefly that the economy is due to the fact that the steam produced by re-evaporation is worked expansively to far better purpose in the compound than it can be in the non-compound engine. It is to this circumstance, far more than to a diminution in the amount of initial condensation which takes place, that the good qualities of the compound engine are due.

Mr. Wyllie lays great stress on maintaining moderate steam velocities. That is to say, he likes large and direct passages. This is a subject concerning which there is a plentiful lack of information. The most conflicting statements are made and the most contradictory results have been obtained. Take, for example, Mr. Wyllie's own figures. Speaking of a certain steamer, he says that with a particular crooked steam pipe "there was a fall of pressure between the boiler and the engine from 135 lb. to 120 lb., but by substituting a straight for the crooked pipe the cylinder pressure was raised to 130 lb." This is a very important proposition, and it is difficult to understand why the bends in question should have produced the stated diminution in pressure. We do not dispute Mr. Wyllie's accuracy. On the other hand, we can instance a case in which an express locomotive coming in for repairs, the locomotive superintendent had the four steam ports plugged for half their lengths. Nothing whatever was said about the experiment to the driver, and he never discovered that any change had been made, the engine keeping time with the same consumption of coal as before. There is reason to believe that it is not the cross section of a pipe alone which principally determines the differences between the pressures at opposite ends, but the number of bends in it. It has often been found that if a flat plate with a hole in it be interposed between the two flanges of a steam pipe, there may be little difference between the pressures at opposite ends. If, however, an entire pipe of a diameter equal to that of the hole be substituted, the substitution will be followed by a very considerable fall of pressure between the receiving and delivery ends. A small steam pipe in a locomotive will be much more effective in reducing cylinder pressure than will a small opening in the throttle valve. Very little, as we have said, is definitely known concerning the coefficient of friction of steam passing through pipes, probably because the legerity of the steam depends enormously on its dryness. Mr. D. K. Clark was, we believe, the first to point out that the back pressure is greater in outside than inside cylinder engines, because the steam is not kept so hot in the former as in the latter; and the fluid is therefore less mobile and offers greater resistance to being pushed out of the cylinder by the advancing piston. We shall hope to find the question discussed when the consideration of Mr. Wyllie's paper is resumed next year.

Mr. Wyllie refers at some length to twisting moments on the crank shaft. We, however, have not reproduced his diagrams, as the whole of his reasoning on this part of the subject is vitiated by the circumstance that he has entirely neglected the momentum of the moving parts. It was shown last April, during the meeting of the Institute of Naval Architects, that owing to the effect of momentum it is quite possible that the twisting moments with a tandem two-crank engine may be much more equable than that of three-crank engines.

That the triple expansion engine is more economical than the ordinary old-fashioned compound engine is indisputable, but we must protest against the character of the comparisons drawn by Mr. Wyllie. Take, for example, the Ingram, Wandle, and Para. These ships are all very nearly alike. The first burns 13¾ tons, the second 14 tons, and the third 10¼ tons per day, the powers developed being respectively 570, 580, and 620 indicated horse-power; but the boilers of the first two ships only carry 75 lb., and the last carries just double as much, or 150 lb. Next let us take the Fellinger, Padang, and Jacatra. The consumption of fuel is given for the first, 2·19 lb. of German coal; for the second, 2·13 lb. of Cardiff coal; and for the third, 1·41 lb. of "mixed" coal. But the first-named ship only carries 70 lb. and the second 75 lb., while the third carries 140 lb.; and an instance may be named in which a tandem triple engine burns less than this, with a boiler pressure of only 120 lb. Take again the Lusitania; the original pressure was only 55 lb., and her consumption was 52 tons of Welsh coal per day. It is not fair to compare an antiquated engine of this type with one of modern construction. There are numbers of compound engines at sea running with pressures of over 100 lb. It is highly desirable that comparisons should be drawn between them and the triple engines. The entire advantage of the triple over the ordinary compound engine lies in the use of much higher pressures, which render larger ranges of expansion possible. But two things have yet to be proved. First, that it is not possible to make a successful two-cylinder engine which shall carry 120 lb. steam; and secondly, that the engines and boiler which work at 150 lb. will be as durable and cost as little in repairs and maintenance as their immediate predecessors. We have no desire to discourage the use of triple engines; far from that, we believe fully in them. But experience is wanted to show whether or not engineers have not been going too far and too fast in the matter of pressure; and furthermore, we advise numbers of our readers who now possess compound engines which they think must go to the scrap heap to consider well before they condemn them, and we repeat that it may be possible by the addition of new and stronger boilers to get results out of the said engines which will enable the owners to run their ships at a profit without incurring any very large expense for an entirely new set of machinery.

THE LATE GALES AND THE BRIGHTON BEACH.

The recent severe south-westerly gales experienced on our southern and western coasts have afforded a striking test of the correctness or otherwise of the conclusions we have from time to time advanced when writing on the subject of the beaches of the conjoint towns of Brighton and Hove. Desirous of learning how far our predictions of the effect of such gales had been verified, we have recently made a strict inspection of the conditions existing after the storm referred to. We found that not alone has what we have all along anticipated come to pass, but that a consideration of the present aspect of the beach affords a lesson which may, we think, be usefully applied in most cases of a similar character of threatened denudation of shingle on foreshores.

To apply that lesson usefully, it will first be desirable to briefly review what we have before written on this subject By reference to our earlier remarks upon it, and by comparing with them the results now to be observed, we shall be in a position to give to our present conclusions greater weight. It is, fortunately, scarcely necessary to do more than just allude to the works completed on the Hove section of the beach of the two towns. From the commencement of Mr. Ellice-Clark's intelligent endeavours to combat the inroads of the sea on that section, we expressed our view that no mere system of groyning would suffice to provide the means to repel them. We contended that a sea wall would have to be built, and our contention had in the end to be acted upon, but only after many useful lessons had been derived from the failure of prior attempts to safeguard the shore. As regards the fine wall which has now been erected, we can say that it has withstood the storm—one of the heaviest and of longest continuance known for many years—entirely without injury. Neither did the beach now accumulating at its base suffer appreciable diminution, and the Hove Commissioners may be congratulated on having at last secured what promises to be most complete and lasting protection for nearly their entire sea frontage. Some damage has, however, been done to a portion of this along which the new wall does not extend. The injured part has long been protected by a low face wall, of such weak construction, however, that it has yielded in places to the force of the late gales. It may prove to be desirable to replace it by a further extension of the stronger design which has now been proved so efficient.

But it is upon that part of the beach which is in charge of the Brighton Corporation that the sea has shown its damaging effects, and it is upon those effects that we purpose to enforce the conclusions that we have drawn. In an article we published in our issue of January 26th, 1883, at the time the erection of the sea wall at Hove was under consideration, we wrote that, while such a work was a necessity, there was "the risk which will undoubtedly be incurred of turning the inroad of the sea on to the beach of the neighbouring municipality of Brighton." We at the same time condemned the impolicy—in the looked-for eventuality named—of the sale of shingle from the foreshore "at the point most proximate to the Hove boundary." The justification of our protest—which was repeatedly reiterated in subsequent articles—became strikingly apparent in February, 1884, when a severe storm removed from the point named what little shingle the commercial tendencies of the Corporation had permitted to remain there. Being rudely awakened to the consequences of their past action, the Town Council adopted proposals for the immediate erection of a series of unsightly groynes, in the hope of reconstituting the lost beach. Commenting upon this decision, we wrote in our article of March 14th of that year, that the members of that Council, "if they exercise the deductive common sense we must suppose them to possess, must be aware, from the experience gained at Hove, that, erect as many groynes as they will, the shingle will not be forthcoming to be retained by them for years to come." In our latest article upon this subject, which appeared in our issue of August 6th of the current year, and after more than two years' trial of the groynes had been experienced, we showed the fulfilment of the above prediction, and stated the cause to which we believed the failure should be assigned.

Having thus reviewed our past comments, we may now proceed to illustrate them by describing the results of the late gale as viewed by us within a few days past, and we shall then be able to offer to our readers the lesson which we think they teach us. The damage done is confined almost entirely to two sections of the beach, one being that commencing at the eastern extremity of the Hove sea wall, and reaching to a point some 150 yards to the eastward of the West Pier. The other section starts from the high concrete groyne at the bottom of East street, and extends to and somewhat beyond the old Chain Pier. On the first-named section the sea made a clean wash round the terminal curve of the Hove wall, and removing what little shingle remained, completely destroyed the footing work at the base of the ornamental enclosures, on which seats were formerly placed. The walls of the enclosures themselves show evidences of the force they had to encounter, and they would probably have also succumbed had the attack upon them been much longer continued. Proceeding eastwards, we found the massive concrete walls protecting the lifeboat house to have been shivered to fragments, while the walls of that building itself have been rendered so unsafe that the boat had to be removed from it. Between this spot and the West Pier, the work and embankment covering the main sewer had been altogether washed away, and we were told that the engineer to the Corporation had had hard work to prevent the entry of the sea into it. Nothing but the most strenuous exertions of gangs of men put on at low tide saved, we are informed, the basements of the houses on the sea front from being flooded. Those exertions probably also alone secured to the sewer itself immunity from very serious injury. But it was below the platform of the West Pier that we saw the strongest evidence of what the sea had done. The markings on the piles of that structure showed to us what the height of the beach had been before the gale, and we could deduce from them that a depth of fully 8ft. of beach had been clean swept away over a distance probably of about 250 yards. There is no doubt that during the height of the storm the arches below the esplanade, occupied by the Boating Club and otherwise, were in very considerable danger. At the point above-named, *i.e*, about 150 yards east of the pier, damage to this section of the beach appears to have been stayed. On viewing the second and more easterly section where damage had occurred, we found that from the large concrete groyne at the end of East-street, and up to a point beyond the Chain Pier, the beach had been practically denuded, excepting only where some of the larger groynes retained some part of their former accumulations on their western sides. To the leeward or eastern sides of them no beach remained worthy of the name. The sea had made a clean run right up to the wall of the Aquarium esplanade, practically destroying the portion of the electric railway running along the base of that wall. The trams themselves had to be secured to the railing of the walk to prevent their total removal by the sea. Having thus detailed the damages done, we may proceed to consider to what causes they are to be attributed, and what course it may now be proper to pursue to guard against their recurrence.

In our latest reference to this subject we named the embayment or crescent form given to the shore between the past accumulation of beach to the eastward of the West Pier and the construction, well seaward, of the Hove wall. We then pointed out that the run of the sea induced by the latter artificial projection must carry the shingle on a course beyond the power of interception by the groynes newly erected. It is evident to us, as the result of our late inspection, that it is to such embayment, however caused, that the absence of an equal deposit of beach must be assigned. We observe precisely the same cause to be present where the damage has occurred in the neighbourhood of the Aquarium. At the latter locality, opposite to the Old Steine, the little river Bourne used in olden times to discharge itself uncontrolled. As is the case with all rivers so discharging into the sea, the attrition of its waters produced an *embouchère* resulting in a certain amount of embayment. The town authorities, a good many years back, erected at the end of East-street the high concrete groyne which has had the effect, while accumulating a large amount of beach on its western face, of stopping all travel of shingle into the former debouchment of the river. The result has been to altogether neutralise the partial straightening of the coast line at this point due to the erection, seawards of the old line, of the Aquarium esplanade. Now it is evident that the destructive action of the sea has only had serious effect on the two embayed sections of the beach that we have named, and we deduce from this fact that one of the first objects to be attained for the equalisation of beach deposit is to straighten the line as far as possible of any foreshore. Yet what do we see with regard to that at Brighton, and, until lately, at Hove? Enormously high and long groynes have been run out at particular and ill-selected points, which have operated to produce a very indented beach. They have, indeed, increased the difficulty which it was sought to remove. Had the groyne opposite East-street, instead of being placed in its present position, been erected to the *eastward* of the Aquarium embayment, the flow of shingle which it arrests would have soon filled up the latter, and removed the present cause of danger. But at both the threatened points referred to the evil has already been done, and further groyning on the present principle adopted must but increase it. Each fresh groyne, indeed, erected upon the past mistaken system, must tend to produce additional irregularities of the coast line, such irregularities being, in our opinion, the main cause of danger. It was the accumulation caused by the Aldrington groynes to the westward of Hove which first brought about the denudation at the latter place; and we see that as protective works have been, perforce, extended to the eastward, so have similar causes operated, and the same results followed.

We have now, and in conclusion, to deal with remedial measures. We may first allude to the recent almost panic-struck discussion of the Brighton Town Council. Each member of that body appears to have proposed some different *nostrum* of his own, while the report of the engineer in charge has been recommended by one member to be "thrown back" to that officer "with ignominy!" Meantime all that has been decided upon is temporary defence, one member of the council moving that no more than one hundred pounds should be spent upon this; for "as the works were sure to be washed away, the less that was spent the better!" It is, however, to the permanent defence of the town that attention must be given, and we hold that to effect this the first principle we have laid down, of straightening the beach line, must receive primary consideration. This cannot be effected as long as the present concrete and other larger groynes are maintained at their present level and with their present length. They must be cut down in height and shortened until the beach can travel fairly and equally, while a groyne of moderate dimensions should be erected at the eastern end or horn of the Aquarium embayment we have named to force a deposit of shingle within it. We feel confident that nothing beyond such measures is required to overcome the difficulty opposite to the Old Steine. With regard to the West Pier embayment, the evil is too serious to be so easily dealt with. Work, and heavy work, will have to be done—as we have all along said that it would—to throw out the line of foreshore there to correspond with that now created by the Hove wall. This can, so far as we can see, only be done by continuing that wall until the eastward horn of the embayment—about 150 yards beyond the West Pier—is reached; care being taken that the line of beach to be afterwards secured in advance of the wall shall correspond with and merge into that of the present and established beach, where the extended wall shall terminate. The objection raised in the Town Council to such an extension of the Hove wall is that it will destroy the beach for bathing and boating purposes. But has it not already been destroyed? Is there the least prospect of recovering it in its present—or rather—late position? Eventually, as is in progress now at Hove, a sufficiently ample beach for the above-named purposes can undoubtedly be obtained in advance of the extended wall; but we regard as hopeless the restitution of the beach now lost in the position it but lately occupied. To the adoption of the measures we have named we feel sure the town authorities must at last be driven, and we counsel that no more money should be wasted in futile attempts before these are decided upon and undertaken.

Turning from the particular case to the instruction it affords for general practice, we would say that—for town defence at all events—endeavours should first be made to remove all prominent irregularities in the beach line. This, as we have pointed out, may be effected by groyning at the extremity of such irregularities which is in the direction of the prevailing travel of the shingle. We have in a former article expressed the opinion that such groynes should start from their base at an angle of about 15 deg. divergence from the right angle, trending in the direction of shingle travel, and then be carried out to their full length at a right angle to the shore. Such groynes, for the purpose we have named, should but little exceed the height and length corresponding to the established beach at such points; and they may well be of a temporary character, as their usefulness will terminate when they have once filled with shingle the hollows in the beach line they were designed to obviate. We think the open groynes proposed by Mr. Dowston might often be usefully placed at intermediate points, but that they would scarcely be effective in the cases we have named where stop groynes, so to term them, are needed. We feel sure that the huge concrete obstructions are a source of much mischief, and that their adoption cannot be too strongly condemned except as terminal groynes, beyond which no thought of preserving the beach is required.

LOWER THAMES VALLEY DRAINAGE, ETC.

The Local Government Board have appointed Mr. Arnold Taylor to hold an inquiry at the Vestry Hall, Richmond, Surrey, on Wednesday next, with reference to the local sewerage scheme. Application had been made to the Board by the Vestry of the Parish of Richmond and by the Sanitary Authority of the Rural Sanitary District of the Richmond Union, for sanction to borrow £100,000 for the execution of a joint scheme of sewerage for the parish of the district. The sewage of the five parishes comprising the union is to be treated by precipitation and irrigation at a site on the river side at Mortlake. Great interest has been felt in sanitary engineering circles at the action of the Richmond Union with reference to this matter, and much satisfaction is now expressed among most of the inhabitants at the prospect of a settlement. It may be remembered that out of seven schemes that of Mr. Mellis, C.E., was adopted. Some opposition is likely to be experienced from the inhabitants of the locality in which lies the proposed site of the works, but it is not anticipated that any objections will be raised by the owners of adjoining lands, amicable arrangements having been come to with the Duke of Devonshire and others. If any arrangements adverse to the scheme are laid before the Inspector, they will probably come from ratepayers in the Kew Gardens district. These urge: That the land is altogether unfit for the treatment of sewage; that the price the Vestry propose to pay for such land is more than treble its actual value; and that the close proximity of a sewerage works to a valuable residential property in the midst of a populous and growing neighbourhood will be simply disastrous. An opposition committee formed some time ago is still in existence, and may bring forward the arguments referred to. They protest, further, against the action of the Vestry in "erecting the proposed sewage works within—comparatively speaking—a few yards of the Royal Gardens at Kew." By the majority of residents in the union, however, it is hoped that the aid of the engineer may be called in as speedily as possible to secure to the district a long-needed sanitary boon.

CRITICAL CONDITION OF AN EXPRESS TRAIN.

In our note last week on the railway collision near Masbrough we omitted to mention that the train was fitted with the Westinghouse brake, and that it was owing to its automatic application that both portions were brought to a stand in safety. Another illustration of the value of this appliance occurred on the Midland Railway on the 26th of October, when the 9.15 p.m. Pullman express from Glasgow had a narrow escape of being wrecked about three miles north of Skipton. At this point the line falls on a gradient of 1 in 132, and as the train was approaching a curve of twenty chains radius after passing Gargrave station, one of the coupling rods of the engine broke, throwing the tender off the line, and fortunately at the same time dismantling the triple valve of the engine. The Westinghouse brake was in consequence instantly self-applied on the whole train, which was safely brought to a stand without further damage. In such emergencies as these the difference of a single second may mean safety or destruction, as has often been shown, and the passengers may esteem themselves fortunate that this heavy train on a steep falling gradient was safely brought to rest at the entrance to such a sharp curve. The Penistone calamity showed only too plainly what is to be anticipated when the front portion of a train is derailed under similar circumstances, and indeed the features were very much alike in both cases, viz., high speed on a steep gradient with a sharp curve ahead. Without the restraining power instantly applied to the rear of the train to prevent it overrunning the derailed portion in front, we should probably now be insisting on the only means by which such a recurrence of the Penistone disaster might have been prevented. We rejoice therefore that ours is the pleasanter task of recording how it really was prevented. The cases named, even taken alone, would justify our remarks on the Westinghouse brake last week; but as our readers will remember, they are only the temporary end of a very long list.

SWORDS FOR THE ARMY.

It is admitted that German-made swords are now being supplied to two batteries of the Royal Artillery stationed at Sheffield. One battery is under orders for India, where the climate will test the steel. Messrs. Robert Mole and Sons, sword makers, of Birmingham, write to the *Sheffield Daily Telegraph* in explanation of Solingen blades being furnished to the British Army. They state that the sword with which the troops are now being armed comprises "fixed loops for the old loose rings, and also an improvement in the mouth-piece and in the mounting of the sword," and that these are the firm's own patented inventions, "which have been adopted by the War Office in the new 1885 sword, and have not emanated from Germany." So far, good. Then Messrs. Mole add, "We are making the new pattern swords for the War Office: orders were sent also to Solingen, because it was thought desirable to replace the old ones as soon as possible, and we were unable at short notice to increase production to such an extent as to deliver them at the rate wished for, and particularly with the prospect that at the conclusion of the present contract no more of these swords will be required for probably a great length of time." But why Solingen? There are other eight reliable firms of sword-makers in Birmingham, any of whom could have made the swords. Why leave England for Germany at a time when work is scarce enough in all conscience, and when this very foreign rival is doing its utmost to cut us out of every market? Cannot the War Office know its own mind for a year at a time? Makers know that if swords are required they will be needed all at once. They get a stock of blades ready. The regiment is ordered to India. Down comes a demand for swords. Then it is ascertained that the War Office has adopted a new pattern, and the blades provided for the emergency are a dead loss. Thus the whole possible profit is lost, and as one maker cannot get a whole pile of new swords out "in no time" the Government go to Solingen for what could be easily had in England if there was something like reliance to be placed on the pattern adopted serving a little longer than the year of its adoption.

THE NAVIES OF ENGLAND AND FRANCE.

We last week gave figures showing that the English Navy is in armoured ships 20 per cent. stronger than the Navy of France. The *Journal des Debats* of Tuesday takes a very gloomy view indeed of the French Navy, and has nothing to urge against our statements, which, indeed, the writer amply endorses. "Our ironclad fleet," he says, "will be inevitably crushed by the numerical superiority, which is beyond all proportion, of the British ironclads. Whatever we may attempt, that disproportion must increase, to our disadvantage. A contest with England carried on by means of ironclads cannot inflict any material damage upon England, and will simply destroy our Navy, both as regards ships, officers, and crews." This is, in one sense, satisfactory enough; but we must be on our guard. Such statements may be written and published in France, not for French, but for English readers; and their purpose would be served if they sufficed to lull Great Britain into a sense of security which would be fraught with great danger to us. Our contemporary does not fail to point out that although France is deficient in ironclads, our commerce is always open to attack by fast cruisers.

TORPEDO EXPERIMENTS.

An important experiment has been carried out by lashing a large fish-torpedo to a spar, placing it beneath the old ironclad Resistance, and exploding it by electricity. The ship remained afloat although the bottom was much injured. The value of the experiment turns on the extent of the injury, and this cannot be fully ascertained for a day or two. We therefore reserve comment for the present.

LITERATURE.

The Naval Review of British, French, Italian, German, and Russian large Ships of War. By Sir Nathaniel Barnaby, K.C.B., late Director of Naval Construction. London: E. Marlborough and Co., 51, Old Bailey, E.C.

The present may be said to constitute a crisis in the history of our ships of war, and the same may be averred of the navies of all the great maritime Powers. The proper use of armour is becoming complicated by many considerations, and it needs no ordinary acumen to discern the direction in which the path of improvement lies. At a moment when wise counsel is so much needed, Sir Nathaniel Barnaby opportunely comes forward with a slender but highly interesting and important volume, in which he brings under review two hundred and fifty-three fighting ships appertaining to the navies of England, France, Italy, Germany, and Russia. The date, with one or two exceptions, comes down no further than August last year, that being the period when this distinguished naval architect vacated his responsible post at the Admiralty. The ships coming within the scope of the work comprehend all the sea-going fighting ships of 2000 tons displacement and upwards, possessed by or building for each Navy at the date in question. The object, we are told, has not been to compare the strengths of the navies of the several Powers, for the reason that other data would be required if that were the purpose to be accomplished. What is the real intent of the writer we have to gather from the general drift of the book. Summing up the results, we may say that the main purpose is to show the value of what is called "internal armour," as compared with "side armour." Sir Nathaniel evidently believes that a due appreciation of the advantage of applying armour otherwise than on the ship's side is a principle destined to govern the future development of the armour-clad fleets. In 1859 "armour was employed to protect the gunners." At the present date armour is used to protect the machinery and magazines, and the gunners have no protection but that of their own return fire. They have numerous gun positions, widely spaced, and rapid-firing guns. When the guns become too heavy to be worked by hand, their machinery is protected by internal armour like that of the ship. This, Sir Nathaniel states, is "the solution of the armour problem indicated by the latest practice of all the maritime Powers, including the United States of America." The reign of the ironclads is not to pass away; these warlike monsters are to exist in a new form, having their armour differently disposed from the original type, so as to permit the development of other qualities required to constitute a thoroughly efficient ship-of-war, approaching perfection as closely as can be compassed by human skill. So far is armour from being abandoned, that iron or steel plating for defensive purposes, as against guns, is being employed in the British Navy, not only in large ships, but also in vessels which are much too small to reach the displacement of 2000 tons.

Sir N. Barnaby is surprised at the assertion put forth some time back, on Admiralty authority, that the Nile and Trafalgar would be the last of the large ironclads. He can only accept the statement by supposing it to mean that a different type of ironclad will be adopted in future. It is not that we are to have smaller ships. On the contrary, he bids us look for ships "adapted to war service much larger than any yet built with such an object." The official statement, Sir Nathaniel says, "can only mean that the question of the distribution of armour will be solved in large ships, as it has already been in the smaller ones, by following the principles of the English design of 1881." The design thus referred to was one proposed by Sir N. Barnaby and by all the Admiralty constructors, including Messrs. Barnes and Morgan, as well as Mr. White, the present Director of Naval Construction. In that design side armour was entirely discarded, and something resembling the great armour-clads of the Italian Navy seems to have been contemplated. "After careful consideration," says Sir Nathaniel, "the Board postponed the abandonment of side armour." So decided has been the postponement, that we find side armour "lavishly" employed in the Nile and Trafalgar, ordered last year. What might have been done, according to the design of 1881, and what is going to be done in the two latest of the armour-clads, is shown in a comparative statement. These examples are also put in contrast with the matured views of the Italian constructors, as represented by the design for the Re Umberto. In this last instance it is stated that the figures are approximate and unauthorised. But we may expect that the approximation is sufficiently close. In each instance the hull absorbs rather more than one-third the total displacement. The steam machinery in the design of 1881 takes 15·47 per cent. of the displacement, the vertical armour and backing 11·69 per cent., and the horizontal armour 16·76 per cent. In the Nile and Trafalgar the steam machinery takes only 9·73 per cent. of the displacement, the vertical armour and backing 27·95 per cent., and the horizontal 8·71 per cent. In the Re Umberto the steam machinery takes 17 per cent. of the displacement, vertical armour and backing 15 per cent, and the horizontal 8 per cent. Steam power has rather more scope in the Italian design than in the English; but Sir N. Barnaby states that the weight taken for machinery in the design of 1881 would give power enough now to drive the ship at 19 knots. The speed proposed for the Nile and Trafalgar is 16·5 knots. In the matter of vertical armour the rejected design takes a smaller proportion of weight than the Re Umberto, but in the Trafalgar type the proportion is enormously large. In the weight of horizontal armour the Italian ship and the Trafalgar are nearly the same, but in the design of 1881 the proportion is more than double that of the Re Umberto. In the proportionate weight of armament the earlier design falls rather below the Trafalgar. It is explained that the guns proposed and estimated for in 1881 were the heaviest which had then been designed by the British Ordnance Department. These were guns of 80 tons. The Re Umberto will have guns of about 105 tons. In each case there is an auxiliary armament of 16 guns. The Trafalgar is to be armed with four 67-ton guns, and eight of 2 tons. Sir N. Barnaby pronounces the Trafalgar and her sister ship to be second-class in speed, in guns, in armour, in volume and rapidity of fire, and in respect to the height at which the guns are carried above the water. They only excel in one thing, and that is cost. There is a somewhat singular addendum to this statement in a succeeding paragraph, where we read in reference to the Nile and Trafalgar—"But while every quality, regarded separately, was second-class at the date of the design, the combination of qualities is undoubtedly powerful." We presume that no combination of second-class qualities could make a first-class ship, although we can understand that some first-class qualities might exist in a ship of inferior character.

It seems to be generally understood that the Admiralty have been unlucky in the design adopted for the two big ships now in hand; but withal there is a prevalent feeling of resignation, as if the case was past remedy, and bygones must be bygones. At all events, we shall get a couple of powerful ships. Mr. W. H. White, the present Director of Naval Construction, is described as being satisfied with the Nile and Trafalgar, "putting on one side the question of cost." But this is admitting that we ought to have something more for our money, and if this be so, the design, or the policy which it represents, cannot be of the best. If Mr. White approved the design of 1881, he must regret the decision of 1885, with which, as it happens, he had nothing to do, but which he accepts, because of all things nothing seems so objectionable just now as delay. We want ships—big ships and powerful—and the Nile and Trafalgar are powerful and big ships. So far we must be content. Yet we may as well open our eyes to the facts, and Sir N. Barnaby tells us that we are going backward instead of forward, retrograding in a direction from which we had been gradually emerging for the past ten years. He says that the two new ships represent a "reversal of policy" as to the distribution of armour. This question of "distribution" covers a good deal. Sir Nathaniel considers that the entire weight of armour in a ship is the proper subject for consideration, let the armour be disposed as it may. Of course this is true up to a certain point. A mass of armour on the sides only would not satisfy Sir N. Barnaby, any more than an equivalent weight of internal armour would comply with the views of Sir E. Reed. Sir Nathaniel says that to employ the word "armour" to signify exclusively plates bolted to the outside of the ship, would be contrary to practice, and absurd. In this way the large Italian ships would be without "armour," although they are defended by thousands of tons of the thickest plates ever made. Estimating the armour on the principles thus laid down, Sir N. Barnaby disputes the statement Lord George Hamilton was "instructed to make" in Parliament, that armour had been reduced unduly in the Admiral class. Comparing the total weight of armour with the ship's displacement, it is shown that no ships in the Navy exceed the Admiral class in their armoured protection, and that they have three times the amount given to the earliest armoured ships.

The value to be assigned to horizontal armour, existing in the shape of an under-water deck, has much to do with this question. Sir Edward Reed believes in a belt. Sir N. Barnaby believes in something else. The latter has confidence in the "protected" ship; the former adheres to the ironclad type, with armour on the sides, and has very little faith in horizontal protection. Sir Nathaniel proposes a new nomenclature for our ships-of-war, which it is not very likely Sir Edward will accept, though there is great need of some improvement in the existing classification. In the diagrams which accompany his book, and which are of great merit, Sir Nathaniel exhibits the Australia, a ship of 5000 tons displacement, as having a fair amount of armour—that is to say, armour weighing nearly one-fifth of the ship's displacement. But some little time ago ships of this class appeared in an official list in company with the Inconstant, because they had no armoured gun positions. They are now recognised as armoured cruisers, and are so designated in the Parliamentary return moved for by Lord Charles Beresford in May last, and issued at the commencement of August. But similar ships in the Russian Navy, such as the General Admiral, and Duke of Edinburgh, are classed under the curious title of "half-armoured." In the same return, ships of the Severn class are called "protected," while certain protected ships in other navies are styled "unarmoured." The French are building two large protected ships, the Cécille and the Tage, having a weight of armour equal to that which appertained to the Gloire. These appear in the Parliamentary return as being "unarmoured." It is clear that this kind of classification cannot continue to be tolerated. Sir Nathaniel would give up the word "unarmoured" as applied to ships like the Inconstant, Tourville, Leipzig, Asia, Africa, and others of the same description, and call all such vessels "unprotected." The word "protected" would then apply to all ships having any kind of iron or steel protection, taking as a minimum a one-inch deck over the machinery and magazines. But a subsidiary distinction has to be introduced, so as to distinguish between armoured and unarmoured "gun positions." Thus the Italia goes along with the Trafalgar and the Duperré, these and other of the most powerful war ships being classed as protected ships with armoured gun positions; while the Australia, Leander, the Mersey class, the Polyphemus, and a host of others appear as protected ships of the second class, having their gun positions unarmoured. The Shah, Inconstant, Mercury, and the "Gem" class are ranked as simply "unprotected." Whatever may be said of this system of classification, it is assuredly better than the maze into which we are led by the Parliamentary Return, where we read of "armoured vessels," "armoured cruisers," "protected vessels," "partially protected vessels," "unprotected vessels," "unarmoured vessels," and "half-armoured vessels." Sir Nathaniel says:—"This last term is quite new to me, and is unintelligible." There is unquestionable simplicity in grouping all the ships under the two titles "protected" and "unprotected," and dividing the former into two classes, according as the gun positions are armoured or otherwise. Concerning the terms used in the much-abused Parliamentary paper, it is only fair to recognise the fact announced within its pages, that the classification adopted is that given in the official Navy List of each country. But it must be aknowledged that our Navy List is none of the clearest in its classification; so that, on the whole, the Parliamentary return No. 153 of the present year is confessedly a most perplexing document.

We have mentioned the excellent diagrams which form part of Sir N. Barnaby's book. These are so contrived as to embody all the essential features of the ships comprehended in the plan of the work. The method adopted is singularly ingenious and explicit, and the particulars are sufficient, if put in the form of letterpress, to fill a portly volume. The materials for forming something like a fair and unbiassed opinion are thus placed at the command of every intelligent reader. Ships of the larger class in the leading European navies may be readily compared with each other, and we are shown not only what ships exist, but what were incomplete in August last year. An asterisk placed against the name reveals in how many instances the French ships constructed in former years are defective owing to the presence of timber in their structure and the absence of water-tight compartments. Among the latest of the unfinished French ships is the Sfax, a protected ship of 16-knots speed, carrying sixteen unprotected guns. The Tage and the Cécille are too recent to appear in the diagrams, although they are mentioned in the book. These protected vessels are to have a speed of 19 knots. There is every indication that the French have discovered the value of such ships, and are less disposed than formerly to expend their resources on large vessels with side armour. Without proceeding further at present with the details of Sir N. Barnaby's book, we can only say that in bringing it out at this juncture he has rendered the nation valuable service. He has an eminently able successor at the Admiralty, but there is none the less reason why an ex-Director of Naval Construction should give the public the benefit of his long experience and independent judgment, unfettered as he is now by the etiquette of office. At the same time, Sir N. Barnaby has written with perfect moderation and fairness, and without anything like the tone of a man who thinks he has a grievance, or who is seeking to overcome an opponent. The public interest is kept in view, and a valuable book is the result.

Speaking of the discovery of immense copper deposits at Sudbury, British North America, the *Colonies and India* reports that, it is said the run of the mine has been from 15 to 28 per cent. of copper. Over 50,000,000 tons are in sight. The Canadian Pacific Railway purpose building a branch line, and the proprietors intend erecting smelting furnaces. Other deposits of copper and nickel are reported in the vicinity.

United Arts Club.—Those who originally interested themselves in this club for architects, engineers, painters, and sculptors, have succeeded in bringing the matter into a practical form, and the publicity given to the proposed club has resulted in very considerable support. Suitable temporary premises have been obtained at the St. James'-place Hotel, St. James'-place, and a general meeting of members and those interested in the formation of the club will take place on Wednesday next, the 10th inst. Many engineers of eminence are taking interest in the scheme, and will be present at the first meeting, when Edward I'Anson, Esq., F.G.S., P.R.I.B.A., will preside.

TORPEDO VESSELS AND THEIR EQUIPMENTS.

No branch of war material has made greater progress of recent years than the construction of small vessels for the special use of torpedoes. The civil war in America showed what could be done with even such a crude weapon as the outrigger torpedo and the slow steamboats then in use. The blockade of the German coast by the French fleet in the last great war was to a great extent rendered inoperative by the fear of torpedo attacks, while later still the only naval loss suffered by the Turks in their struggle with Russia was due to the same cause. It was at that time—nearly ten years ago—that the first impetus was given to the construction of high-speed torpedo boats for coast defence, as their ability to act independently on the open sea was not then recognised. Russia early saw the value of this new arm, and ordered a large number of boats 75ft. long and 10ft. beam; these dimensions being in accordance with certain requirements laid down. In this country we decided upon two types, since known as first and second-class torpedo-boats. The former, about 90ft. long, were to be for harbour defence; the latter, about 65ft. long, were to be carried in our ships and utilised in war as occasion offered.

Only twenty of the larger nature were obtained, and it was some years before their equipment was complete. The reason for these two facts appears to be that as the navy is not responsible for the harbour defence of this country or our Possessions abroad, successive naval Administrations were unwilling to divert money from the sea-going fleet to what was the business of another department, and hence we fell behind in the number and equipment of our early torpedo boats. Even at the present moment it is doubtful whether anybody knows who is primarily responsible for the safety of such a place as Portsmouth in view of an anticipated attack by a hostile fleet, and with whom would rest the supreme control of the different arms comprising the defence.

But this is a digression. Meanwhile other nations were pushing on with boats about the same size, but they usually equipped them with a fixed torpedo tube in the stem, while ours were given a revolving tube. The argument in favour of the latter was that circumstances might preclude the right-ahead attack, and render necessary passing the object at high speed, when the torpedo could be discharged on the beam. The second-class boats were too small for this system, so were equipped with a frame on each side, in which the torpedo was placed. Thus charged, the frames were lowered into the water when it was desired to eject the torpedo. The practical value of either class of boats for torpedo work in war has not been tested, but they have proved very useful for other purposes.

During the recent blockade of the Greek coast some of each type were employed keeping up communication between the ships and boarding the small vessels in which most of the trade of that country is carried on. For this service their torpedo equipment was replaced by one of machine guns, and as nothing but fine weather was experienced, the crews suffered little beyond discomfort.

But there had been growing gradually a feeling that a larger type was necessary, one that could keep the sea independently, and the Batoum, built by Yarrow for Russia in 1880, was a step in this direction. She was 100ft. long, and steamed out by herself to the Black Sea in eighteen days. This craft was followed by others for different countries, some being 110ft. long, which crossed the Atlantic under sail alone. Nearly all these boats were fitted with two fixed torpedo tubes in the bow. England alone remained stationary till 1883, when the Admiralty ordered four boats 113ft. long. Their equipment consisted of two fixed torpedo tubes in the bow and a revolving tube aft, thus combining the advantages of right-ahead and beam discharge. Other slight modifications were also adopted. Two of the boats went out to the Mediterranean, and were employed in the Greek blockade last spring. They are a good type for harbour defence, and decidedly superior to the original twenty, but cannot be considered capable of keeping the sea independently. Therefore, when the pressure of public opinion caused a large vote of money to be devoted to the Navy, a number of boats larger still were ordered by the Admiralty. These are 125ft. in length, and intended to carry five torpedo tubes, one fixed in the stem, and two pairs of tubes arranged in the shape of a V, each pair revolving on a small fixed conning tower, one forward and one aft. These boats do not appear to be a success. The shape of the stem with the single tube tends to scoop up the water and deliver it on to the deck, while the weight of the four revolving tubes is too great to be carried satisfactorily. As a fact, there is invariably a disposition to overburden these small craft, causing considerable reduction of speed besides affecting their seaworthiness. Four tubes should not be exceeded, and a better arrangement would be to have them fixed one on each bow and quarter. The movable tube is a theoretical fallacy involving additional weight and complication. A further advance has been made in the boat recently constructed by Messrs. Thomson for the Russian Government; she is 148ft. long, with a beam of 17ft., and when a complete equipment of fuel, stores, &c., is carried she will have a displacement of 160 tons. Twin screws have been adopted, and thus far proved successful. There is no reason why they should not become the rule when certain dimensions are reached. The torpedo equipment is indifferent. She carries two tubes for the 19ft. torpedo in the bow, and a revolving tube for the same pattern of torpedo abaft the funnel. This arrangement is very similar to that in our four 113ft. boats. The use of the 19ft. torpedo, however, adds considerably to the weight without much corresponding advantage. It has a longer range and heavier charge of explosive, but the speed and accuracy are not greater than in the smaller patterns, while for service on the broadside its length and weight are almost prohibitory. In fitting all these boats with two tubes in the bow to discharge right ahead one serious point seems to have been overlooked. This is, that having arrived within effective torpedo range—which we will assume to be 400 yards—and discharged the contents of their bow tubes, they must, if proceeding at speed, approach considerably within that distance of the ship before they begin to recede. This must be so, even if the helm be put over immediately after the torpedo is discharged, and the act of turning necessarily reduces speed. At such a moment the boat offers a mark which skilful handling of machine guns should not fail to take advantage of and render her escape impossible. Moreover, this system necessitates the course of the boat being directed on either beam of the vessel attacked, from which position she is more likely to be discovered, and has the greatest number of guns against her. Only under the most exceptional circumstances would a torpedo be directed at the bow or stern, which so reduces the length of the target as to make a hit in the highest degree improbable. When, on the other hand, the path of the torpedo after discharge is at an angle to the keel of the boat, the latter can approach from ahead or astern of the object, and without checking speed eject her torpedo when abeam. A small movement of the helm will then enable her rapidly to increase her distance from the enemy and give her a good chance of escape. This will be especially the case at night, when attacks of this nature would usually take place; but in the former case anxiety not to discharge too soon might bring the boat almost in contact with the ship before her course could be altered.

The single revolving tube does not overcome these defects, because it must be fixed beforehand on one side or the other, and when the time comes the torpedo boat may be unable to pass on the arranged side. Altering the position of the tube from one beam to the other at such a moment is impracticable, even if mechanism to do so from the conning tower were devised. It appears therefore that, though great advance has been made in the hull and machinery of torpedo boats, their torpedo equipment shows little improvement, and the latest example is but a compromise between two imperfect systems. It is the custom now to fit all new torpedo boats with an electric search light, and in this case it has not been omitted. But the value of one estimated at 12,000 candles is extremely limited, and hardly worth the extra weight it entails. Experience has proved that only the most powerful light is of any practical use, except for signalling purposes. Owing to the concentration of the rays due to the Mangin reflector, the space illuminated is much contracted, and the distance at which objects can be discerned with its aid is greatly affected by the state of the atmosphere. Notwithstanding the notable increase of length and displacement which this so-called boat exhibits, it is doubtful if her construction can be considered to have solved the question of a torpedo vessel able to keep the sea and co-operate with a fleet under any conditions of weather, whose speed will not be reduced one-half against a light head wind and sea, and which in a strong breeze is able to discharge her submarine projectiles without difficulty. Those who have seen all existing torpedo boats know that they fail to reach this standard, and therefore we believe it necessary still further to increase the displacement, bearing in mind the great point in a torpedo vessel, that she must offer as small a mark as possible to hostile fire. The Vesuvius, of 245 tons, is an excellent type to improve on, and to do this has often been urged by torpedo officers. But our naval constructors did not see their way to combine the necessary conditions in such a displacement, and devised the Scout instead, of 1400 tons. A greater amount of misplaced material will hardly be found anywhere, and the mistake has been repeated in several others of the same class. These vessels should have been our improved sloops, with a moderate gun armament and great speed, for the protection of commerce; and if they had carried no torpedoes it would not have reduced their value for the above purpose. The French, as usual, have been before us, and built several small torpedo vessels of 330 tons, which are to have a speed of eighteen knots. We are at last following suit with the Grasshopper class of 450 tons, which will probably have an equal, if not greater, speed. They are to carry, it is true, a 4in. gun forward, which might be omitted; but there seems a disinclination to part entirely with this weapon, and the result has hitherto been a weakly-armed gun vessel with a few torpedo tubes placed where convenient. In a torpedo vessel, however, everything should be subordinated to developing and concentrating power of torpedo attack, while in a gun vessel the guns should be supreme. Each weapon has its own part to play in naval operations, and this principle should govern all designs of naval construction. It is when we consider the limited range of the locomotive torpedo that the necessity of keeping torpedo vessels as small as possible becomes apparent. This, combined with rapidity of movement, will be their protection against the heavy gun-fire they must encounter; and if a certain displacement is exceeded, full protection by armour must be afforded. In the Polyphemus we see an attempt made to carry this into effect, but her excellent conception has been spoilt by the additions considered necessary to make her more useful and habitable. They have, however, only made her a more conspicuous mark, without removing the discomfort her peculiar construction entails on the crew at sea. Another weak point is her conning tower, which might be displaced by a projectile of moderate size. As this would destroy the various communications to helm, torpedoes, engines, and detachable ballast, she would then be helpless. We cannot therefore consider adequate armour protection is afforded in her case as a substitute for that partial invisibility which more moderate cost and dimensions would give. According to these views there is no intermediate step between the torpedo vessel of 400 and 4000 tons. Great speed, facility in turning, and the absence of large guns should be common to both types. In the larger vessel the water line and torpedo tubes should be protected; but more important still, the conning tower should be capable of resisting the impact of the heaviest projectiles. A vessel of this description would, we believe prove a most formidable antagonist to any ship built or building, and have her distinct place in the squadron of the future. There is equal need for the smaller class; but until we cease the effort to combine everything in a single ship we can, it is to be feared, have little but failure to record.

THE CARDIFF WATER SUPPLY.

New waterworks at Llanishen, promoted by the Cardiff Corporation, were inaugurated on Thursday, the 28th October. The Cardiff water supply was originally obtained from the pumping station at Ely. This was established in the year 1853 by the Cardiff Waterworks Company. Sometime later, in 1860, the company, by Parliamentary powers, started the existing gravitation works in connection with the watershed at Lisvane, which has been the source of the supply of water to the borough ever since. The area of the watershed is 2200 acres, and the water is derived from several streams within that area. Owing to the geological character of the drainage area the water is hard. The Corporation acquired the works of the Waterworks Company in 1879 for the sum of £300,000, and by taking over mortgages amounting to £23,305 14s. 7d. After obtaining the necessary Act of Parliament, the whole of the works and revenues passed into their hands, and the works have since been entirely carried on by the Corporation. It being generally felt at this time that the amount of water available for the use of the town was not sufficient, the Corporation sank a number of wells at the Ely pumping station for the purpose of obtaining a better supply. The works there have cost more than £10,000, and the cost of extensions and mains, meters, and survey has been put down at £17,464 5s. 4d.

The great difficulty in the supply of water to the town has been in the want of a sufficiently large reservoir in which the water could be stored to be filtered for public use. For three years past a reservoir of more than four times the capacity of the one just referred to has been in construction from the designs of Mr. J. A. B. Williams, the engineer to the Corporation, and this was inaugurated on the 28th ult. It will hold 317 million gallons of water, the capacity of the former reservoir in this respect being only 80 millions. The new reservoir will receive all the surplus water from the gathering ground, and thus enable the Corporation to afford an efficient supply of water to Cardiff and the surrounding district, including Maindy, a portion of Llandaff, Cogan, Penarth, &c. The surface area is 60 acres, that of the former reservoir being only 20 acres. The embankment is at its highest point 44ft. above the surface of the ground, and the greatest depth of the puddle trench is 66ft. below it. The greatest depth of water will be 38ft. Besides this large reservoir, there is a service reservoir to hold 1,500,000 gallons of water, which is constructed on the high ground near the Heath, at an elevation of 125ft, above Ordnance Datum, so as to attain the greatest possible height above the general level of Cardiff. This reservoir is connected with the large one by means of pipes. To avoid the possibility of the water it will contain being polluted by any decaying vegetable matter, such as leaves from the adjoining plantations, it has been covered in. For the supply of water to Cardiff extensive filters have been constructed adjoining the covered service reservoir, and three beds have been in continuous operation since the 7th June last, while space has been reserved for four more, and an additional covered service reservoir of a similar capacity, to be constructed when the necessities of the town demand it. Between the filters and the town a line of pipes, 30in. in diameter, similar to that connecting the great reservoir and the service reservoir, has been laid down, and extended through the main streets of the town in readiness for use as soon as a sufficient quantity of water can be received into the new reservoir.

The South Wales *Daily News* says the present source of the supply of water to Cardiff is not a permanent one. A better source has been found in the Taff Vawr Valley, Breconshire, from which it is believed one of the finest and most plentiful supplies to be had in Great Britain will be obtained. The reservoirs at Llanishen will receive all the water from the existing watershed for the next three years, but when the works in connection with the Taff Vawr source—upon which more than £100,000 has already been spent—are completed, the water from Lisvane will be disused, and the water from Taff Vawr brought down to Cardiff and stored in the two reservoirs at Llanishen and Lisvane for the supply of the low level portion of Cardiff, the higher portions of the town and adjacent districts being supplied by means of high level reservoirs and filters which are now in course of construction, upon an elevation of 320ft. above Ordnance Datum, at Rhubina, near Greenhill, 4½ miles from Cardiff. The undertaking, which has been carried out under the supervision of Mr. J. A. B. Williams, M. Inst. C.E., the waterworks' engineer, has cost some £54,000 for the reservoir alone; Mr. T. A. Walker, of Westminster, has been the contractor, and for him Mr. G. Crowe has been engineer on the works.

FORCED DRAUGHT.

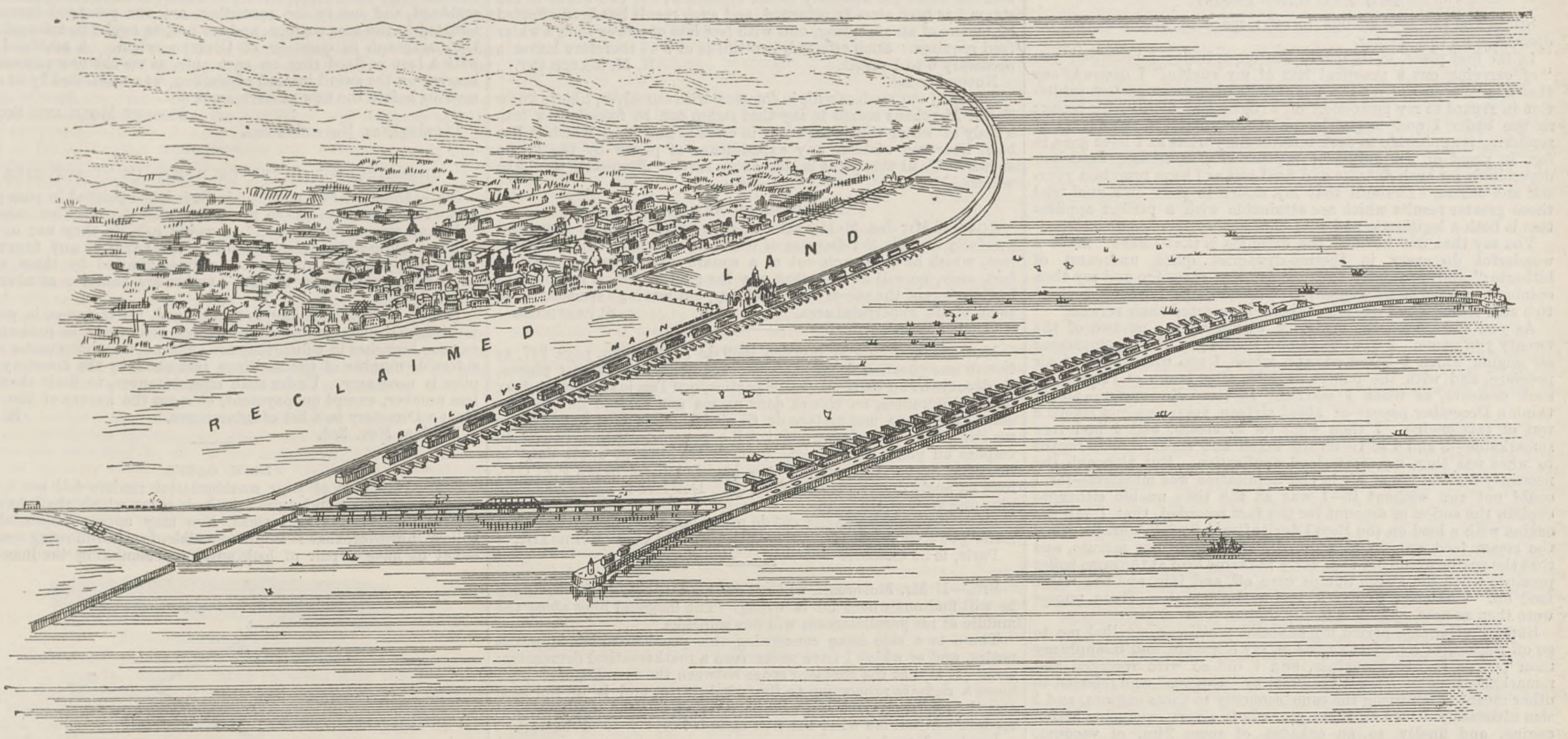
The following is an abstract of a paper on this subject read before the British Association at Birmingham by Mr. J. R. Fothergill:—

Forced draught, or mechanically supplying air above atmospheric pressure to the furnaces of steam boilers, has been the subject of many patents during the last fifty years, but it is only within the last two or three years, particularly in its application to merchant steamers, that practical success has been achieved. The writer views the "closed ashpit" system as the best for merchant steamers. After reviewing the chemical composition of average British steam coal and the oxygen required for the chemical combustion of its consumable constituents, the writer gives the quantity of air required at 62 deg. Fah. for 1 lb. of coal as follows:—For the volatilised gases, 50 cubic feet; for the fixed carbon, 90 cubic feet; or a total of 140 cubic feet, equal to 10·7 lb. In actual practice 22 lb. to 24 lb. of air are required, but with forced draught judiciously applied 16 lb. to 18 lb. prove sufficient; therefore the reduction of furnace temperature and loss of heat carried away by the use of 24 lb. of air are avoided and a saving effected in proportion. By the use of forced draught we are enabled to regulate the distribution of the air at will, and by supplying the requisite quantities to the gases and fixed carbon we readily bring about the chemical union of the oxygen with the carbon to produce carbonic acid, giving 14,500 heat units, instead of only 4400 by the formation of carbonic oxide. The writer then proceeds to show in what manner and how the air supply should take place, pointing out the defects and difficulties in the regulation and distribution of air to the furnace under the ordinary conditions of natural draught.

In September, 1884, the writer applied forced draught to the boiler of the s.s. Marmora, which steamer ran eleven consecutive voyages of sixteen days' steaming per voyage before she was wrecked, with a saving per voyage of £33 16s. 7d., equal to 43 per cent. in the cost of the bunker coals, as compared with eleven voyages prior to the alteration. Drawings in plan and section illustrating the arrangement fitted to the Marmora were shown, and a general description given of the arrangement, indicating particulars as to the air admission and distribution, water gauge pressure, grate area, and the necessity of a damper in the funnel, &c. Utilising the heat of the waste gases to increase the temperature of the air supplied to the furnace unquestionably is a distinct saving, but the writer is of the opinion the cost of fitting an arrangement for such purpose when altering a boiler to forced draught will exceed the saving gained. When new boilers are supplied the increased cost will, however, probably be only small. The application of forced draught to the Marmora proved so economical that it was decided when ordering the s.s. Stella, a steamer of 3800 tons, having triple expansion engines, to apply forced draught to the boilers, which are subject to a pressure of 143 lb. Messrs. Wyllie and Morison's patent system was applied, and the results have proved most successful. The writer believes the Marmora was the first instance in which forced draught on the "closed ash-pit" system was applied to a boiler which had been for some time in use under the ordinary conditions of natural draught.

PROPOSED HARBOUR AND PORT WORKS, BUENOS AYRES.

MR. CHURCH AND MR. JAMES CLEMINSON, M. INST. C.E., ENGINEERS.



BUENOS AYRES PORT AND HARBOUR.

The City of Buenos Ayres urgently requires some extensive port and harbour facilities, and various proposals have from time to time been made by English engineers and those of other countries. The port works question is just now very much to the front, and it seems that two separate and complete projects have been under comparative discussion. The plans of one of these were presented to the Government by Senor Madero on behalf of Messrs. Hawkshaw, Son, and Hayter. This proposes the construction of docks along the whole front of the city, and includes two entrance basins and a line of four docks, each 525ft. in width and excavated along the foreshore to a depth of 24·5ft. An entrance canal about twelve miles in length, dredged to a depth of 21ft. at ordinary low water, is also part of the scheme. It seems that Senor Madero has now a contract under which he is to construct harbour and port works, but is not to spend more than £4,000,000 in carrying out his views, and that his plans are subject to the revision of the Government engineers. A report on the plans presented by him, as above described, has been made by the Government engineers, condemning the greater part of it.

The second scheme which has been presented is the project of Mr. Church, a well-known American engineer, and Mr. James Cleminson, of Westminster. It is a much more comprehensive scheme than any preceding it, and includes a deep-water harbour as well as docks and railway facilities, great improvement of the navigation of the River Plate estuary, constant current of water through the harbour, the reclamation of a large and valuable tract of land—including the whole of the foreshore of the city and district—and the construction of lighthouses and works of defence. We give above a perspective view of the proposed works, and from these it will be gathered that they will include the formation of a narrow island, about three miles long, facing the city. This will occupy the inner edge of what is known as the "Boca Bank," and will be flanked with powerful batteries mounted with heavy guns. The island will be about 350ft. in width, and will provide a fine sea boulevard and promenade about 80ft. in width running its entire length. Projecting from the inner side of the island numerous piers will accommodate shipping, which will be perfectly sheltered from the severe south-eastern gales which sweep up the Plata. Along and near the river wall, and next to the piers, will be a line of storehouses for imports and exports. Railway tracks in front and rear of the storehouses, and on the piers, will give facilities for the economic handling of goods. At the northern end of the island will be a navy yard, with marine slips for ships of the largest tonnage that can ascend the river. Nearly parallel with the inner wall of the island, and about seven-eighths of a mile from it, will be the city wall. Between this and the present beach a large area of land will be filled in from the harbour, which is to be excavated between the city wall and the island wall. The area reclaimed will be about 1200 acres, to be laid out in boulevards and streets, and serve for the extension of the commercial part of the city. Numerous piers will be pushed out from the city wall into the harbour to serve for the already immense river traffic; and behind these piers will be the line of storehouses for the internal commerce. To the rear of the storehouses, and along the entire frontage, will run the numerous railway lines which diverge from Buenos Ayres; and, midway of the city front, a grand central station will be built, where all the railways of the country can be accommodated. The city portion of the works will be connected with the southern end of the island works by a broad bridge, carrying railway and tramway tracks, a carriage road and foot walks. It will have a double swing bridge in its centre, to connect the harbour with the deep channel which leads to the Riachuelo port works.

The northern end of the island and its works are designed so as to catch as large a body of the river as possible and throw it through the harbour. This it is proposed to excavate to a depth of 10ft. below low water on the city side, and to be gradually increased towards the island, or foreign-commerce side, until it has a depth of 21ft.; and it is expected that this will be materially helped by the scour of the deflected southern part of the Plata current. The estimate of dockage room is 19,600ft. lineal for foreign commerce, and the same for the coasting or river traffic, but this may be augmented with facility and at little cost. The area of the harbour is 1800 acres.

Messrs. Church and Cleminson have departed radically from the stereotyped notions as to the relation between ports and docks. There are at Buenos Ayres peculiar conditions which, no doubt, require special plans and a departure from the ordinary way of making a port by constructing docks. Docks at Buenos Ayres could only be approached at certain times, access would be often impossible, owing to periodical winds, and the infrequently changed water of a dock would sometimes become a nuisance. A harbour easily entered in all weathers would obviously possess very great advantages, not only as a commercial port, but as a harbour of refuge also. There are thus weighty reasons for thinking that the project of Messrs. Church and Cleminson is specially worthy of commendation, one that we have not mentioned being that it would cost the Government no more than would have to be paid for docks, because the reclaimed land would be of such high value. The plan would not suit many places, but Buenos Ayres is a seaboard city with special features as to its river and sea shores, which make a special plan necessary to secure the advantages natural to its position.

PUMPING ENGINES, AMSTERDAM.

We commence this week the publication of a series of engravings illustrating machinery now being erected at Amsterdam by Messrs. Easton and Anderson, but must reserve our description till next week. In our engravings on page 370, Figs. 1 and 2 are side elevations and end view of one pair of cylinders, with the parallel motion. Figs. 3, 4, 5, and 6 are sections and sectional plans of the same. On page 368 we illustrate one of the boilers.

LAUNCHES AND TRIAL TRIPS.

On Thursday, 28th October, the steam line fishing boat Edith, constructed by Messrs. J. McKenzie and Co., and engined by Messrs. John Cran and Co., Leith, went for trial on the Forth. The Edith has engines larger in size than those for which Messrs. Cran and Co. received the award of silver medal at the Edinburgh Exhibition, and her performance will sustain the reputation of both shipbuilders and engineers. She has been constructed to the order of Messrs. Howarth and Clark, Leith.

On the 28th ult. there was launched from the yard of the builders, Messrs. Raylton, Dixon, and Co., a steamer named the s.s. Santiago, which has been built to the order of Messrs. Thos. Wilson, Sons, and Co. for their Atlantic line, being the largest and most powerful steamer which has yet been built on the Tees. She is built in accordance with Lloyd's highest class and the Board of Trade requirements for passenger service, her dimensions being 378ft. long by 44ft. 9in. beam by 31ft. depth, and her gross tonnage will be about 4400 tons. She is built of steel, additionally strengthened for the North Atlantic trade, has cellular bottom for water ballast, two decks of steel, and is divided into compartments by twelve thwartship bulkheads as well as a longitudinal bulkhead, all fore and aft. She has long poop, with saloon and passenger accommodation placed amidships, top gallant forecastle, steam windlass, seven steam winches, and is fitted with special steam pipes to each hold for purposes of fire extinguishing, and electric light will also be supplied. She will be fitted with engines of 3500-horse power, by Messrs. Thos. Richardson and Sons, Hartlepool. On leaving the ways she was christened the Santiago by Mrs. Bishop, of Hull, who performed the ceremony of launching by cutting a small cord on a table before her on the platform.

The official trials of the new twin-screw armour-plated barbette ship, Benbow, 12, the latest vessel of the Admiral class, recently built at Blackwall by the Thames Ironworks and Shipbuilding Company, were brought to a very successful conclusion on Saturday. The boilers and machinery have been made and fitted on board by Messrs. Maudslay, Sons, and Field, of London. The trials were made under the superintendence of Captain Alexander Buller, C.B., A.D.C., the vessel being in command of Captain Crofton, of the Medway Steam Reserve. The navigation duties were performed by Staff-Commander Rapson, of her Majesty's ship Pembroke, Mr. Roffey, C.R., Chief Inspector of Machinery, and Mr. H. W. White, fleet engineer, were present on behalf of the Medway Steam Reserve; while the Admiralty Department was represented by Mr. Butler, Engineer Inspector. Mr. W. Maudling, R.N., second assistant to the Chief Engineer of Chatham Dockyard, attended on behalf of the dockyard authorities for the first trial; Mr. Bedbrook, Chief Engineer at Chatham, being present at the trial under forced draught. Mr. J. Yates, Constructor of Chatham Dockyard, who has superintended the building of the vessel, represented the Constructive Department. The engines were in charge of Mr. H. Warriner, the manager for the contractors of the machinery, who were further represented by the Hon. G. Duncan, Mr. Walter Maudslay, and Mr. Charles Sells; Mr. Mackrow, the naval architect, and Mr. Hayward, manager for the Thames Ironworks Company, were also present. The Benbow left Sheerness on Thursday for the natural draught trial, and the weather on this occasion proved favourable. The engines worked smoothly, and there were no signs of priming in the boilers. The trial was of four hours' duration, and the mean results were:—Pressure of steam at engines, 86 lb.; vacuum, starboard, 25·5in.; port, 24·8in.; revolutions of engines, starboard, 95·14, port, 96 34, mean pressure in cylinders, high pressure, starboard, 46·84 lb., port, 43·63 lb.; low pressure, starboard, 11·49 lb., port, 12·43 lb.; total indicated horse-power, 8614, being 1114-horse power over that required by the contract. The draught of the vessel was 22ft. 3in. forward and 24ft. 6in. aft. The mean speed was 16·3 knots. At the conclusion of the trial she returned to the Nore and anchored for the night. The trial under forced draught took place on Saturday, the Benbow starting from the Nore as soon as the officials and visitors were on board. Mr. Arthur B. Forwood, M.P., Secretary to the Admiralty; Mr. W. H. White, C.B., Chief Constructor of the Navy; and Mr. Joshua Field, of the contractor's firm, were present on this occasion, in addition to those already mentioned. The fans for maintaining the pressure of air in the boiler-rooms being set to their normal velocity, the steam soon rose to the required height, and the four hours' trial opened shortly before noon. It proceeded to its close without interruption or mishap of any kind, the engines working well and smoothly throughout, and the boilers giving an ample supply of steam without any tendency to priming. The mean results were as follows:—Pressure of steam at engines, 89·6 lb.; vacuum, starboard, 28·4in., port, 27·1; revolutions, starboard, 100·99, port, 102·44; indicated horse-power, starboard, 5410·68, port, 5441·94; collective indicated horse-power, 10,852 63. The speed of the vessel was 17½ knots. The results of each half-hour's trial were considered very satisfactory. At the conclusion of the four hours' trial, a short trial was made with the centrifugals stopped, and the condensers being used as jet condensers, which proved satisfactory. The Benbow returned to Sheerness on Saturday evening. As soon as the tide serves she will return to Chatham, where she will be completed and got ready for commission.

On Saturday last the Barrow Shipbuilding Company launched from its yard a steel twin-screw steamer, built by it for the Government of the Gold Coast Colony. The vessel is 135ft. in length by 23ft. in breadth by 9ft. depth of hold, with a displacement of about 340 tons. She will be fitted with a steam windlass by Messrs. Clarke, Chapman, and Co., Hastie's screw steering and all modern improvements. The vessel is well and handsomely appointed. There will be ample accommodation provided in the deckhouse for the Governor of the Colony and his staff, as well as cabins for the captain and officers of the ship. The lower deck is to be fitted for the convenience of troops and stores. The saloon and state cabins will be artistically decorated and upholstered by Messrs. Townson and Ward in a very luxuriant manner. For defensive purposes the vessel will be fitted with two 7-pounder R.M. L. guns and two Nordenfeldt guns of 1in. calibre. The ship will be propelled by compound twin-screw engines of 500 indicated horse-power capable of driving her at a speed of 11 knots an hour on trial. At the launch the Crown Agents for the Colonies and the Gold Coast Government were represented by Mr. A. L. Hemming, C.M.G. There were also present Lady Edward Cavendish, Sir James Ramsden, and Mr. John Tell, directors of the Barrow Shipbuilding Company, and Mr. Millard, the inspector for Sir E. J. Reed, under whose superintendence the vessel has been built and designed. Sir Edward was prevented from being present through illness. The christening ceremony was gracefully performed by Lady Edward Cavendish, who named the vessel the Governor Maclean. The vessel will be ready to leave for the Port of Accra by the end of this month.

On Wednesday, the 27th ult., the works connected with the new water supply of Stratford-on-Avon were formally opened in the presence of a large concourse of people, who had assembled from all parts of the town and the surrounding villages to witness the ceremony. The new works were recently illustrated and described in our pages.

The United States Navy.—The United States Navy, which at present consists of only thirty vessels, nearly all of which are of wood and are admittedly of little value, is being reinforced by eighteen new ships, a'l of either iron or steel, and all to be afloat within two years. Seven of these vessels are ironclads, three cruisers with ironclad decks, four fast cruisers built of steel, two gunboats, one a torpedo vessel, and one a cruiser armed with dynamite guns. Five of the ironclads—the Miantonomoh, the Puritan, the Terror, the Amphitrite, and the Monadnock—are monitors with double turrets, which will be employed for coast defence only. The two others, not yet laid down, will be of 6000 tons burden, with double hulls, and a speed of 16 knots ar hour. They will be fitted with torpedo apparatus, and will carry heavy guns. Of the four cruisers, the Dolphin, with a displacement of 1500 tons, is completed, and is being armed; the Atlanta—3000 tons—is now on a trial trip, and the two others, the Boston—3000 tons—and the Chicago—4500 tons—are well advanced towards completion. The cruiser armed with dynamite guns is a new invention, to which the naval department has arranged to give a trial, and should it come up to the estimate of its inventor it is expected to be the most powerful engine of maritime warfare in existence.

LETTERS TO THE EDITOR.

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

THE MARCHANT ENGINE.

SIR,—You are good enough to offer space in your columns for discussion on this matter.

In the first place, in regard to the opportunity I promised you "of carrying out a practical test of my engine," I desire to say that I have been waiting the completion of a more perfect exhibition in regard to my possession of a tight and dependable boiler; as the boiler I now use, although reconstructed to the degree of rendering it applicable to such intermediary trials as I have gone in for, in proof of the action of my process, is neither tight nor dependable for such definite and final test as I have promised yourself and others. I submit that my desire to show on a final trial those greater results which are attainable with a perfect application is both a legitimate and wise one.

You say that one horn of the dilemma is that I have "made a wonderful discovery in thermo-dynamics quite undreamt of hitherto;" and you refer to some twenty years ago and my then opinion in regard to stage pumps. The necessity for their application still exists, but I doubtless then exaggerated their service.

As you state, I was at my work within a year or two of the twenty you name. I went to you on the subject of the compressed air engine which I began on, and which I ran with 500 lb. of air pressure, and with the pumps as cold, after hours of running at such pressure, as when I started. In some ENGINEER—and I think a December paper—of about sixteen years ago you record a test of this engine. I then went on to steam, and I had very remarkable—3 and 4 to 1—results taken and certified to in regard to what was then my steam feed application. But although the necessity for the use of air in the application was manifest—for I could not run without it—I was at the time unable either to explain the action or account for the fact recorded, that I ran the engine with a load on the Royal Agricultural Society's brake, when the steam feed was on, at some 200 revolutions per minute, and that the engine would not even carry the same load at the same boiler pressure when the steam pumps were off, and idle, and the water feed on. Unknown to myself and to the operators, these pumps were then as now, cylinders to the engine.

Shortly after this period my financial position compelled me to go off the line of a perfect engine on my principle, and to apply my then pumps to other engines, and I did so with recorded and remarkable results. I was then met by "experts" who referred to other means of effecting the same economy to these engines, and I was ultimately driven on these grounds to a very expansive action engine, and finally to an exhaust of some 24in. of vacuum, where I learnt my final lesson. And what I have so finally learnt is, how to return a steam feed to the boiler with less loss of power than is required to do the work of a water feed.

I conclude that a steam feed under these circumstances will be admitted by you to be a desirable attainment, and in its proportion an advance towards that perfect caloric action which gives those advantages which I state in a practical manner at the end of this letter. The fact is that you, with other gentlemen, build up your own theory of what I am doing, and then knock down the image you have made yourself with those more correct and perfect theories which you have in a heap ready to your hand to throw at the image you have constructed for the purpose—not considering that the man who has for all these years had good experimental evidence of what there was in his work is the real "Aunt Sally" who receives the blows intended to shatter the false and imaginary image that has been so set up. I have, however, to thank you for taking your "shy" in a gentlemanly and proper spirit, and I only regret that all writers are not actuated by the same. During the many years of my work I have met other very kind and considerate gentlemen who have taken great pains to convince me why the work I was at could never be done; but I stuck to proved facts, although at that time I could not explain them. I have of course met many who were very conceited with a little knowledge, and some who were very offensive under a still smaller possession, and who have always done me what harm they could.

You will remember that I offered to call on you to explain the process by which I return a steam feed with less loss of power than that required for a water feed. I now state a few facts for your consideration. The steam is not pumped back, but it is put back by means of the air spring, which is so applied as to remain behind the charge delivered, and to give back to the pump piston on the return stroke the pressure put into it on the forward stroke. The sensible temperature of the feed is that due to steam of the pressure to which it is finally expanded in the pumps, and all the work of putting it back is first put into the air spring by the engine, and then given back by the air spring to the engine, so that there is little loss in this respect. The air spring requires to be kept alive, as the motion and heat weaken it, and this is done by a very small air pump, which circulates air through the system, the air taking the position due to its gravity. In this case, at Bow, there is one such air pump for each engine of 1¼in. diameter and 3in. stroke.

Before I grew to comprehend the air action, my valves were frequently so placed that I continually lost the air spring, with the results following such loss which gradually taught me my lesson. Consequently, until I comprehended this action I was simply blundering towards its attainment. There are several facts which are not generally considered. Steam leaves its water on account of its inferior gravity; were it heavier it would, of course, lie at the bottom. Power a little in excess of its pressure will replace the steam in its water. It is none the less steam for being pushed back by a power greater than its difference of gravity, for without any further application of heat it will leave its water again when the additional load is removed, and what is obtained by putting the steam back is a more or less elastic water, of which the steam portion is ready to separate itself on the first opportunity. Steam can only be converted into a real liquid by the extraction of the latent heat which made it out of water; that which will expand into steam again by the mere removal of pressure cannot be an actual liquid, for the liquid would require further heat to vaporise it.

There are many things of daily occurrence which will lead to a clearer comprehension of a difference between steam when in the actual presence of water of its own temperature, and of steam when separated from such connection.

Steam separated from its water is lighter than air and floats in it; but in any boiler where you have steam and water with air, the first thing that comes off when the safety valve is lifted is the air in the boiler, showing that in such condition the air is at the top, as being in that case the lightest.

There are, of course, many reasons why steam as a vapour cannot be pumped. But I have met engineers who have had experience in what I call the churning process of any attempt to pump steam where you have water of its temperature in the pump. You simply play with it, and get no forward action, and the steam is pushed into its water by a little over its pressure on the forward stroke and comes out of it on the back stroke. It is to such condition of steam pushed into water that I apply my air spring, and an elastic charge containing 2 lb. of steam for every 1 lb. of water is forced through the forward valve by it.

I think in the foregoing you will find a different image from the one you set up to "shy at," and this is part of the image I am prepared to stand by. I now call your attention in a practical manner to what the effect of returning two-thirds of the steam as feed to the boiler necessarily means. Take 10 lb. of water as the best ordinary practice evaporation from 1 lb. of coal; take 2 lb. of coal as the best ordinary practice consumption per horse-power per hour. From the above we get 20 lb. of steam consumption per 1-horse power per hour; and 20 lb. of steam at 100 lb. pressure contain 24,230 units of heat, which, multiplied by "Joule's equivalent" of 772 foot-pounds per heat unit, and divided by the 33,000 × 60', which is assumed as the horse-power unit, gives us 9·44 horse-power; or, approximately, that 10-horse power, which is frequently spoken of as the result that would replace our existing 1-horse power, could perfect caloric action be accomplished. The return of all the latent heat cannot be accomplished, because water is a necessity to the operation; but two-thirds of the steam has been already returned, and such result has been effected by means of an air spring, and with less loss of power than a water feed requires. Such effected, two-thirds of 9·44 therefore leaves a necessary 6 to 1 result.

R. M. MARCHANT.

November 1st.

[Many of our readers will, in common with ourselves, like to know if Mr. Marchant means to say that steam can be forced back into a body of water with which it is in contact and from which it has been liberated without any expenditure of power by the steam engine. Until this point is cleared up further discussion would be useless.—ED. E.]

SUPERFICIAL AREAS.

SIR,—If Mr. Jas. McDonald will take the trouble to draw out carefully to scale the diagram of the rectangle containing 65 square feet, which he constructs out of a square containing 64 superficial feet only, he will find in what way the gain of 1ft. is made—viz., by the edges of the pieces not coinciding, but leaving a space between them of 1ft. superficial area.

SUPERFICIES.

October 29th.

MONSIEUR,—Dans le numéro 1609 de l'ENGINEER, page 347, se trouve une question de géométrie concernant les surfaces planes. En découpant un carré en quatre parties, que l'on juxtapose de deux façons différentes, on trouve dans un cas une surface de 64 pieds, dans l'autre cas une surface de 65 pieds. Mais dans le deuxème cas l'angle du triangle au point A F a pour tangente $\frac{3}{8}$, l'angle du trapèze au point F C est égal à un droit, plus un angle dont la tangente est $\frac{2}{5}$. Or $\frac{3}{8} = \frac{15}{40}$ et $\frac{2}{5} = \frac{16}{40}$. Les deux lignes F F, C C, font un angle dont la tangente est $\frac{1}{40}$. Dès lors la figure ne forme plus une surface continue.

Dans le second les angles ont de même pour tangentes respectivement $\frac{1}{3}$ et $\frac{2}{5}$ ou $\frac{5}{15}$ et $\frac{6}{15}$.

O. BURCKHARDT.

Paris, le 30 Octobre.

SIR,—If Mr. McDonald will cut out his cardboard with accuracy he will find out where he is wrong. The diagonal lines along the middle of his parallelogram will not coincide.

There is a side issue concerning this problem which is worth notice, and of which I have never seen a mathematical demonstration. It is that the enclosed space between the two diagonal lines bears a definite proportion to the whole area, and is in the case stated apparently just 1ft. Perhaps some of your mathematical readers will tell me what the true ratio is?

FIREMAN.

London Nov. 1st.

SIR,—If Mr. Jas. McDonald, the writer of the letter under the above heading in this week's number of THE ENGINEER, will take the trouble to cut a square—accurately—as he suggests, and place the sections in the form of a rectangle, he will find that the lines $b\,f$, $f\,d$, $b\,g$, and $g\,d$, will not fall in a straight line, but will enclose a quadrilateral space, $b\,f\,d\,g$, equal in area to the square supposed to be gained. For, draw $f\,k$ parallel to $a\,e\,d$. Now if $b\,f\,d$ be in a straight line $\frac{b\,k}{k\,f} = \frac{f\,e}{e\,d}$, or $\frac{2}{5} = \frac{3}{8}$, but $\frac{2}{5} = \frac{3}{7\frac{1}{2}}$. Therefore $b\,f\,d$ is not a straight line, but $b\,f$ produced will cut $a\,e\,d$ at m. Similarly $d\,g$ produced will cut $c\,h\,b$ at n. Now the area of $b\,m\,d\,n$ = 6in.

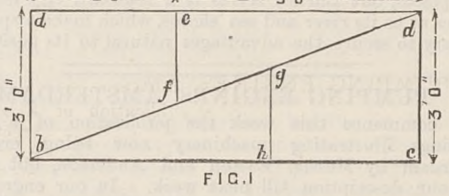


FIG. 1

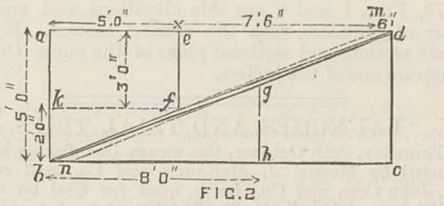


FIG. 2

× 5ft. = 2½ square feet, and the area of the two triangles $b\,g\,n$ and $d\,f\,m$ = 6in. × 3ft. = 1½ square feet. Therefore the area of $b\,f\,d\,g = 2\frac{1}{2} - 1\frac{1}{2} = 1$ square foot.

The error in the second problem is still more obvious, for as the triangles $b\ a\ d$ and $f\ e\ d$ are similar, $\frac{b\,a}{a\,d} = \frac{f\,e}{e\,d}$ or $\frac{3}{8} = \frac{f\,e}{5}$ therefore $f\,e = \frac{15}{8} = 1\frac{7}{15}$ ft. and not 2ft. Therefore the sections will not form a square, as Mr. Jas. McDonald seems to take for granted.

J. W. DIXON.

Engineer's Department, South-Western Railway.
November 1st.

[We have received an enormous number of letters on this subject, one and all to the same effect as the above. It is therefore at once unnecessary and impossible to publish more than we do. The question seems to have excited interest over a great variety of readers. We have received letters from a general officer, and a stoker, a clergyman, and a miller. Mathematicians, undergraduates, physicians, sailors, and engineers have written letters, some short, some long, but all to the same purpose. A more curious problem than that of Mr. MacDonald would be involved in explaining why his letter has excited so much interest.—ED. ENGINEER.]

THE PROBLEM OF FLIGHT.

SIR,—Referring to Mr. Lancaster's letters on the problem of flight, published in THE ENGINEER, I offer the following as a small contribution to the discussion of the subject:—

On asking one's self what are the forces continuously in operation in the act of soaring, the first force which occurs to one's mind is, of course, that of gravity; whilst the second is that of the bird's own momentum in the line of its flight. The result of these two forces will be an oblique pressure. Then follow the action and reaction of the bird's wings and the air, counter-balancing the force of gravity, and maintaining the bird's momentum, to which Mr. Lancaster has given so much attention.

Mr. Lancaster appears to perceive that there must be an oblique pressure resulting from a combination of something or other with the force of gravity. Yet, though he says that motion of the bird, relative to the air, is necessary in the act of soaring, he seems to omit its accompanying momentum from his reckoning, attributing the modification of the force of gravity to the tilting of the plane of the wings. In the order of thought, the oblique pressure must be in existence before the plane of the wings can be adjusted to it.

November 2nd.

A. CHESS.

SOLINGEN SWORDS FOR BRITISH SOLDIERS.

SIR,—As a paragraph under the above heading in your issue of the 29th is calculated to give the public an impression that English-made cavalry swords are being entirely superseded by Solingen swords, will you allow us to say that the issue of new swords referred to is doubtless the substitution of the new 1885 pattern for the previous one, which was very light, but for which we were not responsible, and which it has been decided to replace. In order to expedite this replacement, it has been thought necessary to obtain some assistance from Solingen; but we are making the new sword largely for the War-office, and the substitution of fixed loops for the old noisy loose rings, an improvement in the mouthpiece of the scabbard, and one in the mounting, are our patented inventions adopted in the new pattern, and were not, as might be inferred from the paragraph in question, of German origin. A scabbard also, with a loop or fixed ring on each side, as on the new pattern, for bracing up the sword instead of trailing, was submitted by us many months before the new pattern came out.

ROBERT MOLE AND SONS.

Birmingham, November 3rd.

CHARGING FOR ENTRY OF NAMES IN DIRECTORIES.

SIR,—Messrs. Kelly and Co., in their letter printed in your paper last week, appear to me to misunderstand the question raised by "Manufacturer, Colchester." I would ask, do they not in their Trades' Directories refuse to insert the name of any firm under more than a certain number of headings limited by them, unless the insertions in excess of that number are paid for as advertisements?

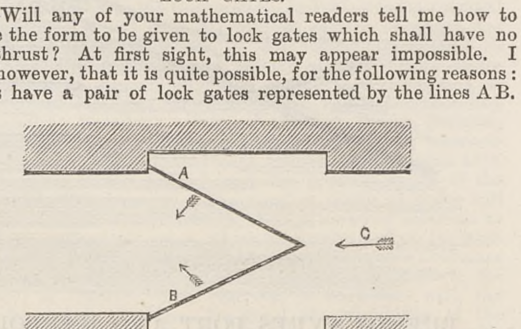
It may happen to many firms engaged, for instance, in general mechanical engineering manufactures, that fully to indicate the various branches in which they are engaged, insertions under a considerable number of the headings furnished by the directory compiler is necessary. Under such circumstances, to limit them to a less number, except on payment, changes the nature of the work from a Directory to a list of advertisers.

B. T.

London, Nov. 3rd.

LOCK GATES.

SIR,—Will any of your mathematical readers tell me how to calculate the form to be given to lock gates which shall have no lateral thrust? At first sight, this may appear impossible. I believe, however, that it is quite possible, for the following reasons:—Let us have a pair of lock gates represented by the lines A B.



Now, the pressure of the water will be at right angles to the faces of their gates, and so will tend to drive them bodily in—to collapse them, in fact, as shown by the little arrows. There will also be, as I understand the matter, a component in the direction of the large arrow C. This will obviously tend to cause the gates to spread at the hinges; that is to say, to produce lateral thrust. Is it or is it not possible so to proportion the angles of the gates that the pressure at right angles to them shall balance the thrust produced by the down-stream pressure, in which case there would be no thrust?

FLUVIUS.

Cheltenham, November 1st.

THE FRICTION OF HYDRAULIC RAMS.

SIR,—In reference to the above subject, it may be interesting to Mr. Robinson and others of your readers to know that from a series of experiments upon the friction of ram leathers, carried out some time ago by Mr. Hicks, of Bolton, the following formulæ may be deduced:—

Let P = pressure of water under ram in lbs. per sq. in.
D = diameter of ram in inches.
F = total friction of ram leathers in lbs.

Then

$$(1)\ \ldots\ D \times \frac{P}{32} = F$$

$$(2)\ \ldots\ F \times \frac{32}{D} = P$$

Taking Mr. Robinson's figures as a basis, *i.e.*, 5 lb. per sq. in. due to friction of ram, the rams being 7in. diameter; then we have area of 7in. = 38·48 sq. in. × 5 lb. per sq. in. = 192·42 lb. total friction of leathers.

By formulæ (2)

$$192{\cdot}42 \times \frac{32}{7} = 879{\cdot}6 \text{ pressure per sq. in. of water under rams.}$$

And

$$879{\cdot}6 \text{ lb. per sq. in.} \times 39{\cdot}48 \text{ sq. in.} = 33{,}865{\cdot}9 \text{ lb.} - 192{\cdot}42 = 15 \text{ tons nearly}$$

total thrust on each ram, and this × 6, the number of rams = 90 tons, total weight of engine.

This weight is, of course, excessive; and a considerable allowance must be made for the newness of rams and leathers, which would make the friction much greater than under ordinary working conditions; and therefore in a calculation such as the above would make the pressure per square inch under the rams appear much greater that it really was. Moreover, it is not at all likely that the weight on the leading wheels would be equal to that upon the drivers.

JNO. F. ELSWORTH.

21, Woodsley-road, Leeds, Nov. 1st.

MASONRY ARCHES.

SIR,—I would suggest to "F. E. R." his referring to the ninth edition "Enc. Brit.," art. "Bridges," sec. 45; also to Robison's "System of Mech. Phil," vol. i., p. 635 *et seq.* Possibly it may lead him to change his opinion.

A. S. H.

Oct 25th.

EXHIBITION AT SALTAIRE IN 1887.—We have received a prospectus of the International Exhibition, postponed from this year, which is to be opened next May at Saltaire, in aid of the building fund of the new Schools of Art and Science now being built by the Governors of the Salt Schools at a cost of over £12,000. It is intended that the exhibition shall be on a scale not hitherto attempted in Yorkshire. It will contain a fine collection of paintings and art productions. Many industrial processes will be shown in operation, the whole exhibition will be lighted by electricity, the refreshment department will receive special care and be arranged to suit all purses, amusements in the buildings and in the grounds will be constantly provided, and the musical arrangements will be in competent hands.

KING'S COLLEGE ENGINEERING SOCIETY.—At a general meeting, held on Tuesday, October 26th, the President in the chair, Mr. V. J. Bouton, A.K.C., read a paper on "Safety Valves." The paper began by enumerating the essential conditions to be fulfilled by all safety valves; it then gave rules for finding the area of a valve; it next described the failures and causes of accident. The different shapes of safety valves were next noticed, and Nasmyth's and Fenton's spherical valves and Giles' differential valves described. The advantages of a spring over weights, and of a compression over a tension spring, were then shown, and the United States Navy supervising inspectors' lever safety valve, Salter's spring balance, Ramsbottom's and Webb's duplex valves, and Richardson's, Ashcroft's, Lunkenheimer's, and Crosby's direct spring safety valves were described.

AMERICAN NOTES.

(*From our own Correspondent,*)

NEW YORK, October 23rd.

FINANCIAL circles are interested over reports of extensive railway schemes in the West and South. Contracts have been placed in English mills for rails to lay 650 miles of road in Texas, and negotiations are understood to be pending for the purchase of rails to lay about 300 miles in other sections of the country within easy reach. The lowest price known is 38 dols. These deliveries are a little beyond the reach of Pennsylvania mills. Railway requirements in the interior, and in the Far West, will certainly tax the rail producing capacity of American mills; and if indications are not at fault, English manufacturers will have some very heavy orders at their command between now and the holidays. It is no use to predict, as the probabilities are sufficiently strong to justify the statement that orders for steel rails and steel rail blooms will be placed for large quantities within the next six weeks. The rail mills are taking orders now, for spring delivery, at 34 dols. to 35 dols. Within the past week railway companies have decided upon additions to their existing systems of not less than 1200 miles. They have the cash for materials and appliances, and the work will be done at an early day. The rolling mills throughout the country are well laden with orders, and buyers who desire early deliveries are glad to pay the advanced prices insisted upon, which are 19 dols. 50c. for No. 1 foundry iron, 17 dols. for special gray forge, 1 dol. 90c. for refined bar iron, and 2 dols. 25c. for good tank iron. There is an urgent demand for all kinds of iron and steel material.

Large bridge orders will be placed within a few weeks. Engineering enterprises are springing up which will demand large supplies. Prices are very firm in all of the industries. A great deal of capital has been voted by syndicates in the North for investment in Virginia, Georgia, and Alabama. Labour agitations are not likely to assume more serious dimensions than at present. A lock-out of 70,000 textile workers in 100 mills in Philadelphia has been agreed upon, to take place on November 3rd, unless the workers in one of the mills will return to work.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

OF the reduced output of the Silesian furnaces, now amounting to 7000 t. weekly, 4000 are being exported over the border to Russia, and the remainder is going into consumption, as the mills and forges are still pretty well supplied with orders, so the pig iron market shows a little movement: but still prices are not yet affected, and stand at 43 for forge, and 50 M p.t. for foundry qualities. An attempt will, however, be made to put them up a trifle next month. Some works are endeavouring to lower their cost of production by manufacturing Puzzolano cement out of their slag. Arrangements have been made with regard to railway rates, which are intended to facilitate Silesian coal reaching Italy for railway consumption, where up to the present England has virtually had the monopoly. The situation of the Rhenish-Westphalian market has remained unchanged this week. The demand has in general been brisk, and although prices of all sorts of iron have not advanced they are more stable. Buyers of pig iron are coming forward more boldly, as if they feared prices were about to rise. The rolling mills are still busy, but as yet prices remain as low as ever. The thin sheet mills are exceptionally well employed, and it is thought an advanced price for them might be ventured, and M. 3 p.t. is spoken of. The foreign competition, English and Belgian, has brought down the price of German rails as much as M. 30 p.t. within the year. A sprinkling of orders for locomotives, tenders, wheels, and axles, springs and light railway material, as well as coaches and wagons, is being given out by the State railways; but where the orders are split up and divided eventually amongst so many hungry competitors, it does not leave anything which is much felt at any one work when successful in carrying off an order. The constructive works are still much in want of orders, and only specialists can boast of satisfactory employment.

In Belgium, to the surprise of the public interested in the matter, the shareholders of the John Cockerill Co. have accepted the resignation of Baron Sadoine, and M. Preudehomme has been appointed general director in his stead. Sadoine was a man of inventive faculties, and will be a loss to the company. There is a talk of restricting output 25 per cent., and in France 10 per cent. In the former country prices are, nevertheless, maintained—bars 100 to 105, special sorts 122·50, plates 125 to 165, thin sheets 185 to 205f. p.t. In the latter country prices are not all over quite so firm as they were, and girders are weaker at 130·50f. p.t. Through greater freight facilities, French coals are now successfully competing in the East Departments against Belgian and German coal.

The coal trade in Westphalia particularly is in a deplorable condition. There is nothing like sale enough for the quantity persistently brought to bank, but to reduce this is to increase general and other expenses. Wages are at the lowest point, so no relief is to be obtained in that direction, and the best selling price is frequently below the cost of getting. A meeting is convened for next month, to consider whether and how production is to be restricted, but, in the meantime, there is a clamour in all industrial circles for still lower railway freights to the north and east, for it now causes more heart-burnings than ever that England sends such large quantities to those regions, which it is considered should come from Westphalia. But the freights have been successively lowered with that very object, and to bring them down lower still would probably mean a loss to the railway, so it is not easy to see that this can take place, unless the loss is to be made up by the State, or, in other words, by the general taxpayer. An ironworks has just been able to contract for the next six months for 400 tons of furnace coal daily at M. 4.30, delivered, which is below the price of getting. Another work has contracted for 40 tons of coking coal daily at M. 1.80 p.t.! No wonder, then, when boards of directors are frequently calling meetings of shareholders to authorise mortgages on the mines and plant.

In the iron business the situation does not seem much better, judging from the yearly report just laid before the shareholders, where a work producing coal, pig-iron, steel ingots, rails, iron, and constructive work, to the amount of 1½ millions sterling per annum, can only offer ⅓ per cent. dividend to the shareholders, and numbers of companies are paying from ½ to 2½ or 3 per cent., and others nothing at all; the Bochum Iron and Steel Company being an exception, which has just declared 6⅔ per cent. dividend.

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

(*From our own Correspondent.*)

AT markets in Wolverhampton yesterday, and in Birmingham to-day—Thursday—ironmasters reported that the improvement was maintained. The opinions which found expression in some quarters two or three weeks ago, that the improvement was beginning at the wrong end, namely, in pigs rather than in finished iron, are becoming slightly more modified as information is obtained of the activity which is just now showing itself among some of the chief local consumers. Certain of these who may be classed as the heavy hardware manufacturers are busier than they have of late been, and the works and factories are now found starting the week on Mondays and Tuesdays.

In none of the lighter industries is improvement more marked than in wrought-iron tubes. Orders have recently been arriving of a very satisfactory character. Some of the largest concerns in the Wednesbury, Walsall, and other localities, have secured contracts which will ensure full work into next year, and which necessitate the machinery being kept running at present until eight and nine o'clock at night.

Very valuable contracts have just been placed for iron telegraph posts for India. In one case the posts are to be of rivetted ironwork galvanised, and, in another instance, welded posts are ordered. Delivery is urgent, and an increased number of hands will have to be employed to get out the work.

In the sheet trade makers' books are better filled than they have been for a long time, and numerous firms can see their way well into the first quarter of 1887. Galvanisers and merchants continue the best customers. Makers are as firm in price this week as before. Specifications are irregularly distributed, but some firms are this week pressed for deliveries by telegraph; 24 gauge are £6 5s. to £6 10s., and 27-gauge, £7 to £7 10s.

Galvanisers are strong, and in actual business are realising advances of from 5s. to 10s., compared with prices prevailing before quarterly meetings. £10 2s. 6d. to £10 5s. is now being realised for 24 gauge, ordinary brands, f.o.b. Mersey, packed in bundles, and £10 12s. 6d. to £10 15s. in skeleton cases. One or two makers of first repute in the trade state that they are getting an advance of 15s.

Manufacturers of the cheaper qualities of bars, and hoops, and other classes of merchant iron, have received an accession of orders, and hoping that before the end of the present month a further improvement will manifest itself, they are declining to enter into contracts for far forward deliveries on the present low basis. The makers of marked bars, although perhaps busier than they were, have not felt the benefit of the improvement to any material extent. Some of the common bar firms have orders upon the books which will occupy the greater part of the current quarter. Marked bars keep at £7 to £7 12s. 6d., the rate fixed in May last, and second brand qualities £6.

Merchant bars are £5 to £5 10s., and common bars £4 15s. as a minimum, which is an advance of 2s. 6d. per ton. Common hoops are £5 10s., and superior sorts £6. Tube strip is in much larger demand than a month or six weeks ago, and makers are booking some good orders. Prices are stronger by 2s. 6d. per ton, making the quotation for narrow sorts £4 17s. 6d. to £5.

The rapid advance of 10s. to 20s. per ton in the prices of Scotch steel plates has occasioned much satisfaction in this district, where the ironmasters have long been experiencing severe competition from the steel firms, particularly in boiler qualities. This week the advance of 5s. per ton in steel tin bars, blooms, and billets determined upon by the Tin Bar Association at the quarterly meetings comes into actual operation. Contracts, it is understood, cannot now be placed except at the advanced quotations of £4 10s. for Bessemer tin bars at works in Wales, £4 for blooms 3in. by 7in., and £4 2s. 6d. for billets 2½in. square. Sheffield steel firms are refusing to keep their contract books open for Staffordshire customers at old prices, and this month advances are expected to be declared by some of the Sheffield steel firms.

Pig iron smelters have had of late a somewhat greater influx of orders, and quotations maintain their upward tendency. Best all-mine hot blast pigs are priced at about £2 15s.; medium pigs are purchasable at 40s. to 41s. 6d.; and common pigs at something less than 29s. to 30s. Should present prospects of better trade continue, several furnaces which have been standing idle for some time past will be blown in. Already Messrs. A. Hickman and Son have blown in one additional furnace.

Imported pigs keep very strong, though the business doing this week is not large. Consumers have, however, lately bought well, and, as is rightly remarked upon 'Change, "They cannot always be buying." Hematites are firmer than any other descriptions, some heavy sales having of late been entered into at the furnaces with the steelmakers, who are reported to be anxious to buy forward. Lancashire brands are quoted 55s. to 56s. per ton delivered here. Makers of certain Welsh brands are not desirous of quoting at all just now, being confident that values will further rise, and delay will be to their advantage.

Lincolnshire pigs have risen fully 3s. 6d. per ton on this market since the revival set in, the 37s. 6d. of a few weeks ago being now 41s. delivered here. Derbyshire and Northampton pigs have advanced nearly 3s., the 34s. and 35s. of some little while back having advanced to 37s. delivered. Numerous Midland furnace owners have sold all the iron they can make during the next three months; some have contracts for their output to the end of March; and offers to take deliveries up to June are received.

The sheet millmen at the Gospel Oak Works having agreed to a reduction of 10 per cent. in wages, the rest of the operatives condemned the action as a fatal blow at the authority of the Wages Board. The men have accordingly agreed to conform to the wishes of the general body of the operatives, and to demand a revocation of the reduction on condition that they are supported by the trade.

The magnificent new pumping engine at Bradley of the South Staffordshire Mines Drainage Commissioners, which is pumping the Bilston pound, was put to stand the whole of last week through the injury of two of the four boilers from a singular cause. Owing to internal heating or to the heat radiated from the boilers, the colliery mounds beneath them became red-hot and burst into flame, injuring the two boilers to an extent which made stoppage necessary. Repairs were rapidly proceeded with, and the engine has now been restarted with the two boilers which were intact. The pump is at work only four strokes a minute, and cannot be put to its full capacity of six strokes until the repairs are completed. These are expected to take some time, as, besides the repairs to the boilers, a new foundation of concrete is being laid down to replace the one which was destroyed by the fire. The whole of the works will then be laid upon firm and solid foundations, and no further outbreak of fire will be feared. The effect of the accident will be to delay the drainage of Bilston pound.

Bridge builders are mostly well engaged on iron and steel structures for India, Australia, and other export markets. This branch of the engineering industries is keeping up better than several others. Competition for the contracts which come into the open market is severe, but this district is fairly successful in the race for orders. The leading constructive engineering concerns hereabouts have all tendered for the steel bridge of 210ft. span required by the Secretary of State for India, and the result of the competition is awaited with much interest. The weight of steel work is somewhere about 240 tons.

Engineering concerns engaged in the production of railway wheels and axles, and other railway material, are not so briskly engaged as they could wish, and in some of the departments the mechanics continue in only partial employment. Indian railway contracts have not of late been up to the average, and it is not regarded as satisfactory that the New South Wales Government should have lately gone to Krupp, of Prussia, for a large supply of railway material, instead of coming to this country. The Southern States of America are proving good buyers just now, and certain of the South Staffordshire engineering concerns are doing a good volume of business with Japan.

The committee appointed by the horse-nail makers of Dudley, Old Hill, and Halesowen, have received a letter from Messrs. J. G. Walker and Son, agreeing to give the second advance of 3d. per thousand for all nails taken from their warehouse from the 13th inst., subject to other firms agreeing to do the same. In the event of negotiations with a view to this end being unsuccessful, the men have determined to "turn out" on Saturday week.

The chain-makers of Cradley Heath are persistent in their policy of antagonism to the masters. They have now entered on the thirteenth week of the strike, and by the action which they now propose to adopt, they are likely to dispel all chance of the dispute being settled. Believing that the masters have withdrawn their sympathy with the cause, they have determined to call out all operatives who have resumed work at the advanced rates.

The Birmingham Industrial Exhibition, which has been open for nine weeks, was formally closed on Saturday. Its complete success may be gathered from the attendance, a total since the opening of upwards of 350,000 persons, being a daily average of 6,250. The receipts have been no less than £11,000, and after disbursing the working expenses of the exhibition, a gross profit of £5500 remains. With a part of this sum the whole of the expenses incurred in connection with the reception of the British Association will be paid.

Various proposals are talked of for the balance; the view which finds most favour is that the money should be used for the purposes of an industrial museum in the town, as an object in accordance with the exhibition itself, and as an institution likely to be of great advantage to the working classes.

At Messrs. Kynoch's ammunition works at Witton, near Birmingham, on Tuesday, a fatal explosion took place. A shed in the "danger" field used for the preparation of fulminate of mercury was blown up, and one of the workmen was killed. The operations upon which the deceased had just entered are of such peculiar nicety, and in them the slightest friction is susceptible of so dangerous a result, that no one cause can be specifically assigned as the origin of the fatality.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—There is a decided quieting down in the iron trade of this district, and if anything prices are rather easier, although there is no material quotable change in the current market rates. Whether this is really a breaking up of the animation which has recently characterised the market remains to be seen, but for the present there is an unquestionable check.

At the Manchester iron market on Tuesday there was only a slow business doing. For pig iron the inquiry was but very limited, and although makers generally were holding on to late rates, there were sellers in the market prepared to take a little under the full quoted prices. For Lincolnshire pig iron prices remain at about 37s. to 38s., less 2½ per cent., for forge and foundry qualities, delivered equal to Manchester, and for district brands about 36s. 6d. for forge and 38s. for foundry, Lincolnshire, and 39s. 6d. to 40s. 6d. for Derbyshire, less 2½ per cent. In outside brands there is little giving way, and both Scotch and Middlesbrough iron can be bought at under the prices for which sellers were holding out last week.

Hematites are not in quite so much demand, and prices are, if anything, a shade lower, No. 3 foundry not averaging more than about 53s. 6d., less 2½ per cent., delivered into the Manchester district.

For manufactured iron there is a fair demand, and prices are steady on the basis of £5 per ton for bars delivered into the Manchester district.

The condition of the engineering trade remains unchanged, the new work coming forward generally being only small, and both engineers and machinists are, as a rule, only indifferently employed.

In the coal trade, business for the time of year continues very dull, and prices still show no material upward movement on the summer rates. For house fire coals there is a moderate demand, and in the Manchester district the leading colliery proprietors have put up their delivered rates 10d. and their wharf prices about 5d. per ton; but so far as pit prices are concerned, no alteration has been made, and in other districts there has been no further advance beyond the 3d. to 6d. per ton which was put upon house fire coals at the commencement of last month. At the pit mouth house fire coals average about 8s. 6d. to 9s. per ton for the best qualities, and 7s. to 7s. 6d. for second qualities. Other descriptions of fuel for iron making and steam purposes still meet with only a very slow sale, and for these prices at the pit mouth remain at about 5s. to 5s. 6d. for steam and forge coals, 4s. 3d. to 4s. 9d. for burgy, 3s. 6d. to 4s. for best slack, and 2s. 6d. to 3s. per ton for common sorts.

For shipment there is a moderate business doing, and prices are steady at about 7s. per ton for good qualities of steam coal delivered at the high level, Liverpool, or the Garston Docks.

The annual meeting of the South Lancashire and Cheshire Coalowners' Association was held on Tuesday at the Queen's Hotel, Manchester, and Mr. H. Bolton, of the Rosendale and Baxendale Collieries, was elected president for the ensuing year.

Mr. F. Wiswall, the engineer of the Bridgewater Navigation Company, Manchester, has been appointed resident engineer for the portion of the Aire and Calder Navigation extending eastward of and including Pollington Lock, on the Goole Canal, and also of the Ouse improvement works; and last week he was entertained at dinner by the representatives of the Bridgewater Navigation Company. The dinner took place at the Clarence Hotel, Mr. W. H. Collier, assistant traffic manager of the company, occupying the chair, in the unavoidable absence of Mr. H. Collier, the general manager, and there was a numerous attendance, including not only the representatives of the Bridgewater Navigation Company, but also of gentlemen connected with some of the leading engineering establishments in the district. The chairman, in proposing the health of Mr. Wiswall, referred to his long connection with the company, and spoke very highly of the work he had done, not only in improving the navigation, but in putting a stop to the floods from the overflow of the river which had previously been of periodical occurrence; and I may add the board of directors of the Bridgewater Navigation Company, desiring not to lose altogether the services of Mr. Wiswall, have decided to retain him for the present as their consulting engineer.

Barrow.—The week's business in hematite qualities of pig iron has been very satisfactory, both as to extent and the increased value which is now realisable. Prices have touched as high as 46s. per ton for No. 1 Bessemer iron net at works, prompt delivery, and 45s. to 45s. 6d. is the quotation for mixed parcels of Bessemer iron of equal portions of No. 1, 2, and 3, in which way most of this class of iron is now-a-days sold. No. 3 forge and foundry iron is quoted at about 44s. per ton. The business doing in Bessemer qualities is especially large, but there is a growing demand not only for steel-making purposes in the immediate district, but from the Sheffield, Midland, and Scotch districts, as well as from America, the Colonies, and the Continent. Stocks of iron have been reduced, and the make has been somewhat increased. Steel makers are busy on rail orders, which they have booked to a very large extent; and the demand from all sources remains steady, and makers are fully employed, and are likely to be busy for several months to come. There is not much doing in other branches of the steel trade, and orders are few for merchant steel, plates, and bars. A fair trade is doing in wire, hoops, and railway tires. In shipbuilding there are no indications of renewed activity. Builders are short of orders, and their yards are now looking exceedingly bare. A few inquiries have been received lately which are expected to lead to new orders, but there is no expectation of a busy trade in the immediate future. Engineers in the general trade are short of work, but there is still much activity among marine engineers. Boiler makers are short of orders, though it is believed there are indications of a brisker trade. Iron ore is in considerable demand, and prices are a trifle firmer, although quotations remain steady at 9s. to 10s. 6d. per ton net at mines. Coal and coke steady, with a prospect of higher prices. Shipping well employed. The Gillfoot Park Mining Company is likely to sink a deep pit very soon to the side rise of its present mines, and is also considering the advisability of sinking another pit at the west of its mines at a depth of 200 fathoms. Messrs. Chas. Cammell and Co. have put many bore-holes down on the west side of Egremont, in their royalties which adjoin the Gillfoot Park royalties, and have, I understand, large deposits of ore in several of their bore-holes. It is stated that they are contemplating sinking a pit here after their Bigrigg pit is fairly at work. Messrs. Bain and Co. have a considerable quantity of ore in bank, apparently 30,000 or 40,000 tons. Messrs. Lindon have found deposits of ore in their Longlands mine on the east side of the river Eden, besides having proved considerable deposits near the vicarage of Cleator, and also at Bigrigg and near to Pallaflat. The deposits at Cleator, Bigrigg, and Pallaflat are untouched, and no doubt will be available in case a greater demand for ore springs up. The Wyndham Company has recently added to its workable area, by underground discoveries to the west of its present workings. There is considerable activity in the Bigrigg district. In addition to the deep pit sunk by Messrs. Lindon, Messrs. Charles Cammell and Co. have sunk a deep pit and found ore at a depth of over 100 fathoms, which is now ready for raising. The Maryport Company, at Pallaflat, has opened out a new pit, in a district which has previously been bored, but always unsuccessfully until this company discovered ore. The ore is found in a new and unlooked-for position, being in a sandstone, instead of the limestone, measures. The ore is of excellent quality. The output at the Maryport mines is about 1200 tons a week. This discovery has been the means of stimulating a research in this new district, and already a good many bore-holes have been put down. A new company, the Southam Mining Company, has been very successful in its boring operations, and is now sinking a pit which is daily expected to reach the iron ore. The ore in this case, as in the Maryport Company's mines, is in the sandstone and is of rich quality. Lord Leconfield's mines at Bigrigg, which are the oldest in the district, are still successfully worked. Bore-holes have recently been put down on Clinty Brow, and have been successful in finding a good body of ore 30ft. in thickness in two or three bore-holes. They are driving to this deposit from the pit, which is situated about 150 yards to the east.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

Dr. C. B. Webster, who has been consul for the United States in Sheffield for many years, is now to be succeeded by Mr. Benjamin Folsom, cousin of Mrs. Cleveland, the President's wife. The first intimation of the appointment was a two-line announcement in the *Times* in the letter of their usually well-informed Philadelphia correspondent. It has now been confirmed, and Mr. Folsom, who is stated to be a lawyer, aged thirty-two, is expected to be here before Christmas. The American papers speak of his appointment in terms of approval. If he is as acceptable as Dr. Webster has been, he will be welcomed. The doctor, though a patriotic American, has been highly successful in reconciling duty to his country with satisfaction to the many firms here who trade with the States, and his removal will be regretted by business firms generally. Our American cousins are not very courteous in their appointments to consulates. The first announcement of any change is usually obtained from the newspapers, unless it comes in the still more abrupt form of the new man stepping in with his credentials and the other walking out.

The American trading year ends on September 30th, and the returns enable us to see the course of Sheffield business during the twelve months. The total value for the year just ended is £523,187 13s. 2½d., an increase of £73,841 1s. 1½d. on 1885. In our two great specialities—steel and cutlery—steel has increased by £37,344 12s. 5d., and cutlery by £34,527 10s. 4d. The values for the four quarters of the year were as follows:—December, 1885, steel, £64,657; cutlery, £45,483; March, 1886, steel, £62,272; cutlery, £36,181; June, 1886, steel, £64,241; cutlery, £45,279; September, 1886, steel, £66,141; cutlery, £51,557. The total values of steel and cutlery exported to the United States during the year ending September 30th were £256,312 8s. 10d. and £178,506 16s. 9½d. respectively.

Our municipal elections were fought this year mainly on a question of trade. A series of charges has been made against Sheffield manufacturers and merchants of importing German goods and reselling them with Sheffield labels as Sheffield goods, and of marking on wares a superior mark to what they really are. The trade council appointed a committee to inquire into the allegations, and rejected the report of a majority of its committee as not established by the evidence adduced, ultimately adopting, by a large majority, the report of a minority of that committee, which was of a more moderate character, and recommended an extension of existing legislation to meet those objectionable features which were admitted. This did not satisfy the trade unionists, who made no secret of their desire to have a Royal Commission on the employers, in return for the Royal Commission on rattening in the Broadhead days. The agitation was cleverly and vigorously worked; the artisans were told that these practices prevailed to an enormous extent, and were the cause of the scarcity of work; and the trade organisations were thrown into the scale. "Down with false marking!" was the cry, and it succeeded. Three wards only were contested, but in all these, the candidates who had the trades unions at their back were returned at the head of the poll. There is a motion on the agenda paper for next Town Council in favour of obtaining fresh parliamentary powers by extending the Merchandise Marks Act; but it is understood that those who are now in a majority in the Town Council will feel themselves compelled to concede what the trades unions demand—a Royal Commission to inquire into the practices, the extreme section of the successful party at the polls evidently believing they can obtain evidence, under an indemnity, which will reveal a great deal more than has already been made public.

Of course, no one defends false marking and fraudulent trading. The difficulty is not in that direction. At present almost every ironmonger in the country has his own name and address stamped on the table knives he sells; yet nobody supposes he ever made a knife, and probably he never saw one made in his life. In getting his name on the blade he advertises his business, and, practically, gives his personal guarantee—standing in the place of the manufacturer—that the goods are what he professes them to be. He has not his name "struck" with any intention to deceive, and the customer is not deceived any more than the person who steps into a confectioner's shop and buys "Nouveautés de Paris" which never saw France. Yet one of the requirements of the new crusade is that every manufacturer stamps his own name on his goods. To prevent and punish false trading is most desirable; but there is reason in all things. Meanwhile the wild and extravagant statements first circulated—now withdrawn, and admitted by the Town Council Committee to be baseless—are doing duty in the hands of American and German rivals to the detriment of Sheffield trade. Here is how the *Chicago Tribune* of March 8th, 1886, "piles up the agony" against our good old town in flaming head-lines, such as press-people out West know so well to display:—"Perfidy at Sheffield. The great Cutlery Manufacturers Playing Havoc with their City's Reputation—Importing Inferior German Goods and Re-exporting them as Home Manufactures. Some Revelations that Americans will do well to ponder over." And then follow portions of an article written, printed, and published in Sheffield!

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

The amount of business done in Cleveland pig iron during the last few days has been quite insignificant. Consumers are not nearly so anxious as they were, the majority of them having purchased largely last month. Certain merchants and speculators have been forced to realise, at the best prices they could obtain, and so it happens that last week's values have not been adhered to. At the market held at Middlesbrough on Tuesday last, small lots of No. 3 G.M.B., for this year's delivery, were disposed of at 32s. 9d., and even as low as 32s. 7½d. per ton, or 3d. to 4½d. per ton less than was paid last week. Forge iron is also now at least 3d. per ton below the maximum lately realised. Makers, however, continue to ask as much as they did a week since, and do not appear anxious to make further sales at present.

The price of Middlesbrough warrants is 33s. per ton, or 6d. less than last week; but there are very few sellers. At Glasgow 32s. 7½d. has been taken for them.

Messrs. Connal and Co.'s Middlesbrough stock of pig iron amounted on the 1st inst. to 300,618 tons, being a decrease of 210 tons since the 25th ult. The increase during last month was 796 tons, the smallest which has taken place for a considerable time.

The shipments of pig and manufactured iron and steel effected at Middlesborough last month amounted to 125,639 tons, being the heaviest for any month since May, 1884. The pig iron reached 84,322 tons, against 77,175 tons shipped in September. Scotland, 29,409 tons; Germany, 14,041 tons; Russia, 11,875 tons; Holland, 5205 tons; Norway and Sweden, 4564 tons; and America, 2770 tons. The shipments of manufactured iron and steel amounted to 41,317 tons, as against 35,700 tons in September. India took 13,422 tons; Denmark and Sweden, 4437 tons; Australia, 3664 tons; and America, 2659 tons.

The finished iron trade is again dull, but prices are the same as quoted last week.

The certificate issued by the accountants to the Durham coal trade shows that the net average selling price of coal for the three months ending September 30th was 4s. 4·63d. per ton. The present rate of wages will not be disturbed.

The owners of the Hutton Henry Colliery, near Hartlepool, appear to have discovered in their pit workings a shale containing petroleum, similar to that which is found in certain districts in Scotland. The shale has been analysed, and pronounced to be rich enough in hydro-carbons to be decidedly of commerial value. The quantity available without extra cost in working is not yet ascertained. Should further investigation prove that a new industry can be founded upon the discovery, it will be very welcome news to the proprietors of the colliery, one of whom is Mr. Joseph Dodds, M.P. Some years ago a considerable portion of the pit shaft fell in, and the consequences of that disaster has been a burden upon the concern ever since.

The Ayrton Rolling Mills, Middlesbrough, belonging to Messrs. Jones Brothers, have just been re-started, after being closed for about fifteen months. Only the sheet mill and nailworks are, however, in operation. The plate mills, which used to make 300 tons per week of iron plates, still remain inoperative, and are not likely to be set going at present. The sheet mills are mainly occupied in rolling down steel billets and steel scrap of various kinds into nail sheets. The cut nails made at the nailworks are now all of steel, iron nails being quite unsaleable.

Inasmuch as the ships now building and recently ordered at east-coast yards are in almost every case of steel, there is little prospect of any more iron plate mills starting. Those already going have considerable difficulty in obtaining sufficient specifications to work regularly. Neither are the proprietors any better off for the small advance in price they have obtained, as the extra cost on materials completely absorbs it.

The venerable firm of Robert Stephenson and Co., engine builders, of Newcastle-on-Tyne, is about to follow the prevailing fashion and become a limited company. More than sixty years have elapsed since the late George Stephenson, Edward Pease, of Darlington, and Thomas Richardson, of Ayton, put down a thousand pounds each, in order to start, in South-street, Newcastle, the factory which afterwards became so famous throughout the world. For five-and-twenty or thirty years it took the lead of all competitors in its own specialities. Latterly, however, numerous works have contested with it the first position. Many of these have been more systematically laid out, are better situated, and are furnished with more modern machinery and appliances. In the matter, however, of an abundant supply of skilled labour, the old place always had an advantage, and perhaps still retains it. It has been, indeed, a very nursery of mechanical engineers for the whole world. Wherever engineers or mechanics are found in any quantity there is sure to be someone or other with a Northumbrian accent hailing from "Stephenson's." The original Stephensons have, of course, been gone for more than a quarter of a century, but the men they trained are still numerous, and still very much to the front. Edward Pease, too, has been dead for an equal length of time, but his grandsons, Sir Joseph and Arthur Pease, appear as directors and large shareholders in the new limited company. The shipyard belonging to Messrs. McIntyre and Co., of Hebburn-on-Tyne, is to be absorbed by the new company; for the tendency in these times is for shipbuilders and marine engineers to amalgamate, and to work into each other's hands. The old *régime* may be said to have passed away when Mr. Douglass, general manager, and formerly a pupil at the works, died. A new *régime*, in accordance with the spirit of the age, has commenced. Whatever disadvantages or drawbacks may have hitherto existed will, no doubt, now be removed, and every advantage possessed will be cultivated and developed. The directorate is an exceedingly strong one, and there can be little doubt that the future of this fine old concern will be equal to, if it does not surpass its previous career.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

There has been something like a breakdown in the pig iron market this week. The drop in prices in the early part of the week was so great as to suggest that the influences that were sending the market up had been suddenly withdrawn. The past week's shipments were poor, amounting to only 6364 tons, as compared with 8651 in the preceding week, and 7818 in the corresponding week of 1885. It also appears that of the 37,638 tons of pigs shipped this year to the United States, 15,175 tons are Cumberland hematite pigs, which were brought round to Glasgow for transhipment, and that, instead of being greater, the exports of Scotch pigs to America this year are really from 6000 to 7000 tons less than those for the corresponding ten months of last year. During the week a furnace was put in blast at Calder, another at Carnbroe, and four at Gartsherrie; so that there is now a total of seventy-two blowing, against sixty-six a week ago. The addition to the stocks in Messrs. Connal and Co.'s Glasgow stores has this week been upwards of 2000 tons.

Business was done in the warrant market on Friday at 42s. 0½d. cash. On Monday a large business was reported at 42s. 2½d. to 41s. 11d. Tuesday's figures were 41s. 10d. to 41s. 8½d. and back to 41s. 11½d. cash. Wednesday's transactions were from 41s. 11d. to 42s. 1d. cash. To-day—Thursday—business took place at 42s. to 42s. 3d., closing with buyers at 42s. 1½d. cash.

The values of makers' pigs are in a number of cases 6d. to 1s. less than last week, as follows:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, 47s. 6d.; No. 3, 44s.; Coltness, 51s. and 44s. 6d.; Langloan, 47s. 6d. and 44s. 6d.; Summerlee, 49s. 6d. and 44s. 6d.; Calder, 48s. 6d. and 43s. 6d.; Carnbroe, 44s. 6d. and 41s. 6d.; Clyde, 44s. 6d. and 40s. 6d.; Monkland, 43s. and 39s.; Govan, at Broomielaw, 43s. 6d. and 39s.; Shotts, at Leith, 46s. 6d. and 44s. 6d.; Carron, at Grangemouth, 46s. 6d. and 43s. 6d.; Glengarnock, at Ardrossan, 44s. 6d. and 41s. 6d.; Eglinton, 42s. 6d. and 39s.; Dalmellington, 44s. and 40s.

It appears from inquiries made among the steel makers that this branch has entered upon a period of great activity, which, it is hoped, may be of some permanence. Prices have been materially advanced, and an advance was much required, as the rates had fallen to a very low point, so much so, indeed, that some firms had ceased to make certain articles in consequence of the prices being unremunerative.

Rather more than a week ago the colliers in the West of Scotland adopted a further restriction of their work to four days a week, seeing that the five days a week were ineffectual to compel a second advance of 6d. a day. The coalmasters and ironmasters met last week to consider the matter, the meeting being the largest of the kind that has been held for many years. They unanimously resolved to refuse the advance, and resolved to form themselves into an association of employers for the purpose of resisting the further action of the men. The latter were generally idle on Monday of this week, and held meetings, at which their leaders exhorted them to stand firm. Some of the men complained that as the rent term was approaching, and as they were not earning enough to meet the wants of their families, they should be allowed to discontinue the restriction. But they were told by their leaders that they ought to work only four days, and, if need be, three days a week, as the struggle with the masters in that case would be smart and successful. There can be little doubt that the leaders are really misleading the men on the present occasion, and if they persevere it is not at all unlikely that a lock-out may follow.

The total coal shipments from Scotch ports in the past week have been 86,114 tons, as compared with 91,571 in the corresponding week of 1885. There was shipped from Glasgow, 20,716 tons; Greenock, 2513; Ayr, 8064; Irvine, 1404; Troon, 5578; Port Glasgow, 2860; Burntisland, 21,252; Leith, 4364; Grangemouth, 16,713; Bo'ness, 2650 tons. There is no further improvement in prices, notwithstanding the restriction.

In Fife the colliers propose to give the masters two weeks' notice that they will no longer be bound by the rule that requires them to work eleven days a fortnight, but that they will work five days a week on condition that they get an immediate advance of pay. The masters have had a meeting to consider these proposals, when they declined to entertain them. A lock-out was talked of, but it was considered that if the men left the pits because they could not get the advance, they would be locking themselves out, and save the employers the necessity of so doing. It was stated that the restriction was injuring the trade, and obliging shippers to obtain supplies elsewhere.

Only 6692 tons of new shipping were launched from the Clyde shipyards in October, as compared with 18,390 tons in October, 1885, the output of the ten months being 145,582, against 157,599 tons in the same period of last year. A good number of new contracts have been fixed within the last few weeks.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

An able engineering project of Mr. Harpur's, the town surveyor of Cardiff, for weiring the Taff has for the present been abandoned. In the face of the outlay of £300,000 for a water supply, this seems judicious. Good work is being done at the Cwmtaff reservoir, and a large addition of hands will soon be made. Local discussion is going on about two matters of importance, first, that of providing a harbour of refuge near Swansea, and the second of getting good coast defences for the Severn. As regards the latter, Cardiff is much exposed, and the position it has taken of being the largest coal exporter to foreign destinations of the world demands consideration. With respect to the first, it is a matter of grave discussion whether coalowners and insurers should not look more closely than they do into the hazardous conditions of the Welsh coast. Here, every week, an average of 130,000 tons is sent away in steamers and sailers along a coast upon which prevailing gales often dash them to pieces. It is really a question for Lloyd's and kindred societies. Increased risk from lack of ordinary precaution should mean increased insurance rates, and this, telling upon the local coalowner, would create the necessary agitation for a reform.

The coal trade continues to look up, but with no improvement in price. Present quotations vary from 7s. 3d. to 8s. 9d.; small steam is in good demand at 5s.; house coal generally is looking up, and coalowners becoming more active. This applies to the Monmouthshire and Glamorgan Valleys. Most of the large steam collieries are doing better, and notices which have run to an end have been rescinded. At present there is a slight benefit to owners in the increased quantity worked, but the colliers derive most benefit, working being more regular. It has been suggested that outputs be kept about the present average, and then possibly prices may go up. I do not think this feasible; some collieries have the advantage of others generally. The only corrective is that the smaller men become absorbed by the larger, unless demand becomes much greater than it is.

Bristol is seriously bestirring itself in opposition to Cardiff, and in the better development of its coalfields.

It is contended that if Bristol erect tips, vessels can load there more cheaply than at Cardiff; in fact, saving in pilotage and loading 1s. 6d. per ton in coal.

There seems a thorough intention to carry this out, and as trade in Bristol is improving, the tonnage during the past year having been 1,344,000, the movement is taken at an opportune moment. Cardiff, however, so long as its 4ft. steam coal holds out, need not despair.

There is a good deal of vitality shown in the coal trade in the neighbourhood of Swansea, and various sinkings, re-openings, &c., are in hand at Birchgrove.

In the Rhondda things are not quite so active as one would wish, and a strike was attempted at one of the collieries this week, but it is not expected to continue. The dispute is regarding the price paid for working a certain seam. In the Cymmer Colliery it is suggested, but not yet adopted, that men should work three in a stall, and get 2d. extra per ton.

A brisker tone prevails in the iron and steel trade; railways are now putting in their orders, and what with home renewal business, some good foreign orders, and the average bar trade, merchant and tin bar projects are decidedly better.

The doctor's dispute in the Rhondda is still unsettled. The men contend that it is illegal to keep back money from their wages unless they are agreed as to the disbursement.

Manufacturers are steadily increasing their stocks of foreign ore, and price remains moderate enough to tempt them to do so. Possibly freights will advance. In the Swansea district they are decidedly looking up, and in Cardiff firm, especially in the ore trade, on account of the few boats engaged.

Tin-plate continues in good form, both in the Newport and Swansea districts. In the latter the export last week was over 55,000 boxes and the make 45,000 boxes, in round numbers. This shows that the works are again at full power. Stocks amount to 105,000 boxes, or almost double the quantity at this period last year. In pig iron and steel bar there have been large imports. Prices are not quite so advanced as makers wish, the principal trade being in coke and Bessemer at 13s. to 13s. 1½d. Best brands command 13s. 3d., and some sales have even been effected at 13s. 6d. Considering that tin is high and pig iron and steel bars advanced, prices should go up for makers to do any good. Tin is at £101; pig iron at 42s.

A Naval and Colonial Engineering Exhibition is to be held at Islington next year. It is being organised by Mr. Samson Barnett, 4, Westminster-chambers, S.W., by whom the Marine Exhibition was organised three years ago.

Price of Local Time-tables.—At various London suburban stations, such as those of the London and Brighton Company, little pocket time-tables, sheets about the size of notepaper, are sold for one penny each. Almost all of these are bought by the regular users of the line. The price at which the tables are sold realises a profit of over 1000 per cent. Are the railway companies mean enough to treat their customers in this way, or who does it?

Wanted, a Steam Dredger.—The Secretary of State for Foreign Affairs has received a dispatch from her Majesty's Consul at Gothenburg enclosing the following advertiesment from the "Göteborgs Handles och Sjöfarts Tidning" of the 28th ult.:—"Steam Dredger.—The harbour authorities at Ystad receive offers before the 15th of November for the delivery of a steam dredger of wood or iron of 15 to 20-horse power. Depth to be dredged 22ft. to 24ft., hard clay. The dredger must be of modern construction, and the offer, accompanied by a detailed specification and statement of time of delivery." Applications should be sent to the "Hamndirektionen," Ystad, Sweden.

NEW COMPANIES.

The following companies have just been registered:—

Bloxham Ironstone Company, Limited.

This company was registered on the 21st ult., with a capital of £50,000 in £1 shares, to acquire and work ironstone and other mines, and to manufacture and deal in every kind of iron and steel. The subscribers are:—

	Shares.
A. M. Napier, 9, Wilkinson-street, South Lambeth, clerk	1
M. Hearon, 171, Breakespeare-road, Brockley	1
S. T. Ellis, 6, Russell-grove, Brixton, clerk	1
W. J. Griffiths, 4, Percy-terrace, Greenwich	1
W. Silver, 45, Tottenham-street, Fitzroy-square, clerk	1
C. Beddall, 23, Cornhill, insurance broker	1
H. Tripe, 4, Hope-villas, Dulwich, insurance agent	1

The subscribers are to appoint the first directors.

Contract Construction Company, Limited.

On the 27th ult. this company was registered with a capital of £10,600, divided into 600 founders' shares of £1 each, and 1000 10 per cent. preference shares of £10 each, to construct, equip, manage, maintain, and work railways, tramways, bridges, buildings, telegraph lines and cables, and all kinds of public and private work, and to assist other persons and companies engaged in such works; also to transact business as general contractors and financiers. The subscribers are:—

	Shares.
*E. J. Bailey, Lordship-lane, East Dulwich	30
*J. C. Bolton, 26, Great St. Helens, chartered accountant	30
*C. C. Cramp, 1, Boscombe-road, Uxbridge-road, engineer	30
*Wm. Penrose Green, 9, Newton-grove, Leeds, engineer	30
*W. Lyster Holt, C.E., 17, Parliament-street	30
Wm. Gunn, 10, Station-road, Harlesden, commission agent	30
*E. E. Walduck, 148, Gresham House	30

The number of directors is not to exceed seven; qualification, £300 in shares; the first are the subscribers denoted by an asterisk, and one other to be appointed by the subscribers. The first directors are to retain office for five years. The remuneration of the directors will, after the expiration of five years, be fixed by the shareholders, provision having been made for the entire satisfaction of their remuneration during that period by the issue of fully-paid shares. The following appointments have been made in connection with the company, viz.:—Mr. John Sproxton, of 148, Gresham House, to be secretary; Mr. William Lyster Holt to be engineer; and Mr. Edward Marley Chubb, of 11, Pancras-lane, to be solicitor to the company.

Hydrocarbon Gas Light and Fuel Company, Limited.

This company proposes to manufacture and deal in gas and gas apparatus and machinery, and for such purposes will acquire the following patents:—No. 9733, dated July 28th, 1886, for "improvements in apparatus for heating and cooling fluids;" No. 12,340, for "improvements in apparatus for the manufacture of gas from fluid hydrocarbon." The company was registered on the 25th ult., with a capital of £120,000, in £10 shares. The subscribers are:—

	Shares.
A. W. Rixon, 10, Austin Friars, solicitor	1
*G. Allan, C.E., 10, Austin Friars	1
A. P. Meikle, The Avenue, Gipsy Hill, accountant	1
J. Anderson, 31, Poultry, chartered accountant	1
*T. S. Lindsay, 4, Oakhill-park, Hampstead, accountant	1
*B. F. Weeks, 33, St. Oswald's-road, merchant	1
*C. Monkton, C.E., Pinner	1

The number of directors is not to be less than three, nor more than seven; qualification, fifty shares; the first are the subscribers denoted by an asterisk; remuneration, £1000 per annum.

Inman and International Steamship Company, Limited.

This company was registered on the 23rd ult., with a capital of £1,000,000, in £10 shares, to carry on the business of a steamship company in all branches, and for such purpose to enter into an agreement with the International Navigation Company, Messrs. Peter Wright and Sons, and Messrs. Richardson, Spence, and Co. The subscribers are:—

	Shares.
James Spence, 17, Water-street, Liverpool, merchant	1
E. Taylor, 17, Water street, Liverpool, merchant, &c.	1
Hy. Wilding, 17, Water-street, Liverpool, manager	1
Wm. Anderson, 17, Water street, Liverpool, cashier	1
W. J. Arrowsmith, 17, Water-street, Liverpool, book-keeper	1
T. H. W. Withers, 17, Water-street, Liverpool, freight manager	1
J. E. Willett, 17, Water-street, Liverpool, salesman	1

The number of directors is not to be less than three, nor more than seven; the subscribers are to appoint the first; the company in general meeting will determine remuneration.

Lancashire Simplex Loom Company, Limited.

This company was registered on the 25th ult., with a capital of £10,000, in £1 shares, to acquire and work the letters patent No. 3352, dated 6th July, 1883, for improvements in smallware looms, and partly applicable to other looms, together with the plant and stock-in-trade of the vendor, Mr. C. Prest, situate upon the Jersey-street Mills, Ancoats, Manchester. The subscribers are:—

	Shares.
J. Lucas, Leamington, house agent	1
H. Kelvin, 18, St. Ann-street, Manchester, accountant	1
E. A. Boyer, 9, Albert-square, Manchester, chartered accountant	1
R. Prest, 47, Spring-gardens, Manchester, manager	1
E. Armstrong, Urinston, traveller	1
F. Shelton, Salford, clerk	1
S. R. Freeman, Moss Side, accountant	1

Directors qualification, fifty shares. After £10 per cent. dividend has been paid, the directors may receive such remuneration as the company in general meeting may appoint.

Liverpool and Great Western Steamship Company, Limited.

This company proposes to carry on the business of a shipowner in all its branches, and for such purpose will enter into an agreement with the Liverpool and Great Western Steam Company, Limited, and its liquidators, Messrs. Gordon, Ross, Henry Davis Pickford, and William Durant Mack. It was incorporated on the 27th ult., with a capital of £500,000, in 1250 shares of £40 each. The subscribers are:—

	Shares.
Gordon Ross, 26, Preeson's-road, Liverpool, merchant	1
J. G. Brown, 32, Chapel-street, Liverpool, merchant	1
W. D. Mack, Oriel Chambers, Liverpool, shipowner	1
J. S. Mack, Oriel Chambers, Liverpool, shipowner	1
H. Nash, Tower-buildings, Liverpool, merchant	1
W. Pearce, Govan, Glasgow, shipbuilder	1
R Barnwell, Govan, Glasgow, shipbuilder	1
H. D. Pickford, 9, Exchange-buildings, Liverpool, marine insurance broker	1

The number of directors is not to be less than three nor more than eight; qualification, £1000 in shares; the subscribers are to appoint the first; the company in general meeting will determine remuneration.

London and Counties' Saw Mills Company, Limited.

This company was registered on the 23rd ult., with a capital of £30,000, in £1 shares, to establish and carry on in London or elsewhere saw mills with steam or other power, and for such purposes to acquire and work the letters patent for the United Kingdom dated 15th February, 1879, and 27th January, 1885, respectively, granted to Mr. John Watts, of Bristol, for "improvements in endless band saw machines." The subscribers are:—

	Shares.
F. W. Hodges, 35, Gowlett-road, Dulwich, surveyor	1
J. Legie, 68, Cheapside, accountant	1
Wm. Scott, 3, Broad-street-buildings, stock and share broker	1
E. W. Austin, 3, 4, and 5, Queen-street, accountant	1
C. Minns, C.E., 37, Walbrook	1
G. Levick, Parliament-mansions, Victoria-street, engineer	1
E. E. Allen, C.E., 111, Cheyne-walk, Chelsea	1

The number of directors is not to be less than four, nor more than ten; qualification, fifty shares; the subscribers are to appoint the first. The remuneration of the directors other than the managing director, beside ordinary attendance fees, will be £500 per annum, or any less sum payable half-yearly; but in those years in which the net profits are insufficient to pay £10 per cent. dividend, the directors are to forego their remuneration either wholly or to such an extent as will enable £10 per cent. per annum for the half-year to be paid. In the event of the dividend being 15 per cent. per annum, the board will be entitled to £1000, providing the net profits after such dividend be sufficient for the purpose.

Robert Stephenson and Co., Limited.

This company was originally by deed of settlement, dated 30th June, 1886, and was registered as a limited company on the 22nd ult. with a capital of £400,000, in £100 shares. The object of the company is to take over the partnership business of Messrs. Robert Stephenson and Co., of Newcastle-on-Tyne, engine manufacturers. The partners in the business are George Robert Stephenson, Sir Joseph Whitwell Pease, Robert Stephenson, and George Stephenson. The company will take over the lands, buildings, machinery, and all other assets of the firm, and these, after deducting the liabilities, are of the estimated value of £165,975, which amount will be satisfied by the issue of shares credited with £75 as paid upon each. 2278 shares are taken up, and are paid up to the extent of £75 per share. The following is a list of members:—

	Shares.
C. E. Carr, Gateshead	64
*David Dale, Darlington	20
*J. McIntyre, jun., Newcastle	64
*Sir Joseph Whitwell Pease, Bart., M.P., Hutton Hall, Yorkshire	380
*Arthur Pease, Darlington	312
Sir J. Whitwell Pease, Bart., M.P., and Arthur Pease	312
A. E. Pease, M.P., Pinchintheyse House, Yorkshire	20
*G. R. Stephenson, C.E., Victoria-street, Westminster	1024
Robt. Stephenson, South-street, Newcastle, engine manufacturer	73
*George Stephenson, South-street, Newcastle, engine manufacturer	72

The number of directors is not to be less than three, nor more than seven; the first are the subscribers denoted by an asterisk. Mr. G. R. Stephenson is appointed chairman, and Sir J. W. Pease, Bart., M.P., vice-chairman. The former will be entitled to £1000 per annum, and the latter to £200 per annum. Messrs. Robert Stephenson and George Stephenson are appointed managing directors, each at a salary of £500 per annum. The remuneration of the ordinary directors will be determined by the company in general meeting. The qualification for subsequent directors will be the holding of shares to the nominal value of £2000.

South Kensington Museum.—Visitors during the week ending October 30th, 1886:—On Monday, Tuesday, and Saturday, free, from 10 a.m. to 10 p.m., Museum, 9741; mercantile marine, Indian section, and other collections, 3188. On Wednesday, Thursday, and Friday, admission 6d., from 10 a.m. to 4 p.m., Museum, 1468; mercantile marine, Indian section, and other collections, 232. Total, 14,629. Average of corresponding week in former years, 14,444. Total from the opening of the Museum, 25,238,988.

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.

25th October, 1886.

13,657. Motive-power Engines, T. McCarter and T. Cooper, London.
13,658. Treatment of Tin Scrap, &c., W., F. E., and A. S. Elmore, London.
13,659. Feilding Combination Boot, R. C. Bowley, London.
13,660. Combination Electrical Switch, Sir D. L. Salomons, O. E. Woodhouse, and F. L. Rawson, London.

26th October, 1886.

13,661. Handle Socket for Saucepans, &c., F. Baker, London.
13,662. Gas and Atmospheric Burner, J. Rebbla, near Dewsbury.
13,663. Supporting, &c., Dynamo-electric Motors, F. Wynne, London.
13,664. Producing and Storing Motive Power, G. Quarrie, London.
13,665. Producing Electricity for Lighting, &c., Purposes, G. Quarrie, London.
13,666. Ribbons or Tapes, W. H. Barratt London.
13,667. Hair Pins, &c., J. Appleby, Birmingham.
13,668. Preparing Silk Cocoons for Reeling, E. W. Serrell, jun., Paris.
13,669. Tools for Forming Bevel Grooves in the Mouths of Bottles, D. Rylands and B. Stoner, Barnsley.
13,670. Hinge Joint for Step Ladders, J. Summerscales and H. C. Longsdon, Halifax.
13,671. Centrifugal Machines, D. McC. Weston, London.
13,672. Folding Fire-escape, G. Worsley, jun., and J. Brelsford, Manchester.
13,673. Stoppering Bottles, F. Coe, Manchester.
13,674. Heating or Lighting, G. T. Chinnery, Newcastle-on-Tyne.
13,675. Ornamentation of Gas Lamps, J. Whitehead, Birmingham.
13,676. Lubrication of Steam Engine and other Shafts, G. A. J. Schott, Bradford.
13,677. Tennis or Racket Bat, J. Hudson, Birmingham.
13,678. Mashing Malt for Brewing, &c., J. and R. B. Bonthrone, Glasgow.
13,679. Bed Pans, &c., C. F. Forshaw, Bradford.
13,680. Drawing Iron and Steel Bars through Dies, B. C. Tilghman, London.
13,681. Artificial Ear-drum, H. J. Allison.—(*F. Hiscox, United States.*)
13,682. Coating Metal Plates or Sheets, J. R. Turnock, South Wales.
13,683. Railway Ticket Holder, J. B. Chaplin, Halstead.
13,684. Ships or Navigable Vessels, G. B. Proctor, Liverpool.
13,685. Fire-extinguishing Apparatus, W. Miller, Glasgow.
13,686. Safety or Miners' Lamps, J. Laidler, Durham.
13,687. Raising Liquids by Compressed Air, J. Fyffe, Dundee.
13,688. Opening and Closing Fan-light Windows, N. B. Locke, Glasgow.
13,689. Clamp or Bridge for use in Securing Caps or Covers for Orifices in Steam Generators, C. McNeil, jun., Glasgow.
13,690. Cistern Ball-cock Valve, R. Newbery, London.
13,691. Washers for Locking Nuts, G. H. Hovey, jun., and F. A. Warlow, Sheffield.
13,692. Clamping Devices, W. W. Popplewell.—(*W. D. Elger, United States.*)
13,693. Cleaning the Pans, &c., of Closets, J. Gozney, London.
13,694. Cleaning or Sharpening Knives, &c., P. A. Martin, Birmingham.
13,695. Hearths, &c., G. G. Hattersley, Sheffield.
13,696. Umbrella and Walking-stick Holder, G. Finney, Liverpool.
13,697. Button, J. Neuflies, Birmingham.
13,698. Door Furniture, J. Brownrigg, Windermere.
13,699. Laying Rails, J. B. Bell, Grantham.
13,700. Ladies' Fur Boas, H. Davis, London.
13,701. Gas Lamp, F. Siemens, London.
13,702. Calculating Machine for Working Sums, J. Wright, Bradford.
13,703. Umbrella Ribs and Stretchers, W. Corder, London.
13,704. Coupling of Railway, &c., Carriages, G. W. Moon, London.
13,705. Fastenings for Gloves, &c., C. H. Pugh, London.
13,706. Steam Engines, H. Wormald and J. Hargreaves, London.
13,707. Music Stools, &c., G. F. Beutner and A. A. Lateulère, London.
13,708. Revolving Hair-pins, G. F. Beutner and A. A. Lateulère, London.
13,709. Fly-catchers, Z. F. Xevers, London.
13,710. Permanent Way of Railways, A. M. Clark.—(*E. C. Davis, United States.*)
13,711. Agricultural Drills, C. Cottis, London.
13,712. Dynamo-electric Machines, A. M. Clark.—(*The Electrotechnische Fabrik Cannstatt [Wirth and Co.,] Germany.*)
13,713. Horse Collars, A. M. Clark.—(*A. Dufresne, France.*)
13,714. Treating Hemp, &c., E. Edwards.—(*H. Wolff, Germany.*)
13,715. Appliances for Delivering Prepaid Newspapers, W. S. Oliver, London.
13,716. Air Brakes for Railroads, S. R. Kneeland, London.
13,717. Manure, H. H. Lake.—(*H. O. Peabody, United States.*)
13,718. Nails, G. J. Capewell, London.
13,719. Wrappers for Bottles, J. N. Beach and G. H. M. Smyth, London.
13,720. Travelling Dressing Bags, W. F. Williams, London.
13,721. Syringes, A. J. Boult.—(*E. W. Creecy, United States.*)
13,722. Rag and Rope Cutting Machines, J. Nuttall, London.
13,723. Boilers, H. H. Lake.—(*W. S. Post and H. de W. Sawyer, United States.*)
13,724. Pulley, W. J. Brewer, London.
13,725. Combined Belt and Braces, A. T. Bending, London.
13,726. Tool for Opening Tins, R. and E. Holbrook, London.
13,727. Gas Engines, H. E. Newton.—(*P. Murray, jun., United States.*)
13,728. Rotary Engines, C. Griffin, London.
13,729. Self-acting Couplings and Brake, J. Collins, London.
13,730. Water Supply Cistern, R. Crane, London.
13,731. Lock, C. J. Leazing, London.
13,732. Movable Targets for Skirmishing, E. Midgley, London.
13,733. Valve Arrangement for Closets, E. Pearson, London.
13,734. Biscuit Bread, E. Serrant, London.
13,735. Reaping and Mowing Machines, A. Simpson, London.
13,736. Reaping and Mowing Machines, A. Simpson, London.
13,737. Expanding Piston Rings, J. D. Churchill, London.
13,738. Malt, &c., H. H. Lake.—(*J. W. Free, United States.*)
13,739. Scroll Work, F. Hainsworth, London.
13,740. Wheels for Vehicles, H. H. Lake.—(*H. W. Fowler, United States.*)
13,741. Mechanical Telephone, H. H. Lake.—(*M. G. Farmer, United States.*)
13,742. Article of Food, H. H. Lake.—(*P. B. Rose, United States.*)
13,743. Shells for Ordnance and Guns, M. Delmard, London.
13,744. Tub for Holding Butter, &c., H. F. Coombs, London.
13,745. Churns, H. F. Coombs, London.
13,746. Handle for Box Covers, H. F. Coombs.—(*J. Emery, Canada.*)

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13,747. Trussing and Pressing Machines, G. Wood, Manchester.
13,748. Trimmings, J. W. Thompson and J. W. Gorton, Manchester.
13,749. Steamers and other Vessels, H. B. Barlow.—(*J. Scott, India.*)
13,750. Navigable Balloon, F. Vanek and A. Edelstein, London.
13,751. Fenders, F. R. Baker, Birmingham.
13,752. Inducing Combustion, G. T. Chinnery, Newcastle-on-Tyne.
13,753. Furnaces, J. Newton, Sheffield.
13,754. Picket and Tent Peg, C. E. Jeffcock, Sheffield.
13,755. Drawing Pens from Penholders, W. Gaskill, London.
13,756. Adjusting Railway Signal Wires, J. P. Annett, Eastleigh.
13,757. Wheel Attachment or Coupler, T. Fox, Sheffield.
13,758. Preparing a Digestive Substance, J. and T. A. Marshall, Glasgow.
13,759. Fastener for Buttons, R. J. Urquhart and T. Humphreys, Chorlton cum-Hardy.
13,760. Holder for Pencils, &c., J. Buckland, Taunton.
13,761. Constructing, &c., Electric Arc Lamps, W. Rowbotham and F. S. Worsley, Manchester.
13,762. Manufacture of Hydrated Carbonate of Magnesia, &c., W. Bramley and W. P. Cochrane, Redcar.
13,763. Gridiron Carriage Steps, J. G. Harrison, Birmingham.
13,764. Measuring People Automatically, J. H. Airey, Sunderland.
13,765. Straining Oil, Liquids, &c., J. Stott, London.
13,766. Spanners, J. Brown and J. Howard, Liverpool.
13,767. Elevating and Discharging Mud, &c., W. Bull, Liverpool.
13,768. Washing Grain from Stones, &c., J. E. Shaw, Liverpool.
13,769. Detachable Driving Chains, F. H. Harrison and G. T. Wildsmith, London.
13,770. Toilet Purposes, S. Travado, London.
13,771. Raising and Lowering Costume Stands, J. Goodwin, London.
13,772. Hanging Short Window Blinds, W. H. M. Knight, London.
13,773. Preventing the Escape of Soot into Rooms during Chimney Sweeping, W. H. M. Knight, London.
13,774. Boots and Shoes, F. L. Smith and F. Tidy, London.
13,775. Killing Lime, &c., in Hides, C. I. Palmer, London.
13,776. Fastening the Loops of Reins, &c., S., J., and T. Copland, Glasgow.
13,777. Submarine Illuminated Telescope, J. J. Fletcher and H. Moreton, London.
13,778. Holding Photographs, &c., J. Harper, London.
13,779. Holding Window Sashes for Railway Carriages, &c., E. R. Calthrop, London.
13,780. Process for the Production of Azo Colours from Orthosulpho or Orthocarbo Acid of Benzidine, C. D. Abel.—(*Actiengesellschaft für Anilin-Fabrikation, Germany.*)
13,781. Wrought Iron Barrow Wheel, T. E. and W. R. Rowland, Fenny Stratford.
13,782. Velocipedes, A. C. and J. Sterry, London.
13,783. Frames for Displaying Photographs, &c., W. Moffatt and W. Scott, Glasgow.
13,784. Stoppering Bottles, &c., H. Bateman, London.
13,785. Fire-extinguisher, H. Bateman, London.
13,786. Cleaning Flues and Chimneys, D. Webster and P. Pfeiffer, London.
13,787. Pumps, W. H. Cloud, London.
13,788. Regenerative Gas Lamps, F. Siemens, London.
13,789. Combined Evaporating and Calcining Furnace, F. Siemens, London.
13,790. Electric Light Switches, G. Binswanger and H. Hirsch, London.
13,791. Deodorising Sewage, P. A. Ames, London.
13,792. Boxes of Cardboard, L. Gunn and J. Perry, London.
13,793. Annealing Pots, E. I. H. E. Whitehouse, London.
13,794. Suspended Hall Lamps, C. W. Torr, London.
13,795. Drawing-off Liquids from the Surface without Removing Sediment, E. F. Daniel, London.
13,796. Scoring Cardboard, L. Gunn and J. Perry, London.
13,797. Metal Bottles, &c., D. Clark, London.
13,798. Tools for Moulding Grooves in Mouths of Bottles, H. Codd, London.
13,799. Liquid for Preventing Incrustation in Boilers, W. G. Gard, London.
13,800. Propulsion of Vessels, E. Davies, London.
13,801. Increasing Draught of Gas, &c., Flues, R. A. Smith and W. Clark, London.
13,802. Construction of Valvular Apparatus of Syphon Bottles, H. Gelbfuss.—(*The Hanover Vulcanite Company, Germany.*)
13,803. Turrets for Guns, H. H. Lake.—(*La Compagnie de Fives-Lille, France.*)
13,804. Scrapers for Fuel Economiser Tubes, Sir E. Green, Bart., M.P., London.
13,805. Rotary Motive Power Engine, J. G. Tongue.—(*A. Brunner, Switzerland.*)

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13,806. Drilling Appliance for Fixing Wire Hinges to Boxes, E. Birch and J. H. Batty, Manchester.
13,807. Combined Safety Inkwell, H. Maynard, Newton-le-Willows.
13,808. Registering the Miles Travelled by Trap, &c., R. McShane, Camlough.
13,809. Ball Castor for Furniture, J. W. T. Stephens, Southfields.
13,810. Excavating and Delivering Machine, J. W. T. Stephens, Southfields.
13,811. Pulverising Machines, S. Mason, Leicester.
13,812. Paper-holder, &c., J. Chambers.—(*J. Burnett, Canada.*)
13,813. Gas Heating Stoves, H. J. Davies and H. C. Turner, London.
13,814. Aniline Black Dyeing, A. Aykroyd, W. E. Aykroyd, and J. Smith, Liverpool.
13,815. Bending Ships' Plates, H. Smith, Glasgow.
13,816. Reels for Holding Fabrics, C. Longbottom, Bradford.
13,817. Attachment for Brace Buckles, A. S. Taylor, Manchester, and W. H. Walker, Birmingham.
13,818. Forcing Oil into Cylinders, &c., J. Dickman, Newcastle-on-Tyne.
13,819. Steam Washing Machines, J. Heselwood, Manchester.
13,820. Washing Machines for Laundries, J. Heselwood, Manchester.
13,821. Soaping, &c., Textile Materials, &c., J. Heselwood, Manchester.
13,822. Polishing Metals, J. Hibbert and T. Clarke, Manchester.
13,823. Artificial Manufacture of Coal, F. V. Hadlow, Buxted.
13,824. Gas Fires, A. Thomson, Glasgow.

13,825. CHANGING BOXES for PHOTOGRAPHIC PURPOSES, A. W. Dollond, London.
13,826. REGULATING the MOVEMENTS of DIGGING MACHINE FORKS, J. J. Arnold, Southampton.
13,827. FITTING CYLINDERS with BLADES, B. Makin, London.
13,828. INTERCEPTING SAFETY APPARATUS for GUNS, W. J. Penn, London.
13,829. TREATMENT OF SEWAGE, F. Candy, London.
13,830. WEIGHING MACHINES, F. T. Wenborn, H. W. and J. F. Coppen, London.
13,831. INKING APPARATUS, F. Myers, Liverpool.
13,832. ELECTRICAL IGNITING APPARATUS, A. Schweizer and S. Grunwald, London.
13,833. SEPARATION OF WOOL from SKINS, J. R. Tussaud, London.
13,834. PREPARING CARD for BOXES, &c., T. Nevell, Suffolk.
13,835. REGULATING the FLOW of WATER into HOUSES, A. Caldwell, Glasgow.
13,836. WRAPPERS for the CONVEYANCE of TINS, H. E. Aspinall, London.
13,837. COLOUR PRINTING, A. B. Johnston and W. F. Fair, Glasgow.
13,838. COMBINATION TAPS for BURNERS, T. A. Greene and C. M. Walker, London.
13,839. EJECTING CARTRIDGES from FIRE-ARMS, E. Harrison, London.
13,840. VENTILATOR for POULTRY HOUSES, H. D. Terry, London.
13,841. BICYCLES, W. H. Parkes and the Sparkbrook Manufacturing Company, London.
13,842. ELECTRICITY for CARRIAGE LIGHTING, J. Mettlik, London.
13,843. IRRIGATORS, H. Wartmann, London.
13,844. FRANKEL'S DEFLECTOMETER, &c., O. Leuner, London.
13,845. LAWN TENNIS NETS and POLES, &c., J. Reid, London.
13,846. MACHINE for WASHING LINEN, &c., J. Eaton, London.
13,847. TOBACCO PIPES and CIGAR HOLDERS, R. Jeantet-David, London.
13,848. FIRE LIGHTERS, L. Falk, London.
13,849. TRANSPORTING LOADS by HAULING ROPES, J. P. Roe, London.
13,850. MACHINERY for GATHERING BOOK SECTIONS, T. W. Jamieson, London.
13,851. ROTARY RETORTS, J. H. Selwyn and E. Field, London.
13,852. HOLDING BALL PROGRAMMES, &c., F. W. Powell, London.
13,853. SPANNER for CARRIAGE WHEEL OIL CAPS, H. Walker, London.
13,854. SEWING MACHINES, O. Robinson, London.
13,855. COPYING PAPER, G. B. Blandner and I. Traube, London.
13,856. MACHINES for WASHING BOTTLES, H. H. Lake.—(N. J. Simonds, United States.)
13,857. RETAINING CORKS in BOTTLES, J. Deek, London, and T. E. Harper, Essex.
13,858. AXLE BOXES and the LUBRICATION of SHAFTS, H. K. Austin, Birmingham.
13,859. SHIPPING COAL, P. G. B. Westmacott, Newcastle-upon-Tyne.
13,860. ORGANS, S. Chatwood, London, and A. B. Chatwood, Prestwich.
13,861. DISTILLING, I Bernhardi, London.

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13,862. CANDLE SHADE HOLDERS, G. Whyte, Elgin.
13,863. COLLAPSIBLE BOXES, &c., A. L. Lineff and W. Jones, London.
13,864. SELF-ACTING CANDLE EXTINGUISHER, J. R. Ruthven, London.
13,865. PREPARATION of IODISED OIL, A. Macalister and W. Stewart, Glasgow.
13,866. HAT LEATHERS, W. Ruttenau, Manchester.
13,867. PAPER GUMMING, &c., MACHINE, P. Trussy, London.
13,868. PARTITIONS, G. Humblet, London.
13,869. METALLIC ALLOY, H. Levetus and M. Wilkins, Birmingham.
13,870. RAISING GALLERY HOLDERS for LIGHTING PARAFFINE LAMPS, H. A. Walker, Epping.
13,871. FOLDING BOOK SHELVES, &c., C. Haarburger, London.
13,872. FITTING SPRINGS to HEEL of BOOTS, S. S. Hazeland, St. Sampson's, Par Station, Cornwall.
13,873. RELIEVING WEIGHTS of WINDOWS, &c., when being RAISED, J. Simpson, Heaton Chapel, near Stockport.
13,874. TWISTING FRAMES, A. Combe, Belfast.
13,875. COMBINATION LETTER FILE and COPYING BOOK, G. F. Attree, Brighton.
13,876. CUTTING CHEESE, A. Wilson, Fife.
13,877. GOVERNORS of STEAM, &c., ENGINES, W. Hornsby and F. J. Cribb, Grantham.
13,878. BRAKES for LOCOMOTIVES, &c., G. H. Poor, London.
13,879. COMBINED LATCH and LOCK, J. C. Craig, London.
13,880. CIGAR HOLDER and PIERCER, H. Agar and T. S. Griesbach, London.
13,881. EMERY, &c., GRINDING WHEELS, E. D. Barker, London.
13,882. ADVERTISING by PANORAMAS, &c., G. E. Skliros, London.
13,883. WOVEN WIRE MATTRESSES, &c., J. Pickering, London.
13,884. CUTTING PILE of PILED FABRICS, W. Howarth, London.
13,885. TIPPING CARTS, &c., H. Briggs, Leeds.
13,886. DISTILLING WATER for BOILERS for SHIPS, &c., C. Blagburn and A. Thomson, London.
13,887. UMBRELLAS, &c., T. A. Classon and J. Hampson, London.
13,888. POCKET INHALER, J. L. Mérigot, London.
13,889. INCANDESCENT ELECTRIC LAMPS, A. P. Laurie, London.
13,890. PNEUMATIC RAILWAY BRAKES, J. Y. Johnson.—(L. Soulerin, France.)
13,891. SHIPS' BOATS, A. McDougall, Glasgow.
13,892. LOCKING NUTS, C. Henderson, Glasgow.
13,893. MECHANICAL LEVER MOTION, J. C. Mewburn.—(T. A. Weston, United States.)
13,894. STIFFENING HEMP, &c., G. Walker, London.
13,895. HOLDING and TUNING STRINGS of PIANOS, &c., F. Rähse, London.
13,896. SUPPLYING CIGARS, &c., in EXCHANGE for COINS, E. Edwards.—(C. Bach, Switzerland.)
13,897. HEATING by GAS, W. T. Sugg, London.
13,898. STEP LADDERS, J. T. Bower, London.
13,899. HAT BOXES, K. Hobson, London.
13,900. MEDICINAL PREPARATION, H. W. Bellew, London.
13,901. AERIAL MACHINES, S. Lemmon, London.
13,902. TRAVELLING WHEELS, W. N. Nicholson and W. Mather, London.
13,903. FORMATION of HOSE, A. C. Oakes and C. Coggan, London.
13,904. TRICYCLES, R. Robertson, London.
13,905. GAS REGULATOR and SAFETY STOP VALVE, J. Stott, London.
13,906. WIRE ROPES, A. Latch and T. C. Batchelor, London.
13,907. LIGHTING FIRES, E. Hawkins, London.
13,908. TRANSMISSION of SOUNDS, C. Pollak and G. Binswanger, London.
13,909. HEATING APPARATUS, J. Kaufmann and J. Regan, Liverpool.
13,910. PRODUCTION of ELECTRICITY, G. Quarrie, Liverpool.
13,911. GAS BURNERS, A. J. Boult.—(G. H. Candler, Canada.)
13,912. HANDLES for CRICKET BATS, F. Dark and Sons, London.
13,913. GRIPPING ROPES, W. P. Bullivant, London.
13,914. GRIP for ROPES, W. P. Bullivant, London.
13,915. SAND BLAST MACHINES, H. H. Lake.—(F. W. King and J. Nase, Canada.)
13,916. LOOSE REED LOOMS, G. F. Bancroft and F. Hopkinson, London.
13,917. TABLES for GRINDING, &c., PLATE GLASS, E. Brown, London.
13,918. MEMORANDA APPARATUS, G. C. J. Jelf, London.
13,919. CRANES for WORKING GRAB DREDGERS, W. Pitt, London.
13,920. CASTINGS in IRON and STEEL, T. Nordenfelt, London.
13,921. MEDICAL PADS and BANDAGES, W. B. Robinson and E. Robinson, London.
13,922. MOULDING COAL DUST into SOLID BLOCKS, W. H. Lindsay, London.
13,923. VELOCIPEDES, W. T. Shaw, W. Sydenham, and A. Sydenham, London.
13,924. SADDLES, F. P. L. White, London.
13,925. PACK SADDLES, F. P. L. White, London.
13,926. SEWING MACHINES, J. H. O'Kelly and H. S. Russell, London.
13,927. CONSTRUCTION of PROJECTILES, A. Lancaster, London.

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13,928. HUMID REDUCTION of GOLD, &c., ORES, J. E. Baugh and C. Hinksman, London.
13,929. DISTILLATION of COAL TAR, &c., H. Ellison and G. E. Davis, Manchester.
13,930. NEW SLIP SCREW BUTTON FASTENING, I. Drakeford, sen., Wellingborough.
13,931. STEERING VELOCIPEDES, O. B. Granville, London.
13,932. COMPLETE BOX BALANCED BLIND FITTINGS, I. Drakeford, sen., Wellingborough.
13,933. PRODUCTION of ORNAMENTAL FIGURES, M. Watts-Hughes, London.
13,934. DOUBLE SHIELD SCYTHE RAZOR, I. Drakeford, sen., Wellingborough.
13,935. GAS HALL LANTERNS, R. H. Best, Handsworth.
13,936. OBTAINING a more even TENSION on the THREAD of WAX-THREAD SEWING MACHINES, J. Willis, Worcester.
13,937. ATTACHING KNOBS to their SPINDLES, E. W. Taylor, Birmingham.
13,938. FORMING MOULDS, J. Butler and J. Evans, Manchester.
13,939. DRIVING GEAR for WASHING, &c., MACHINES, W. Smith, D. Marks, and R. Watson, Skipton-in-Craven.
13,940. CUTTING DOUBLE PILE FABRICS, J. A. Bright, Manchester.
13,941. SPRING LOCKS, C. S. Madan, Manchester.
13,942. WASHING COAL, J. F. Waldie and R. Stewart, Glasgow.
13,943. BARLEY MILL, J. Watson, Glasgow.
13,944. ADJUSTING DOOR KNOBS to their SPINDLES, W. G. Macvitie, A. E. Phiips, and C. F. Davis, Birmingham.
13,945. ADJUSTABLE CYCLOMETERS, &c., R. W. Willis, London.
13,946. REGENERATIVE GAS LAMPS, T. G. McEwen, London.
13,947. GOVERNOR for the SUPPLY of GAS, T. G. McEwen, London.
13,948. CYCLES, &c., C. H. Guest and L. Barrow, Birmingham.
13,949. CONDENSERS, W. Whittle, Smethwick.
13,950. ORDNANCE, W. Tranter Birmingham.
13,951. WAIST BELT BOBBIN REEL HOLDER, A. Cheek, London.
13,952. ECONOMISING STEAM in ENGINES, A. H. Chartres, Derby.
13,953. SASH FASTENER, M. Macleod, London.
13,954. SANITARY BED-PAN, &c., J. H. Saunders, London.
13,955. CURING ARTICLES of FOOD, H. Stockman, North Sunderland.
13,956. NEEDLES, P. Gotthelf, London.
13,957. FANCY YARN, F. Broadbent and J. Brown, Halifax.
13,958. SPRING MOTOR for BICYCLES, J. Cheshire and A. Bindschädler, Birmingham.
13,959. OPEN KILNS, &c., J. Howie and T. Groves, Glasgow.
13,960. TOBACCO PIPES, W. H. Burwood, Smethwick.
13,961. CASTORS, C. J. Harcourt, London.
13,962. ZINC for the PREVENTION of CORROSION in STEAM BOILERS, E. J. Pape, Liverpool.
13,963. VALVE GEAR for MOTIVE POWER ENGINES, Rolzano, Tedesco, and Co., London.
13,964. SILICA BRICK, J. A. Watson, London.
13,965. BATS, &c., for LAWN TENNIS, &c., P. G. Shadbolt, London.
13,966. CLEANING BAGS employed in the MANUFACTURE of SUGAR, W. T. Crooke, London.
13,967. RAISING or LOWERING the SEATS of CHAIRS, &c., W. Bendall, Birmingham.
13,968. CORSETS, J. Fuchs, London.
13,969. BALING MACHINES for HYDRAULIC, &c., PRESSES, A. Urquhart, Glasgow.
13,970. SAFETY VALVE, A. C. Bewers, Colchester.
13,971. SELF-REGULATING ELECTRIC PORTABLE BATTERY and LAMP, H. R. Fisher, London.
13,972. WALNUT HOLDER and PEELER, A. C. Adcock, Birmingham.
13,973. AUTOMATIC GAS BURNER, J. F. Wright and G. E. Wright, Birmingham.
13,974. ELECTRIC TELEPHONY, J. G. Lorrain, London.
13,975. ELECTRIC ALARM CLOCKS, R. Eras, London.
13,976. LOOMS for WEAVING CARPETS, F. L. Whistler, Halifax.
13,977. COMBINED LETTER PAPER and ENVELOPE, P. H. Hewitt, London.
13,978. COUPLING DYNAMO-ELECTRIC MACHINES with a MAIN CIRCUIT, C. D. Abel.—(Siemens and Halske, Germany.)
13,979. LUBRICANT, A. G. Wass, London.
13,980. AUTOMATIC VENT, H. P. Dick, London.
13,981. HYDRAULIC ENGINES, B. Tydeman, Erith.
13,982. DREDGING or ELEVATING MACHINERY, B. Tydeman, Erith.
13,983. BOSS VALVE, J. Creighton, London.
13,984. MOULDING BRICKS or BLOCKS, W. H. Lindsay, London.
13,985. ARTIFICIAL FUEL, W. H. Lindsay, London.
13,986. PEDALS for VELOCIPEDES, C. K. Welch, Tottenham.
13,987. COLLECTOR for DYNAMO MACHINES, J. G. Statter, S. L. Brunton, and J. W. Kempster, London.
13,988. CYLINDER PRINTING MACHINES, A. Parrizy, London.
13,989. ELECTRIC MOTOR, J. B. Denis, London.
13,990. VELOCIPEDES, H. H. Lake.—(La Société P. Rousset and E. Ingold, France.)

1st November, 1886.

13,991. HORSE and CATTLE MEDICINE BIT, R. Wright, T. J. Hester, and S. Wright, London.
13,992. CARTRIDGE for BREECH-LOADING FIRE-ARMS, L. L. Sullivan, Cork.
13,993. PEN and PENCIL-HOLDERS, G. F. Beutner and A. A. Lateulère, London.
13,994. KEY for RAILWAY CHAIRS, W. W. Ward, Burton-on-Trent.
13,995. BUILDING, &c., HEELS by TREADLE POWER, J. M. Gimson J. Gimson, A. J. Gimson, and S. A. Gimson, Leicester.
13,996. COMBINATION TOOL, N. Goodier, Manchester.
13,997. CYLINDER PRINTING MACHINES, D. T. Powell, London.
13,998. METALLIC RECEPTACLES for HOLDING ALIMENTARY SUBSTANCES, F. M. E. Pizey, London.
13,999. UNIVERSAL SLOTTING and BORING BARS, J. Findlay, Birmingham.
14,000. PACKING TOBACCO, J. Hignett, Liverpool.
14,001. REVERSIBLE VALVE STOPPER for BOTTLES, A. Barnfather, Carlisle.
14,002. SELF-ACTING ELECTRO-MAGNETIC COMBINED SWITCH and CUT-OUT, J. M. V. Kent, Westminster.
14,003. ELECTRIC SAFETY LAMPS, W. Banks and S. Brierley, London.
14,004. STOP VALVE, A. Pohlman, Halifax.
14,005. FACILITATING the WORKING of TRICYCLES, &c., E. G. Pepper, Gainsborough.
14,006. FIXING SOLES and HEELS of BOOTS, W. P. Sherwood, Northampton.
14,007. OUTSIDE SHOP WINDOW LAMPS, H. Campbell, Glasgow.
14,008. WHITE RICE MACHINERY, R. Douglas and L. Grant, Kirkcaldy.
14,009. PURIFYING the ATMOSPHERE of COAL MINES, J. A. Ramsay, London.
14,010. STOP JOINT or HINGE, J. B. Fenby, Sutton Coldfield.
14,011. SPINDLE for LOCKS, &c., J. Buckland, Taunton.
14,012. ADJUSTABLE SPANNERS, J. Carter and W. J. Whiting, Sutton Coldfield.
14,013. AUTOMATIC INKSTAND, A. E. Gorse, West Bromwich.
14,014. FIRE COAL SAVERS, S. Broadbent, Manchester.
14,015. PLAIN and CORRUGATED SHEET IRON ROOFS, W. Bagshaw, Dudley.

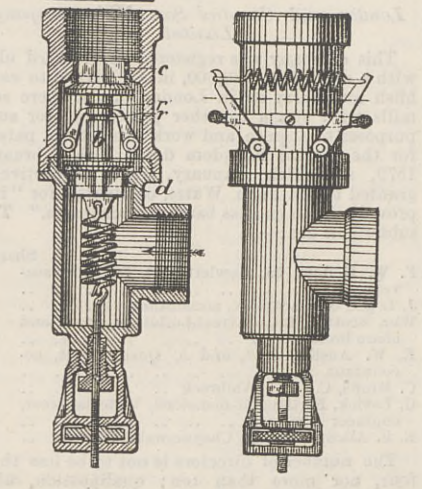
SELECTED AMERICAN PATENTS.

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

347,840. GAS REGULATOR, *John Stubbe, Pittsburg, Pa.—Filed May 7th, 1885.*

Claim.—(1) The combination of a valve chamber having opposite ports for the passage of gas, which flows directly through both ports, and a double-faced regulating valve arranged between the ports and actuated by the gas flow, variation in which causes the approach of one of the valve faces to its port and the recession of the other valve face from its port, substantially as and for the purposes described. (2) The combination of a valve chamber having opposite ports for the passage of gas, which flows directly through both ports, and a double-faced valve moving in the direction of the gas flow on the increase thereof, and

347,840.

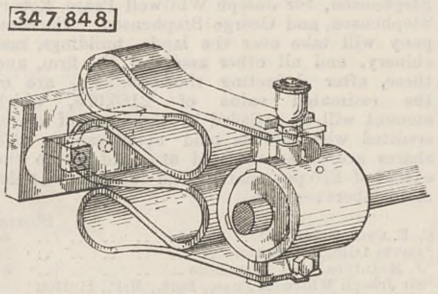


so arranged and actuated relatively to its port that an increase of gas pressure shall cause the approach of one of the valve faces to its ports to contract the opening thereof, and shall simultaneously cause the recession of the other valve face from its port to increase the opening thereof, and that a diminution of gas flow shall cause a reverse movement of the valve face to correspondingly open one port and contract the other, substantially as and for the purposes described. (3) As an automatic locking device for regulator valves, the combination of the valve and locking fingers bearing against opposite sides of the valve or its stem and arranged to engage a notch therein, substantially as and for the purposes described. (4) The combination, with the double-faced valve b, arranged to seat in opposite directions against its ports c d, and having the two notches r r^1, of a locking finger bearing against the valve and arranged to engage the notch r when the valve is seated against one port, and to engage the notch r^1 when the valve seats against the other port, substantially as and for the purposes described.

347,848. EXCENTRIC FOR OPERATING SCREENS OF MIDDLINGS PURIFIERS, *John T. Walton, Easton, Pa.—Filed March 31st, 1886.*

Claim.—The combination, with a driving shaft, excentric, and the box or casing thereof, of a flat

347,848.

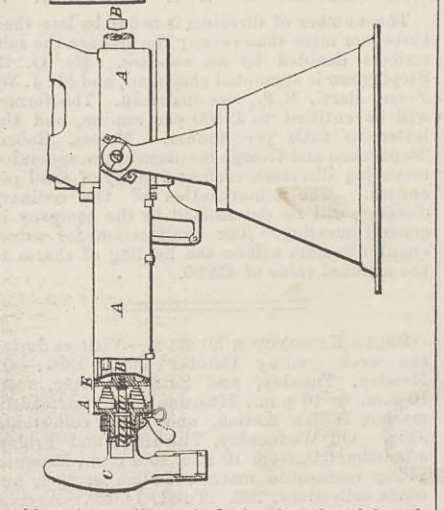


metal spring bent in serpentine shape or in folds, as shown, in contradistinction to the coil or spiral spring, and connected to the box or casing and to the object to be vibrated, substantially as and for the purpose set forth.

347,945. RECOIL MECHANISM FOR GUNS, *Hiram S. Maxim, London, England.—Filed May 18th, 1886.*

Claim.—(1) The combination, in a gun, of a frame or support mounted upon trunnions and provided with a

347,945.

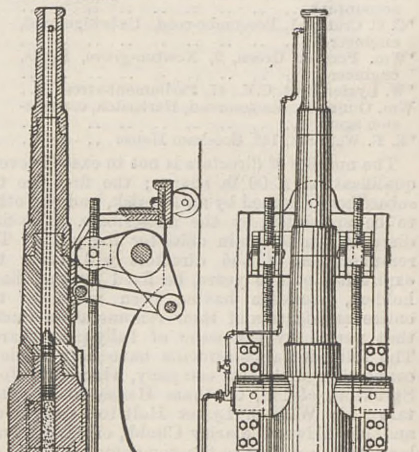


shoulder piece or its equivalent, a barrel and breech mechanism movable in said frame, and a buffer or device interposed between the barrel and the frame for diminishing the shock produced by the recoil, as herein set forth. (2) The combination, in a gun, of an outer frame or support mounted upon trunnions and provided with a shoulder piece or its equivalent, an inner frame adapted to slide to and fro in said outer frame, a barrel and breech mechanism carried by the inner frame, and a buffer or device, substantially as herein described, interposed between the two frames for diminishing the shock of the recoil, as set forth. (3) The combination of a frame or support mounted upon trunnions and provided with a shoulder piece or its equivalent, a barrel and breech mechanism adapted to move to and fro in said frame, and a dash-pot, the two parts or members of which are connected respectively to the frame and the movable barrel, whereby it is adapted to act as a buffer to diminish the shock of the recoil of the barrel, as set forth. (4) The combination of a frame or support mounted upon trunnions and provided with a shoulder piece or its equivalent, a barrel and breech mechanism adapted to move to and fro in said frame, a dash-pot, the two parts or members of which are connected respectively to the frame and the movable barrel for taking up the recoil of the barrel, and a volute spring or its equivalent interposed between the barrel and frame for restoring the barrel to position after recoil, as set forth. (5) The combination of the outer frame A, provided with the trunnions A^1 A^1 and the shoulder piece or its equivalent C, the inner frame B, movable in the frame A, the barrel and breech mechanism carried by the frame B, the chamber D, containing glycerine or other fluid and contained in or connected with the frame A, the piston a, connected to frame B and working in the chamber D, and the springs or their equivalent interposed between the two frames, as and for the purpose set forth.

347,984. OPERATING ORDNANCE, *Benjamin T. Rabbit, New York, N.Y.—Filed February 6th, 1886.*

Claim.—The combination, with a cannon or piece of ordnance and its carriage, of an air exhausting apparatus mounted independently of the cannon or piece of ordnance, a socket concentric with the

347,984.

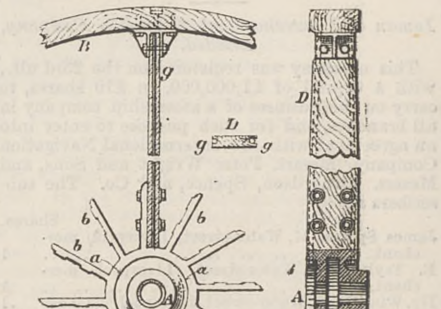


trunnions of the cannon, a pipe leading from said socket to the cannon or piece of ordnance in front of the charge, and a pipe leading from the air exhaust apparatus into said socket, and through which the air may be exhausted from the bore of the cannon in front of the charge when a cap is applied over the muzzle, substantially as herein described.

348,283. SUPPORTING WHEEL FOR BAND SAWS, *George M. Hinkley, Milwaukee, Wis.—Filed July 20th, 1886.*

Claim.—The herein described carrying wheel for a band saw, comprising hub A circumferential flange a, projecting laterally therefrom, plates b, radiating from said hub, felly B, sockets c on the inner face of the felly, spokes D, secured at opposite ends of the sockets c, and plates b and rods g, connecting the hub and felly, substantially as shown and described. (2)

348,283.



In a carrying wheel for a band saw, the combination, with a hub, a felly, flat wooden spokes secured to the hub and the felly, and the metallic tie rods inserted in the edges of the spokes. (3) In a band saw mill, the upper saw carrying wheel herein described, comprising a hub, a rim, and a series of broad flat spokes connected at opposite ends to the hub and rim, and arranged with their flat faces substantially in line with the axis of the wheel.