SCREW PROPELLER EFFICIENCY.

By A. G. GREENHILL.

No. VI.

(71) LET us examine the reason for the discrepancy between our results and those of Rankine in (69).

We have, using Coriolis' formula (*Comptes Rendus*, 1843), taken the thrust

$$T = m\,a\,u\,(n\,p - u),$$

implying that the top edge of the lowest float of a paddle-wheel is just immersed when the vessel is at rest, so that a denotes the sectional area of the streams before they are acted upon by the floats.

But Rankine works with the formula

$$T = m\,a\,v\,(v - u)$$

when $v = n\,p$, (Trans. I.N.A., 1865); implying that the top edge of the lowest float is such a distance below the level of the water when the vessel is at rest, that when propelling the vessel the cross section of the stream driven astern by the paddle-wheels is exactly equal to a, the area of a pair of floats.

By the preceding investigations of (64) the depth of the top edge of a float in the lowest position should then be

$$b\left(\frac{n\,p}{u} - 1\right)$$

to obtain Rankine's result, and our value of the thrust T = 9570 lb. must be multiplied by

$$\frac{n\,p}{u} = \frac{1}{1-s} = 1{\cdot}28,$$

giving the thrust 12,271 lb., exactly as given by Rankine.

The augmentation of resistance due to the fall of level of the wake of the paddle-wheels would be, as before (70)

$$64\,B\,b\left(\frac{n\,p}{u} - 1\right) = 2688\text{ lb.},$$

if B = 50, b = 3; so that the net resistance should be

$$12{,}277 - 2688 = 9589\text{ lb.}$$

The vessel will now be drawing

$$12\,b\left(\frac{n\,p}{u} - 1\right) = 10{\cdot}08\text{in.}$$

more than was supposed in (69, 70); and the horse-power consumed by the paddles will be now 390; so that the examination of this discrepancy shows the important effect of a slight alteration of draught on the efficient working of paddle-wheels—an effect which is not experienced to such an appreciable extent with a screw propeller, when once the blades are properly submerged.

(72). *The feathering paddle-wheel.* — As usually constructed, the mechanism of the feathering-wheel is arranged so as to make the planes of the floats pass through the highest point of the pitch circle, that is, the circle through the centres of pressure of the floats; the perpendiculars to the floats then all pass through the lowest point of the pitch circle (Goodeve, "Mechanism").

This is right for securing the proper direction of the floats on emergence from the water, and the action is analogous to the operation of "feathering" an oar by a slight turn of the wrist.

But in order for the floats to enter the water at the proper angle, the normal to the float should pass through the lowest point of the apparent rolling circle, that is, through a point a distance $\frac{u}{n}$ vertically below the axis of the wheel; so that the entering float will have to be very nearly parallel to the emerging float.

Buchanan's original paddle-wheel of 1813 would very nearly secure this motion of the floats if set with the proper amount of lead.

Then to determine the thrust of such wheels, the formulæ of (61) and (71) would be most appropriate.

VI. INVESTIGATION OF THE EFFICIENCY OF A SAILING VESSEL, INCLUDING THE ICE-BOAT.

(73) Before investigating the propulsive effect of the wind on the sails of a vessel, let us consider some preliminary propositions on the aberration of the wind due to the composition of the vessel's motion with the true wind, producing a resultant apparent wind, as experienced by the vessel.

A steamer moving in a calm feels a wind equal to its own velocity reversed; but if moving in a breeze, feels a wind which is compounded of the true wind and the wind the vessel creates, that is, a wind equal to its own velocity reversed.

The true wind is given in direction by a vane, and in velocity by an anemometer fixed on shore, while the apparent wind on the vessel is given in direction by the vane on the mast, and in velocity by an anemometer carried by the vessel, the velocity of the vessel itself being given in direction and magnitude by the compass and the log.

In a steamer the line of smoke from a funnel will appear to an observer standing close under the funnel to assume a general direction in a vertical plane parallel to the vane in the mast.

For the particles of smoke on issuing into the open air are almost immediately carried away with the velocity of the true wind, but the general column of the smoke assumes the direction of the apparent wind. Knowing, then, the direction only of the true wind, and the direction and velocity of the apparent wind as observed on the vessel, we can immediately determine the velocity of the vessel by the triangle of velocities.

For drawing, O S to represent in direction and magnitude the apparent wind, parallel to the vane on the mast or to the smoke of a funnel, and drawing S W parallel to the direction of motion of the vessel to meet O W parallel to the true wind in W, then S W will represent the velocity of the ship.

(74) Drawing S O′ parallel to W O to meet O′ O, the direction of motion of O in O′, then the particles of smoke which issued from the funnel when at O′ will now be at S when the funnel has come to O. In fast steamers the aberration of the wind is so great as to make the apparent wind draw ahead to such an extent that is is very rarely found useful to set sail to help the progress of the vessel, unless the sails set well and flat and the true wind is a good deal abaft the beam. For in order that a sail should draw and propel the vessel, it is necessary that the

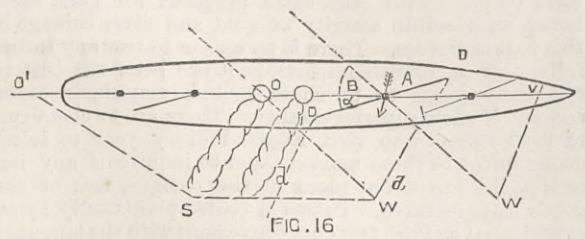


FIG. 16

plane of the sail should lie in the angle between the apparent wind and the vessel's line of motion, the pressure on the sail being smaller the more nearly its plane is parallel to the apparent wind.

(75) *The Ice-boat.*—In the ice-boat, Fig. 17, the resistance of friction to motion in the line of the keel may be considered so small as to be practically negligible, so that when going at full speed in a steady wind the apparent wind is felt parallel to the sail, and the vane is also seen pointing parallel to the sail, or nearly so. If the wind freshens a little, the apparent wind makes the sail draw a little more, and the ice-boat is accelerated; if the wind lulls a little, the sail ceases to draw, and even backs, and the ice-boat is retarded. On the supposition, then, that the vane is parallel to the sail, a simple geometrical construction gives the velocity of the boat, when the velocity of the wind is known.

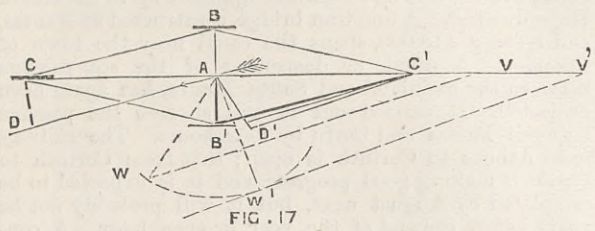


FIG. 17

For the skates or runners B, B′, C of the ice-boat prevent any lee-way, and therefore C A, the line of the keel, is the direction of motion.

Draw A W to represent the true wind, and W V parallel to the vane on the mast, represented by the arrow, which we may suppose parallel to the sail A D; then A V represents the velocity of the ice-boat.

The velocity of the boat will thus be greater, the closer the sail is hauled in to the line of the keel; in fact, in an ice-boat the sheets are always hauled in close, and the sail made to sit as flat as possible.

The figure shows that A V is greatest when A W is at right angles to the vane or sail; denoting by γ the angle between the sail and the keel, then the maximum velocity of the boat is W cosec γ, W denoting. the velocity of the wind; the true wind is then an angle γ abaft the beam. For instance, if we can set the sail so well as to make γ so small that $\sin\gamma = \frac{1}{3}$, then the maximum velocity of the boat is 3 W; or with the true wind slightly abaft the beam the boat will go sixty miles an hour when the wind is blowing only twenty.

(76) Again, in beating to windward, A U will represent the windward component of the velocity if V U is drawn perpendicular to W A, produced to meet it in U.

If β denotes the angle V A U between the boat's keel and the eye of the wind, V the velocity of the boat, U the windward component, then generally

$$\frac{V}{W} = \frac{A\,V}{A\,W} = \frac{\sin\,(\beta-\gamma)}{\sin\,\gamma},$$

and

$$U = V\cos\beta = W\,\frac{\sin\,(\beta-\gamma)\,\cos\beta}{\sin\,\gamma}$$

$$= \tfrac{1}{2}\,W\,\frac{\sin\,(2\,\beta-\gamma)-\sin\,\gamma}{\sin\,\gamma};$$

so that, keeping γ fixed, U is a maximum when $\sin(2\,\beta-\gamma)=1$, or $\beta = 45° + \frac{1}{2}\gamma$, giving the most advantageous course for beating to windward; and then

$$U = \tfrac{1}{2}\,W\,(\text{cosec}\,\gamma - 1).$$

For instance, if as above we can make sin. γ equal to or less than $\frac{1}{3}$, then we shall have U equal to a greater than W; so that we have theoretically the extraordinary fact that it is possible to beat to windward and make ground against the wind faster than the wind is blowing in the opposite direction; for instance, to make twenty miles in the teeth of the wind in an hour against a wind blowing twenty miles an hour.

(77) Even when running before the wind there is no necessity to let out the sheets, as the boat then runs with the wind at the same velocity as the wind. In fact, it is found better in going with the wind to beat to leeward, for β now denoting the angle between the keel and the direction of motion of the wind—Fig. 16—the component velocity to leeward is

$$U = W\,\frac{\sin\,(\beta + \gamma)\,\cos\beta}{\sin\,\gamma}$$

$$= \tfrac{1}{2}\,W\,\frac{\sin\,(2\,\beta + \gamma)-\sin\,\gamma}{\sin\,\gamma},$$

a maximum when

$$\sin\,(2\,\beta+\gamma) = 1,\ \beta = 45° - \tfrac{1}{2}\gamma,$$

and then

$$U = \tfrac{1}{2}\,W\,(\text{cosec}\,\gamma - 1),$$

which is equal to or greater than W, according as sin γ is equal to or less than $\frac{1}{3}$. For a further account of the ice-boat, and of the experimental verification of the above theories, the reader is referred to *Scribner's Magazine*, vol. xxii., and the *R. E. Journal*, November, 1886. The ice-boat is made of a triangular framework, B B′ C—shown in plan in Fig. 17—carried by fixed runners at B and B′, and a pivotted runner at C′, actuated by a helm to steer the boat. The mast at A and the bowsprit A C′ carry the sails A D, C′ D′, like the mainsail and jib of an ordinary cutter yacht.

(78) *The theory of the sailing vessel.* — Returning to the theory of the ordinary sailing vessel, and supposing the lee-way insensible, so that the velocity of the vessel A V is in the direction of the keel, then as before W V will be parallel to the vane on the mast (Fig. 16), but now the sail must lie in the angle between the vane and the keel in order to catch the wind and propel the vessel against the resistance of the water, and therefore make an angle α with the keel, less than γ.

To obtain the pressure of the wind on the sail, let us first adopt the ordinary theory employed for determining the pressure of a jet on a plane area—*vide* Unwin's "Hydraulics," "Encyclopædia Britannica," ninth edition, p. 512.

Then if a denotes the area of the sail in square feet, v the velocity of the *apparent* wind in feet per second, ρ the density of air in lb. per cubic foot, the quantity of air in lb. which strikes the sail per second is

$$\rho\,a\,v\,\sin\,(\gamma - \alpha),$$

and the momentum perpendicular to the sail destroyed per second is

$$\rho\,a\,v^2\,\sin^2\,(\gamma - \alpha),$$

which is therefore the thrust of the wind on the sail in poundals, which must be divided by g or 32 to reduce it to lbs.

The component thrust of the sail propelling the vessel in the direction of the keel is therefore

$$T = \rho\,a\,v^2\,\sin^2\,(\gamma - \alpha)\,\sin\,\alpha\text{ poundals,}$$

the component perpendicular to the keel

$$\rho\,a\,v^2\,\sin^2\,(\gamma - \alpha)\,\sin\,\alpha$$

tending to produce lee-way.

Now,
$$\frac{u}{W} = \frac{V\,W}{A\,W} = \frac{\sin\,\beta}{\sin\,\gamma};$$

so that

$$T = \rho\,a\,W^2\,\frac{\sin^2\,\beta\,\sin^2\,(\gamma-\alpha)\,\sin\,\alpha}{\sin^2\,\gamma},$$

involving the three angles α, β, γ.

But if V, the velocity of the vessel, is known by the log, we can determine one of these angles, say γ, in terms of the other two α and β.

For
$$\frac{V}{W} = \frac{\sin\,(\beta + \gamma)}{\sin\,\gamma}$$

$$= \sin\,\beta\,\cot\,\gamma + \cos\,\beta;$$

so that
$$\cot\,\gamma = \frac{V - W\cos\,\beta}{W\sin\,\beta},$$

and

$$T = \rho\,a\,W^2\,\sin^2\,\beta\,\sin\,\alpha\,(\cos\,\alpha - \cot\,\gamma\,\sin\,\alpha)^2$$

$$= \rho\,a\,W^2\,\sin^2\,\beta\,\sin\,\alpha\left(\cos\,\alpha - \frac{V - W\cos\,\beta}{W\sin\,\beta}\sin\,\alpha\right)^2$$

$$= \rho\,a\,\sin\,\alpha\left\{W\sin\,(\beta + \alpha) - V\sin\,\alpha\right\}^2;$$

and the problem in sailing is to determine the maximum value of T by variation of α, the angle at which the sail is set, for a given course determined by β.

Differentiating T logarithmically with respect to a, keeping the other quantities constant, to determine the maximum value of T,

$$-2\,\cot\,(\gamma - \alpha) + \cot\,\alpha = 0,$$

or

$$\sin\,(\gamma - 2\,\alpha) = \tfrac{1}{3}\sin\,\gamma,$$

or

$$\alpha = \tfrac{1}{2}\,\gamma - \tfrac{1}{2}\sin^{-1}\,(\tfrac{1}{3}\sin\,\gamma),$$

meaning that the sail should be set a little closer than the bi-section of the angle between the vane and the keel; and then the propelling thrust

$$T = \tfrac{4}{9}\,\rho\,a\,W^2\,\frac{\sin\,\alpha\,\sin^2\,\beta}{\cos^2\,\alpha}.$$

(79) The principle we have just employed to determine the thrust of a sail due to the wind, will be found very nearly the same as that given in (17, 18) for the action of the windmill and the thrust of a screw propeller.

The section of the sails of the windmill on the blades of a propeller by a coaxial cylinder of radius r and circumference c, was represented in Figs. 7, 8, and 10, developed into a plane, when the relative stream lines of the air or water before and after being acted upon developed into straight lines, and the sections of the blades followed each other at fixed distances like the sails on the mast of a ship; similar figures will be found given by MM. de Bruignac and Gouilly in the "Comptes Rendus de la Société des Ingénieurs Civils," 1885 and 1886, in their papers on the "Theory of the Screw Propeller."

(80) The determination of the actual stream lines past a single blade set obliquely in a current has been performed by Helmholz, Kirchhoff, and Rayleigh, but the mathematical investigation is very complicated ("Phil. Mag." Dec. 1876). According to this theory the average pressure on a plate due to a stream of density ρ and velocity v impinging at an angle θ, is

$$\frac{\pi\,\sin\,\theta}{4 + \pi\,\sin\,\theta}\,\rho\,v^2;$$

the distance of the centre of pressure from the centre of the plate, is

$$\tfrac{3}{4}\,l\,\frac{\cos\,\theta}{4 + \pi\,\sin\,\theta},$$

where l denotes the breadth of the plate, and the stream divides at a distance

$$\frac{2 - 4\cos\,\theta + 2\cos^3\,\theta + \theta\sin\,\theta}{4 + \pi\,\sin^2\,\theta}\,l$$

from the anterior edge of the plate, and there the pressure attains its maximum value.

In this theory there is a certain region of dead water or fluid behind the blade, limited by lines like D′ d, D′ d for the sail D′ D in Fig. 16.

The introduction of these more exact mathematical expressions in the previous investigations will modify but slightly the theoretical deductions.

ABSTRACTS OF CONSULAR AND DIPLOMATIC REPORTS.

No. VII.

Australia: Sugar-making machinery.—The United States Consul at Sydney reports that the bulk of machinery used for crushing and refining sugar in Australia is of British manufacture, very little coming from France and the United States, and a still smaller proportion from Germany. American machinery is admitted to be superior to all others; it runs more smoothly, is less liable to get out of order, and when out of order is easily repaired. There is an opinion here that the higher cost of production in the United States renders it impossible for their manufacturers to compete successfully with those of Great Britain. Not long ago several articles from the *Scientific American*, describing sugar-making machinery used in the great factory of Claus Spreckles at San Francisco were copied in the Australian papers, and attracted general attention; and if Americans would take the same pains to advertise their machinery here as they have done in Central America, the Hawaiian Islands, and the West Indies, the trade in such articles would soon be much greater. As yet some of the Australian refineries have introduced machinery for the manufacture of sawn cubes or block sugar, and as this article is preferred to any other kind there ought to be no difficulty in introducing sugar companies to manufacturers. The cost of making this kind of sugar is about the same as that of ordinary crystal or granulated sugar. It is said that the cost of converting sugar into cubes will not amount to 0·25 of a penny per lb. A refinery that does not make hard sugar, could, by using one of the American machines at a cost not exceeding from £416 to £624, increase its profits largely during the year. Some of the machines turn out easily 4000 lb. or 5000 lb. of sugar per hour. Five men only are required to work one of these, including putting in and taking out the sugar from the drying-rooms or stoves.

Canada: Tubular subway for Prince Edward Island.—When in 1872 Prince Edward Island entered into the Canadian Confederation, the Dominion Government guaranteed to keep open communication with the mainland in winter. This promise has not been kept, and high tides bring immense quantities of ice up and down the strait. In 1873 the Hon. George W. Howlan, a member of the Dominion Senate, conceived the plan of an iron tubular railway, so that goods can be shipped through at all seasons without break of bulk, shortening the time by days, and increasing trade with the United States. The shortest distance from Prince Edward Island—Carlton Head—to the mainland in New Brunswick is fourteen and a-half miles. It is proposed to run out on piers made from the New Brunswick shore. The tunnel will be 16ft. in diameter, built in segments of five to the circle, each 14ft. in length, composed of iron, and lined inside with 2ft. 8in. of concrete in the bottom, and 1ft. of concrete round the circumference. The subway will be laid by a plan recently patented in the United States by H. H. Hall, president of the Submarine Tunnel and Tube Company of New York, and exhibited lately at the Provincial Exhibition. The Dominion Government made a survey of the strait this summer for the proposed route. The bottom was found to be free from rocks, and composed entirely of brick clay. The work is considered practicable and simple, will take about three years to complete from the time of commencement, and is estimated to cost about £1,042,000. The plan of laying the subway is described in the United States patent 344,813, June 6th, 1886, entitled "Method of Construct ing Waterworks," and consists in laying a submarine tube by means of a travelling caisson which is moved ahead as the tube is built therein.

Germany—American goods for Sonneburg.—The following advice of the United States Consul at Sonneburg should be carefully studied by British manufacturers:—"The best way to increase American imports in this district is by exhibiting at the annual fairs and in large towns samples of our articles, especially of agricultural machinery and other implements. Mere advertisements and circulars will not do, as they seldom lead to the desired result here. Besides there has arisen in Germany a prejudice against American goods, though these goods are as honestly and substantially made as native productions. If our manufacturers would humour the German farmer somewhat, and send him ploughs with handles much heavier than those used in America, and hoes and spades similarly made, there would be some hope of our implements gaining a permanent foothold in the German markets, and the continual exhibition of our implements at central points, and in the many industrial fairs, would help greatly towards the same end. The German farmer is very conservative, and looks at new methods and tools cautiously, but he is neither a bigot nor a simpleton, and when convinced that a new implement is better than his old one he is willing to make the change. Goods made to suit the nature of the country and with some regard to the tastes of the people, together with cheerful and constant exhibition of the same, are methods which cannot fail to gain for our manufacturers a good and permanent market here.

Greece: Trade of Patras—Public Works.—The import trade of Patras remained stationary in 1886, owing to the difficulties caused by the blockade and the loss of property occasioned by the earthquake in August last. The value of goods imported by British vessels into Patras in 1882 was £244,290; the average value for the five years, 1882-6, was £249,072, and the value for 1886 was £236,100. These figures give a reduction in value of 3·34 per cent. between 1882 and 1886, and a reduction from the average of the five years of 5·20 per cent. Coal increased from 7193 tons in 1885 to 13,304 tons in 1886, or nearly nine-tenths. Most probably this increase will continue as soon as the canal through the Isthmus of Corinth and the railway from Athens are completed. In consequence of the forced paper currency being established in Greece, the exchange varied so much that merchants had great difficulty in calculating the value of their purchases. The new drachma is equal to a franc, or 9·6d. The increase of import duties on many articles, and the exaction of import duties in gold or its equivalent in paper money, have been very inconvenient and injurious to importers, as they have to pay 15 per cent. extra premium for gold, there being an absolute scarcity of gold and silver coinage in this part of Greece. There is no reason to fear any future falling-off in British imports, as it has been the custom for many years to purchase British manufactures on account of their superior quality. There are twelve firms of local dealers who visit England every year to select goods suited to these markets, and to inquire if any improvement has taken place in the designs, &c., of the goods manufactured. Patras is visited periodically by an experienced English traveller conversant with the language of the country, and several useful improvements in the make and shape of earthenware have, at his instigation, been introduced by English manufacturers, so as to suit the requirements and tastes of these markets. Cheaper goods are imported from Austria, France, and Switzerland, but it is questionable whether England ought to make inferior articles, and by doing so lose our markets for superior goods, as foreign articles would then be passed off as of English make. The breakwater to the westward of the Patras mole has been lengthened to the extent of about 334ft., and although during the earthquake in August last it subsided a little, the base seems now to be quite firm, and further works will be gradually carried on, so as to make a better shelter for vessels. At Carone and Modone, on the south-west coast of the Morea, contracts have been made for improving these ports. The canal at Corinth is making good progress. Out of the entire quantity of 10,475,400 cubic yards of earth and rock to be excavated, about five-eighths had been accomplished up to the end of December last. A fine iron bridge, constructed at Nantes, and costing £13,000, spans the canal near the town of Poseidon. A canal, or deepening of the sea passage between the mainland and Santa Maura, has again been projected. If carried out it will shorten the passage between Patras and Corfu by four hours. The railway from Athens to Corinth is open; that from Corinth to Patras is making good progress, and it is expected to be completed by August next, but it will probably not be ready before the end of the year, or even later. A considerable quantity of steel rails has been brought from Antwerp; some iron bridges and wooden sleepers have been imported from France. The labourers, numbering several thousands, working upon the Corinth Canal and Railway, come from Dalmatia, Italy, and Montenegro.

Japan: How to extend British commerce in.—The best way to do this is to send out skilled experts in the trade, who can not only investigate its prospects and wants on the spot, but also actively and vigorously push the sale of the productions in which they are interested direct to the Japanese retail and wholesale dealers in Tokio, personally meeting the former, taking their orders immediately from them, and generally acting as commercial travellers do. This course cannot be too earnestly urged on English manufacturers in general. It is, of course, best that such agents should be permanently located in Tokio, but the experiment might at first be tried temporarily, and the cost need not be very great; it would bear no proportion whatever to the ultimate profits which would follow the success of the experiment. Apart from the salary or commission paid to such agent, the necessary expenses incurred by him for a year should on a very liberal estimate be:—

	£
Return ticket, available for one year	140
Hotel expenses for nine months in Japan	150
Wages for Japanese interpreter for nine months ...	45
Entertaining and travelling in Japan	166
Servant's wages...	18
	519

Or allowing a large margin in, say, a total of £600 per annum.

At the end of twelve months' residence, the agent, if of fair linguistic ability, ought to be able to conduct ordinary business transactions without the aid of an interpreter, though such aid would be requisite for a few years more when technical details were being discussed. If business increased the services of one or two native clerks might be required, and a further expense of perhaps £14 or £15 a month would have to be incurred for the rent of an office and storehouse. These, as things are, would be absolutely necessary for receiving goods ordered from England on their arrival and storing them until the buyer was ready to accept delivery. Many Japanese merchants and retail dealers are not punctual in observing their engagements as to time, and the whole business of English importers with them is carried out on the strict principle of cash on delivery, any departure from which is attended with risk. The success of the above experiment cannot, of course, be guaranteed, but every year Japan is visited by French and German commercial agents, to whom orders are given because they are there, although firms prefer to deal with English manufacturers, finding them in every way more satisfactory than continental. The visit of an agent of a London firm during last year has resulted in satisfactory arrangements for the sale, through a Japanese agent, of the firm's goods. A commercial traveller pushing his goods must be prepared to find every possible obstacle thrown in his way by the whole class of native brokers in Yokohama who now practically control all sales by foreign importers, and from the latter of whom he could expect no assistance for interfering with their business. The above remarks are written with relation to the opening in Japan for British flannel, but they are equally applicable to all trades. Of course, manufacturers must satisfy themselves as to the amount of trade and the probability of its increase. An earlier report gives the tonnage of foreign shipping entering Japan in 1885 at 1,134,722 tons, 731,980 tons, or 64·5 per cent. of which were British. The imports into Japan decreased in value from £5,999,805 in 1884, to £5,918,179 in 1885, or 1·4 per cent. During the same period the imports of machinery and metals increased in value from £479,245 to £646,101, or 34·8 per cent.

	Value of imports. 1884. £	Value of mports 1885. £
Machinery	80,257	109,325
Metals—		
Iron bar and rod	61,296	60,187
,, nails	63,050	84,706
,, rails	35,835	76,311
,, ware	26,164	44,674
Miscellaneous: brass ware, lead, pig, sheet and tea, quicksilver, steel and steel wire tin-plates, yellow metal, and zinc	212,643	270,898
Total	479,245	646,101

The advance in metals may be taken as an earnest of much greater things to come. Copper is one of the staple products of Japan, steel of fine quality is also made; but with these two articles the country's capacity for supplying its own wants seems to cease, though those wants are yearly growing larger. Once a free admission into the country and an opening to invest their capital are afforded to foreigners, a large impetus will be given to the whole import trade. With a large development of the export trade a corresponding increase in imports may be expected.

HOTEL SALOON CARRIAGES.

It will be within the recollection of some of our readers that at the time of the recent visit of the British Association to Birmingham, we published a brief description of the extensive railway carriage works of Messrs. Brown, Marshall, and Co. Thanks to the courtesy of the general manager, Mr. A. L. Shackleford, we have recently had an opportunity of inspecting some saloons termed hotel carriages, which the company now has approaching completion; and as they in a great many respects introduce novel features for railway carriages, we to-day give an engraving of them with the following short description. The carriages in question are built for shipment abroad. They are designed after the pattern of some twin saloons now running on the Libau to Romney Railway in Russia, and we understand that, with this exception, the idea of a travelling hotel is quite unique. Entering the carriage from the end balcony, in the Pulman style, we are shown into a capacious compartment termed the reception room. This is handsomely furnished and decorated, the wood being dark mahogany relieved with walnut mouldings. Passing from this compartment down a long corridor, the first room on the right we come to is a library and study, furnished with writing-table, book-shelves, couches, &c., the walls of which are covered with an elegant combination of walnut and maple woods. The next room, the best bedroom, is luxuriously furnished with full-sized bedstead, washhandstand, and adjoining dressing-room, with lavatory, bathroom, shower-bath, and all complete, to suggest to the weary traveller every possible comfort which can be wished for by the most fastidious person. This room is trimmed in light blue silk, all the furniture being made to match. The interior decoration is an elaborate combination of Hungarian ash, maple, and sycamore, affording a very pleasing contrast; the floors are richly carpetted, and the windows trimmed with curtains and sunshades.

The next compartment is a drawing-room, in which is introduced a full-sized fireplace, with mantelpiece and over-mantel elaborately carved. The room is furnished with table, sofa, chairs, &c., making a most comfortable drawing-room. The interior panels are of a red wood of foreign growth, from the Thuya tree, relieved with black walnut and rosewood and gold lines, the room having a most handsome appearance. The carpets are of thick pile. Adjoining this is another bedroom of less ornamentation than the first, intended for an attendant.

We then pass through a gangway into the next carriage, the first room in which is a handsome dining-room, 20ft. by 9ft. 6in., in Italian walnut. In this compartment the dining-room table is made so that twelve persons can enjoy a comfortable meal, At the ends of the room are large ornamental panels well decorated with inlaid wood. At night these can be let down, and four comfortable spring beds are found, enabling the room to be easily converted into a sleeping apartment. Adjoining this room, through a short archway, is a buffet, finished in old brown oak, with all the conveniences for a butler's pantry, beyond which is another passage to the end of the carriage; opening out of this are two bedrooms for servants and a kitchen, in which is a full-sized cooking-stove and every other requisite for supplying a high-class dinner *en route*.

The carriages throughout are heated by hot-water pipes and heating apparatus by Messrs. John King, of Liverpool. The whole of the furniture has been made and trimmed in the highest style by Messrs. Maple and Co. The two carriages make a total length of 122ft., mounted upon four bogie frames, the underframes being made of iron. They are 10ft. 6in. wide. Every compartment is furnished with an electric bell communicating with the servants. Great care has been given to ventilation, a free passage of air being allowed through the double roof, every compartment having also what is termed a Monitor roof.

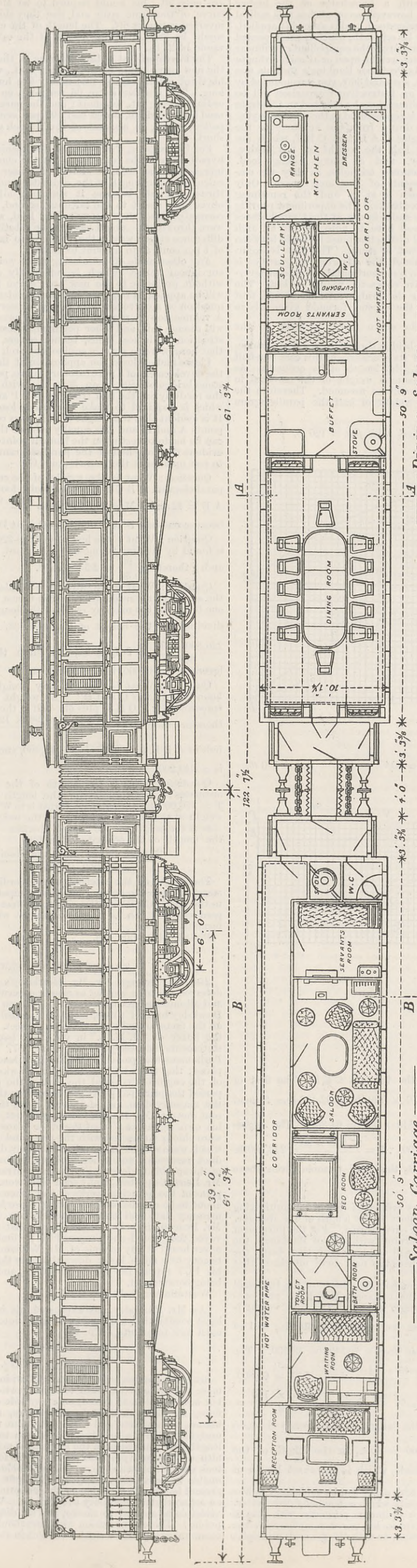
The carriages are certainly the most complete that we have ever had the pleasure of inspecting. Messrs. Brown, Marshalls, and Co. have been celebrated for a great many years past for building saloon carriages, but we certainly think that on this occasion they have eclipsed any previous work which has been made for abroad.

Junior Engineering Society.—On Saturday, 19th inst, the members of this Society visited the Engineering Laboratory, University College, by the kind invitation of the president, Professor Alex. B. W. Kennedy, who showed them round. A large number availed themselves of the opportunity thus offered of visiting this interesting place. The experimental compound tandem engine was working, a demonstration being made of the methods of measurement used in such experiments in this engine as were described and discussed in the presidential address on "Steam Engine Economy." The apparatus for the correct measurement of the feed and discharge waters was shown, and the manner of application and manipulation of the indicator gear was pointed out. Several sets of four cards were taken simultaneously from each end of the two cylinders. Tests were made with the horizontal testing machine, to which was attached the recording apparatus from which could be read the amount of extension of the specimen as the test proceeded. The autographic test recorder was also exhibited, much interest being evinced in that ingenious contrivance.

HOTEL SALOON CARRIAGES.

BUILT BY MESSRS. BROWN, MARSHALLS AND CO., BRITANNIA WORKS, BIRMINGHAM.

(For description see page 142.)



LETTERS TO THE EDITOR.

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

EQUIPOLLENT ARCHES.

Sir,—The following letter upon the construction of equipollent arches may interest you and your readers, as it presents some new ideas. The popular conception of an arch is the erroneous notion that it is a structure which grows safer and stronger the heavier it is loaded. In point of fact every arch has to support some specific weight, not an indefinite weight, and if it pretends to equipollence its configuration—dictated by its load—must be modified in accordance with each required condition. In scientific interpretation therefore the lines of no two arches carrying different weights can be identical. Here then arises an abstruse problem which calls for exact principles, to determine the extent and nature of the changes which variously loaded arches must undergo to preserve their equipollence.

Architects and engineers, in all nations and ages, have vainly striven to formulate these principles. This important end has been only recently accomplished, as will appear in the sequel, and, by a method both in theory and practice equally distinguished for mathematical accuracy and extreme simplicity. Should the allegation of its novelty be questioned, the reader is referred to pages from 475 to 492 of the "Encyclopædia of Civil Engineering," by Edward Cresy, London edition, where he will find collected the opinions of all the leading doctors, professors, divines, and engineers of England upon this subject. No scene of more unanimous discord can be imagined. Professor Playfair, then the most brilliant mathematician of his time in Great Britain, frankly gives up the solution of the arch problem, and even said in his final report to a Committee of Parliament, that it is not from theoretical men that the most valuable information in such a case as the present is to be expected. When a mechanical combination becomes in a certain degree complicated it baffles the efforts of the geometer and refuses to submit even to the most approved methods of investigation. This holds good particularly of bridges, when the principles of machines, sided by all the resources of the higher geometry, have not yet gone further than to determine the equilibrium of a set of smooth wedges acting on one another by pressure only, and under such circumstances as exist except in a philosophical experiment, can hardly be realised. It is therefore from men educated in the school of daily practice and experience, and who, to a knowledge of general principles have added from the habits of their profession a certain feeling of the justness or insufficiency of any mechanical contrivance that the soundest opinions on a matter of this kind can be obtained. The general ignorance of equipollent arch construction is manifested also by testimonial and historical evidence; for, since the fall of the Roman Amphitheatre, whose arches, supposed to be correct, slaughtered by their downfall 25,000 persons, scarcely a century has elapsed uncharacterised—although on a smaller scale—by similar catastrophes. Now the formulæ which solved this enigma is embodied in a mere statement of simple proportion, viz., T : W :: A : O.

T is the equipollent curvilinear thrust.

W is the weight on or at any ordinate whose length is sought.

A its abscissa.

O its length.

(1) Hence we have $T \times O = W \times A$

(2) Also $T = \frac{W \times A}{O}$

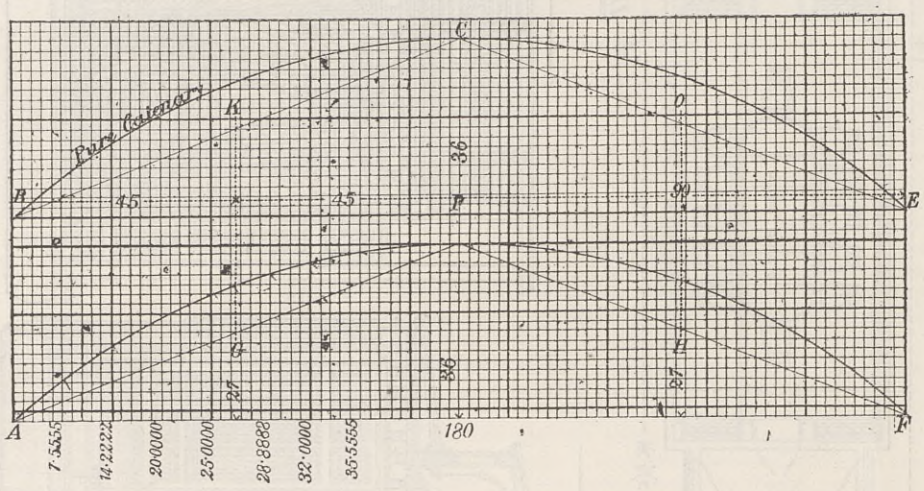
(3) $O = \frac{W \times A}{T}$

(4) $W = \frac{T \times O}{A}$

(5) $A = \frac{T \times O}{W}$

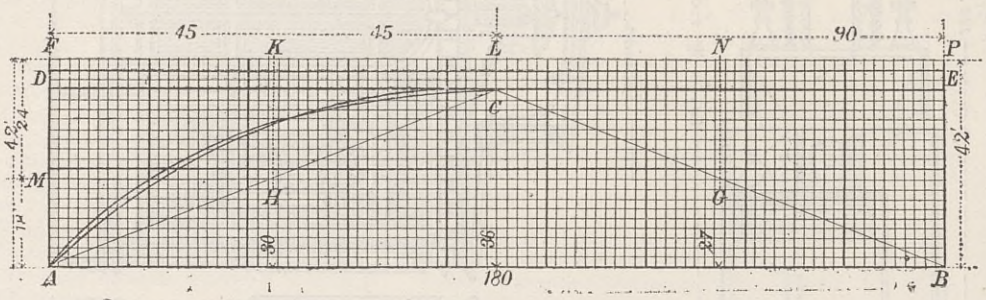
These formulæ are proffered as an amendment to that of the late Professor Rankine, which was a creditable approach to truth, and, indeed, is the only effort of the kind worthy of consideration. His is the only formula which has heretofore even partially recognised the true principle that the radius vector of the equipollent arch—whenever safety or cost of construction and repairs are considered—must gradually diminish from the skewback to the keystone. He applied this principle more or less correctly from the springings as far as the haunches of his arch, but singularly erred in substituting from the haunches to the keystone, a pure catenary, in lieu of a modified catenary. The latter is demonstratively the nature of every unevenly loaded equipollent arch. The properties of the pendent catenary are well understood, The increase or diminution of its even load—which means any equal weight on every link—will not distort it, whilst an uneven load inevitably does. These propositions are equally true when the catenary—being inverted—becomes an arch. Accordingly, accuracy in the construction of an equipollent arch resolves itself into an exact calculation and distribution of its load. No method of construction heretofore employed has either recognised or accomplished this; nor, until Professor Rankine's time, has ever approached success. The application of his very complicated formula requires great engineering skill, combined with a knowledge of the higher mathematics. The new formula, however, accomplishes this radical purpose, is, moreover, readily understood, and is as readily applied. Its mode of application will now be set forth, which is accompanied by a new and easy method of computing the equipollent curvilinear thrust, as well as finding the exact weight upon or at each ordinate of an equipollent arch curve. As Professor Rankine's formula was applied to a stone bridge of 180ft. span and 36ft. rise, surmounted by a horizontal roadway 6ft. thick, an instructive comparison will be afforded if an arch of the same dimensions be selected to illustrate the new method. Such an arch is represented in the accompanying figure. Lines C A and C B are drawn from the keystone to the springing developing the triangles C A D and C B F, which are assumed respectively to equal half the weight of the bridge, minus its overlying roadway, and a heavy rolling load. They are denominated constructional triangles, as they are employed in computing the elements of the arch curve. Only one third of the weight of each is at C, and the remaining two-thirds at their respective skewbacks. The experiment proving this was verified by the accurate scales in use at the United States Mint in this city. It may be well here to note that in all arch and bridge construction a radical distinction must be made between gravity pressure, curvilinear thrust, or strain. The first is exclusively vertical, the latter—although the offspring of gravity—is weight invariably multiplied into some horizontal distance or leverage without which its distinctive character would be lost. The equipollent curvilinear thrust for the bridge referred to will first be calculated. Pursuant to the second formula given above $T = \frac{W \times A}{O}$ it appears that the curve thrust is equal to the weight which either half of the bridge throws upon the keystone, multiplied by 90ft. the length of its abscissæ—in this case one-half the chord—and divided by 36ft., the length of its ordinate. As 120 lb. per cubic foot was the assumed weight of the material in the professor's bridge, the same will be assumed. Therefore the weight at C is the combined weight of half the parallelogram

Inverted Catenary by New Formula. Scale: ¼in. = 10ft.; each cubic foot = 120 lb.
See Table for the Length of Ordinates.



The Rankine Arch Curve, New Equipollent Arch Curve, and the Inverted Catenary. Scale: ¼in. = 10ft.; each cubic foot = 120 lb.
See Table for the Length of Ordinates.

Exhibit of the Curves and the Length of the Ordinates.



New Curve Ordinates by New Formula.	1·9896	7·901139	13·6126	18·5998	22·7164	26·1998	29·0106	31·2129	32·7837	34·2917	35·00469	35·6352	35·9111	36
Rankine Ordinates by his Formula.	1·8860	8·6586	14·5026	19·4168	23·3556	26·5356	29·0946	31·1364	32·7414	33·9764	34·8867	35·5114	35·8890	36

L C E O, and of one-third of the triangle C E B. The first of these amounts to $\frac{90 \times 6}{2}$, or 270 × 120 lb. = 32,400 lb. Second amounts to $\frac{90 \times 36}{2} = \frac{1620}{3} = 540 \times 120 = 64,800$. The aggregate weight at C is therefore 97,200 ∴ $T = \frac{97,200 \times 90}{36} = 243,000$ lb. the equipollent curve thrust. By the third formula given above $O = \frac{W \times A}{T}$.

Accordingly, the length of any ordinate is found by multiplying the weight it is supposed to support by the length of its abscissæ, and dividing the quotient by the curve thrust. For the purpose of comparing the new arch curve formula with that of Rankine's, the length of the haunch ordinates will be calculated, that being the point, as shown in the figure, where the new curve intersects that of the professor.

W in this case is the sum of one-half the weight of the trapezoid H K N G, half the weight of the rectangle M F K H, and one-third of the weight of the triangle A M H. The first weight is composed of $\frac{90 \times 6}{2}$, or 270 cubic feet × 120 = 32·400 lb., and of H P C = $\frac{45 \times 18}{2}$, or 495 cubic feet × 120 lb. = 48,600. The second weight is M F K H = $\frac{45 \times 24}{2} = 540 \times 120 = 64,800$. The third weight is A M H, or $\frac{45 \times 18}{2} = \frac{405 \times 120}{3} = \frac{16,200}{162,000}$; ∴ 162,000 lb. × 45 (the length of the haunch abscissa) = $\frac{7,290,000}{\text{thrust, } 243,000}$; ∴ 7,290,000 = 20ft., or the length of the equipollent curve haunch ordinate, which is the exact length of that of the professor.

All the ordinates of the new arch curve can be calculated in like manner, as appear by the exhibits which accompany this letter. The length found for the haunch ordinates coincides with that of the professor, but no other point in his curve complies with the condition either of the new formula or with the general principles involved. His deviation from equipollent lines requires an augmentation in the depth of his voussoir. Those for the new curve are only 3ft.; his would require to be 4ft. For a circular arch curve of the same span and rise they should be 5ft., and in an inverted catenary 6ft. The length of the circular haunch ordinate would be 28ft., and the length of the catenary haunch ordinate would be 27 lb.

The increased cost of the arch ring of the professor over that of the new curve would be then 33 per cent., which is on account of his third ordinate being (95) ninety-five hundredths of a foot too long. The circular curve 66 per cent. on account of the haunch ordinate being 2ft. too short; and the pure catenary arch curve, if used in this bridge, would cost 100 per cent. more than the equipollent curve, on account of the haunch ordinates being 3ft. too short.

For two reasons, the weight of the maniscus, lying between the hypothenuse of the triangles below the construction triangles and intrados of the arch, is allowed to enter as fractional factor in calculating the length of the ordinates and the equipollent curve thrust. First, because it simplifies all these calculations by obviating a resort to the calculus; second, because its weight may correctly personate a heavy rolling load, which—if the maniscus were thrown out—would have to be substituted in its place. The difference either way in the result is so infinitely small a fraction of 1 per cent. as to amount to nullity.

Any other mode of calculating these weights or the equipollent curvilinear thrust—which is sufficiently accurate—can be used without prejudice to the new arch curve formula. The formula will be applied to the pure catenary pendant or inverted, and the question of a curve factor of safety is reserved for a future article. A volume now in preparation for the press, and soon to appear, will discuss this, and other pertinent questions, including the construction of domes, dams, tunnel sewers, &c., and demonstrate that heretofore so strictly equipollent arch has ever existed.

Please find enclosed the application of the arch curve formula as the development of a pure catenary curve, pendant or inverted, for a stone bridge of 180ft. span, 36ft. rise, with a 6ft. roadway. Above the roadway are the two triangles B C P and C P E, the weight of which is required to make the bridge load a catenary even load. It is evident that the weight of this mass rests upon the springing points A and F, and it is equally evident that one-half of this mass can be made to rest upon the haunch points G and H, and it is also evident that one-half of the parallelogram A B K G can be made to rest upon or at the haunch point G.

Question: What is the weight of the crown of the arch of the parallelogram A B C D when each cubic foot is estimated at 120 lb.? A B = 42 and A M = 90; therefore $\frac{42 \times 90 \times 120}{2} = 226,800$ lb., because one-half is at A and the other at D.

Question: What is the leverage of the 226,800 lb.? The leverage is found by dividing 90 one-half the chord, by 36ft., the rise of the arch; therefore, $\frac{90}{36} = 2{\cdot}5$ leverage.

Question: What is the catenary equivalent curvilinear thrust of the arch under consideration? The thrust is found by multiplying one-fourth of the mass by one-half the length of the chord 90, and dividing by the height of the arch 36, therefore $\frac{180 \times 42}{4} = \frac{226,800 \times 90}{36} = 567,000$ lb., the curve thrust, or 226,800 × 2·5 leverage = 567,000, the curve thrust.

Question: What is the catenary weight concentrated at the haunch ordinates G and H? The weight at G = one-half of the trapezoid G K C O H D plus one-half of the parallelogram A B K G, therefore the weight at $G = \frac{42 \times 90 \times 120}{2} = 226,800$ lb. plus one-half of A B K G = $\frac{42 \times 45}{2} = 113,400$, the catenary weight at G is = 340,200.

Question: What is the length of the catenary curve haunch ordinates? The formula for the length of any ordinate is as T = 576,000 lb., the catenary thrust is to W 226,800 lb., the catenary weight at the haunch ordinate—or the weight at any other ordinate—so is the length of the haunch abscissa—or any other abscissa—the length of its ordinate; therefore

$$\frac{340,200 \text{ the W} \times 45 \text{ the abscissa}}{567,000 \text{ the thrust.}} = 27\text{ft.}$$

The length of the catenary haunch ordinates, the weight of the mass between the line A D and the equipollent, can be transferred to the line B C without the slightest effect on the formula, or the parallelogram can be made rectangles without prejudice to the formula.

J. M. D.

Philadelphia, Jan. 6th.

THE VYRNWY WATERWORKS.

Sir,—My respect for Mr. Hawksley's age and eminence has deterred me from writing as would otherwise have been suitable, and all must regret that the first letter on this subject, which Mr. Hawksley himself wrote, made it impossible for those who knew all the facts to avoid pursuing the subject. I regret, further, that the letter of "J. H. L." in your last issue makes the following statements necessary:—That from 1877 until 1881—the Act of Parliament was passed in 1880—Mr. Deacon did prepare all the plans; that from 1881 to 1885 Mr. Hawksley's commission as one of the engineers covered the cost of the plans; that during this period the principal plans prepared were the original drawings for the masonry dam, and of these it is not the fact that "they were sent down to Mr. Deacon to be carried out, Mr. Deacon then adding his own signature;" that the other plans prepared in this period were chiefly connected with the pipes and pipe-laying, the sizes of which were settled in consultation—they did not include the aqueduct reservoirs, and other highly important works; that, in spite of the specific understanding to the contrary, and, I believe, under Mr. Deacon's protest, many such plans were so sent down; that the plans of the principal works of the scheme as now carried out, or about to be carried out, excepting those for the lower part of the masonry dam and others named above, have been prepared by Mr. Deacon since September, 1885; that until after he had surveyed the ground and prepared his preliminary plans, Mr. Deacon never heard of any scheme of Mr. Williams' nearer than twenty to twenty-five miles lower down the river than the site he showed in his 1877 report for the Vyrnwy dam, and upon which it is now being constructed.

Civil Engineer.

Westminster, February 22nd.

[As Mr. Hawksley has expressed his intention, in the face of legal possibilities, not further to enter into this correspondence, it must now terminate.—Ed. E.]

SMOKE CONDUITS.

Sir,—As London extends far and wide so will smoke become more and more detrimental to those portions originally suburban, but now closed in all round, on every side enveloped by millions of flues, the most beautiful architecture, and the whitest stone, become soon marred and begrimed. Can there be anything more unsightly than the forest of black iron tubes of every shape and length which are seen on the sky line of many a handsome terrace, filth distributors *pro bono publico*? In former times each house took care of its own sewage; the householder, however willing, was unable to part with it beyond the limit of a cesspool, thus the ground became defiled, hence the adoption of public sewers, now an acknowledged necessity everywhere. Why should not the same principle be applied to smoke, and its disposal undertaken by the public? There is no reason why flues should not all go downwards, communicating with a smoke conduit in the street, and through it

be led into tall chimneys capable of producing a draught into the conduit, and for the combustion of the smoke before its escape. A steady uniform draught maintained in the conduit would be a matter of great advantage in regulating domestic fires; the exact amount of air necessary at any time for combustion being admitted by valves and moderated by dampers. Though chimneys can be made features of house architecture, no one will say that they are necessary features, nor deny that buildings without visible chimneys are more beautiful than those showing such deformities. It is very evident without much consideration that as all flues have to go to the top and far above the highest ridge, all the material above the top floor is wasted as compared with flues going downwards; besides, the bottom bricks have to bear the superincumbent weight of the whole stack, and must be proportionately increased in strength, so that at least one-half the brickwork would be saved, which would twice over-build a flue into the middle of the street. There would, of course, be a large quantity of soot deposited in the street smoke conduits, but from the fact of its being in large quantities and easily removable, the valuable constituents in soot could be made available; the small quantities now collected by sweeps is only acquired and brought together by great labour; for the purpose of cleaning there should, of course, be double conduits.

The arrangement of these flues underground conducting so much heat would have a very considerable effect on the climate, as all warmth in the air comes from contact with the ground; certainly, in winter, when there is a great consumption of coal, the effect would be very decided, and the waste heat which is now dissipated overhead would go to warm our streets. Probably whoever proposed public sewers first was set down as a very visionary party to imagine such monstrous innovations, but in the present day any proposal not manifestly absurd receives fair consideration, as I have no doubt this will sooner or later. This is the only direction in which an effort can be made to save London from being smothered in its own smoke, and the only objection that can be urged to it is the difficulty of altering existing flues; but this could be got over, if, on being tried in new suburbs and found effectual, it was thought advisable to make smoke conduits in the existing streets of the metropolis.

JAMES PRICE,
44, Harcourt-street, Dublin, M. Inst. C.E., M.A.I.
February 17th.

PRESTON AND THE RIVER RIBBLE NAVIGATION.

SIR,—Mr. David Alan Stevenson, of Edinburgh, has not answered my letter, consequently it may be taken for granted that the map of the estuary of the river Ribble shown in Stevenson's "Canal and River Engineering," "Harbour Authorities' Return, 1883," and "Tidal Harbour Commission Report, 1845," is incorrect. I am not surprised at Mr. D. A. Stevenson, not attempting to reply to my letter in THE ENGINEER of the 4th inst. In April last I sent a letter to the local newspapers, and it was answered by an architect in this town, a prominent member of the Ribble Committee of the Town Council, and a pupil of the engineer of these works, who no doubt gave him all the assistance he could, and even with that valuable assistance he was vanquished and defeated in the controversy. I enclose you a copy of the correspondence, which was printed in a pamphlet, and two charts added to it, so as to make it intelligible to all.

Yesterday I went down the river Ribble, past the buoys, along the Channel, out to the Irish Sea. Near to No. 5 buoy, four miles from the end of the proposed south training walls—the end of the proposed works—we anchored, and whilst dinner was prepared we went ashore and walked on the sands. Miles and miles of sand could we see, and all the way to Southport five miles off, St. Anne's-on-the-Sea four miles off, Preston Dock fourteen miles off, and three miles off deep water in a straight line measuring due west. Over all this sand we could have walked. It was proposed that this next summer we should hold a picnic on these sands, then the inhabitants of Preston could see for themselves that fourteen miles from the dock is dry land when the tide is out, and only a narrow, shallow—not 3ft. deep in many places—tortuous channel is left, and as they picnic on these sands they can imagine what vessels can come up or go down such a channel, and no dredging or deepening could ever be done across these sands. After we had partaken of our dinner we steamed to the bar, and arrived a little before low water, and I sounded 9ft., the tide being 8ft. lower than the ordinary spring tides on the Lancashire coast. For the sake of informing those of your readers who may not have much knowledge of tides, allow me to tell them that the higher the tide rises the lower it goes down, consequently at low water spring tides I have measured 4ft., and sometimes it has been known to be almost dry on the bar. We came up to Preston on the top of the flood tide, and several times grounded, and had to wait for the tide to float us, though the steam launch only draws about 3ft. of water, and we got here about a little over an hour before the time of high water.

I think your readers will now be able to understand something about the Ribble navigation works; and if you will insert the accompanying communicated article from the *Preston Chronicle* of the 5th inst., your readers will then certainly be able to form an idea of the impracticability of the works.

G. HENRY ROBERTS, C.E.
87, Fishergate Hill, Preston, February 19th.

[The article in the *Preston Chronicle* is too long for reproduction. It is practically a repetition in other words of Mr. Roberts' statements.—ED. E.]

THE ELECTRIC LIGHT AT WHITELEY'S.

SIR,—An apt illustration of the old adage, "There's nothing new under the sun," occurs in your very complete description of the engines recently erected by Messrs. Richmond, of Bow, at Mr. Whiteley's huge emporium for everything—even, I believe, including a wife. I refer to the cut-off motion, which is no novelty in Lancashire. Within my own knowledge it has been applied successfully for years past in cases where extreme regularity of turning is necessary, as in cotton spinning; and, unless I am in error, it is an old patent of Mr. Rye's firm, Woolstenholme and Rye, Oldham. The arrangement shown in your paper is so like the usual application, that one glance is sufficient to "name" it by any who have ever seen it. The success of this installation seems so complete, that I would say no word in detraction save,

"PALMAM QUI MERUIT FERAT."

Eightlands, Dewsbury, February 23rd.

[We have received other letters to the same effect as the foregoing.—ED. E.]

DONKEY BOILERS.

SIR,—I notice in your issue of the 4th inst. a letter on the above subject, in which your correspondent, Mr. Jas. W. Beck, justly calls attention to the risks run in working donkey boilers in our merchant ships. It is to be hoped that the calamity caused by the recent boiler explosion at Hull may be followed by improvements which may lessen the danger to life and property. It cannot be denied that new ships are often fitted with donkey boilers and winches which are only fit for the scrap heap, and thoroughly unfit for the duty they have to perform. This truly must be false economy. The steaming capability of any boiler should be equal to the maximum amount of duty to be done, inclusive of loss due to condensation and friction. The amount of steam used in lifting cargo from the bottom of a ship's hold when the winches are at full work is generally in excess of the actual amount the donkey boiler is capable of generating, and in the majority of cases one or two of the winches only, in place of four in the case of large steamers, can be worked at the same time. Under these circumstances the fires are forced, and the water may be low in the gauge glass to meet the emergency; this happens, sadly, too often, and it should be avoided entirely in the fitting of new steamers.

A liberal allowance of steam space and steam generating area of water surface are indispensable, which, unfortunately, most donkey boilers do not possess. Steam piping on deck is often too much exposed, and a saving would result in covering them with good non-conducting material; this would in no way interfere in the removal of any pipe when required. In some instances I have noticed too much condensed water coming from the winches, this has all to be made up by the donkey boiler with cold water feed. It is bad engineering to fix a boiler in such a position where its mountings cannot be easily overhauled, but how common a practice it is to fix dead-weight safety valves close under the deck where weights 60 lb. each have to be manœuvred in a space of 18in. Greater care should be exercised in these and many other details in connection with donkey boilers and their fittings; they were never intended to be a useless and ugly ornament on board a ship, which some really are, and I am of the opinion that they do not receive that consideration which they deserve.

ANDREW YOUNG.
Hull, February 15th.

PROBLEM IN PRACTICAL MECHANICS.

SIR,—While staying, a few months ago, with a friend of mine who is an antiquarian, he showed me some specimens of the ancient stone battle-axe known as "Celt." These "Celts" possessed the following curious property. When a "clockwise" rotation was imposed upon them they rotated quite smoothly; but when a "counter-clockwise" rotation was imposed, they at once began to oscillate violently, causing a very disagreeable rattle, and finally began rotating in the "clockwise" direction. I am under the impression that this curious behaviour is due to the position of the centre of gravity in relation to the surface of contact with the table about which the rotation occurs, but am at a loss to conceive what the exact relation is. If any of your numerous readers can throw some light on this interesting problem I shall be much obliged to them. I may mention, for the information of any of your readers who have never seen these "Celts," that they are approximately elliptical in shape, and of nearly similar cross section.

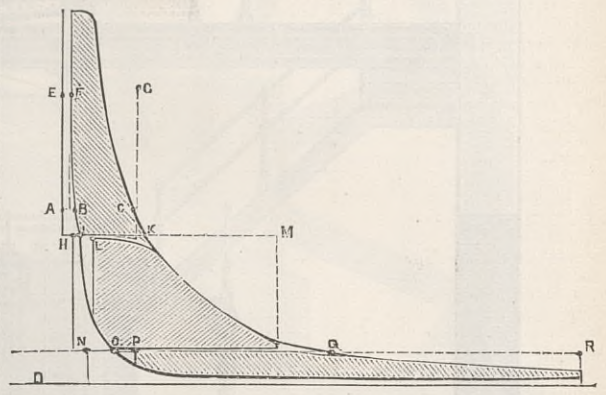
Crewe, February 19th. JAMES D. MACKINNON.

THE INSTITUTION OF MECHANICAL ENGINEERS.

(*Concluded from page* 136.)

IN continuing the discussion of the late Mr. Wyllie's paper on triple expansion marine engines, read at Leeds, and published with diagrams in THE ENGINEER of 5th November last, Mr. Seamington said he wished to speak with reference to Figs. 5, 6, and 7 (diagrams which were given on page 364 of the number of THE ENGINEER referred to. He thought there was there shown a little experience which would be of great value to marine engineers. They would see on No. 5 there was an initial pressure of 120; No. 6, 130; No. 7, 140; and he believed in each case the boiler pressure was the same. Now he believed that the defect in No. 5 was due to some bends in the steam pipe, and probably it was an improvement when those bends were taken away. No. 7 represented the same size engine, but probably with different pipes; he would like to ask if Mr. Morrison would give them the size of the pipes, and any particulars of the fittings there, because his experience with those engines was that the difficulty arose, especially with high speed engines, from not knowing in the matter of steam ports what not to do—not so much what to do as what to avoid. There were also Figs. 10 and 11, where an increase of 10 or 11 revolutions was obtained, but the back pressure was increased 1½ lb. Having to do with engines from a great number of different makers, he found there was a very great difference in practice, and if they could only get hold of those particular cases, which might be called the comparative failures, it would be of very great service to them. Upon the question of jackets he would only say that with high-pressure cylinders a loose lining was particularly desirable, because the wear was sometimes very great, and it always gave facilities for renewal. But upon the question of piston speeds he would like to say a few words, because those three-cylinder engines that were now becoming so popular certainly did give a well-balanced engine, and the advancing use of steel gave also a material which admitted of higher piston speed, without an increase of wear and tear; and he ventured to think with a well-balanced engine, and with the material now coming into use, more particularly that higher piston speeds might be adopted with great advantage and without much, probably without any, perceptible increase in the wear and tear. Of course, they wanted a first-class working ship with a high speed, but a high piston speed allowed them to use a much smaller engine and power, and therefore they got some diminution in the first cost, which, of course, was always a consideration, and they got less weight and less space, and he believed also more practical working, than with those high-pressures that were now used. To his mind it was a matter of regret that the invitation of Mr. Morrison to discuss the artificial or forced draught question had not been responded to. He was quite sure that marine engineers generally were considering the question as of more importance than any manipulation of indicator diagrams. Of course in war ships the forced draught was used for a very different purpose from what it would be generally used in the mercantile marine. There, by adding a few pounds of air, sometimes they got 50 per cent. more power out of the boilers, with only 10 per cent. more consumption of fuel; and, of course, as the highest power was only required for short periods of time, and on very few occasions, the increased amount of fuel was not a serious drawback; but in the mercantile marine, what must be had there if the forced draught was to become the general practice was a diminution of consumption of fuel without any deterioration of the boilers, and he thought if they could have some information on that point, and as to the durability of the boilers that often worked with forced draught, he was quite sure it would be most acceptable to marine engineers.

Mr. Schönheider referred to the mode of putting the diagrams together both of the two-cylinder and of the three-cylinder engines, because he found that there was a great diversity of opinion as to how they should be put together, and this evening he had heard for the first time from Mr. Mudd, as an approximation, how it should be done, but he thought that Mr. Mudd was a little astray on one point, and that was the expansion curve. If he understood Mr. Mudd rightly, he said, or meant to say, that an engine with a given sized cylinder, with a given amount of clearance, if there were no compression in the engine, they would get a certain expansion diagram. If they had compression they got a different expansion curve. That was incorrect. The expansion curve was quite independent of the compression in the cylinder. Before making compound engines, whether two or three cylinders, it was necessary that they should match the diagrams in order to know exactly where their cut-off was to be, where their compression was to be. If they did it, it must be correctly done. It was no use to measure with an india-rubber rule. In referring to the diagrams, there was one which showed a small cylinder with an expansion curve, and also a compression curve going up to a certain height. Now, if they put in the diagram a horizontal line A C, then the volume H B would represent the amount of steam which was compressed back into the clearance spaces. Volume A C was the total volume which expanded in the cylinder, and the difference between the two, that was to say, volume B C, is, that volume which passed through the cylinder and which exhausted from the one cylinder and passed into the other at the pressure, of course, of B D. The same thing took place in the second cylinder. There they had H M the volume of the cylinder, H L was the volume of the clearance, but the amount of steam which passed into that cylinder and also passed out of it was the steam marked by the line I K. That was the steam measured by horizontally cutting it at any point lying between the expansion curve and the compression curve, in the same way with the low-pressure cylinder. Then N R was the volume of the low-pressure cylinder. N P was the volume of clearance. N was the amount of steam which was compressed back into the low-pressure cylinder, and O Q was the volume of steam which passed through that cylinder. It was the same volume which was exhausted from the little cylinder, and it went up into the larger cylinder. He would further say, that the expansion of the curve for the small cylinder should be set from the clearance, also passing through E, because it was the total volume in the cylinder and clearance spaces which expanded and came through that curve. In the same way the compression curve should be set off in the same line. The expansion curve should be set off from the vertical line passing through H, because it was the volume H K which expanded in the cylinder in the same way as the volume in H I which was being compressed from that cylinder, and the whole expansion from the curve of the cylinder was not



necessarily a continuous curve. It might have brakes—it might have humps upon it, or it might be hollow. He did not think Mr. Mudd could say in excuse that he had not seen this published in any book, as, early in 1871, he published in *Engineering* a diagram of expansion, showing how these diagrams should be put together, and in this Institution about three or four years ago he also gave them an illustration.

Mr. Parker said that during this discussion it had occurred to him, both at Leeds and here, that there were two or three points which required clearing up. He had taken a great deal of trouble to get some information with regard to one particular point that was raised by some speakers at Leeds, and that was whether having such high pressure, whether 100, 110, or 120, to utilise in a high-pressure engine, whether you could get anything like the same result in other than a triple expansion engine. The figures he had got were obtained from actual practice, and unlike Professor Ryan, he had had some experience in stokeholes and served an apprenticeship there and in the engine room, so that he knew something about it. Two steamers, both working at 110 lb. pressure, one vessel had an engine of 47in. high-pressure cylinder, 86in. low-pressure cylinder, 4ft. 9in. stroke; that engine exerted 2600-horse power and consumed fifty-four tons per day, representing 1·94 lb. per indicated horse-power per hour. The next steamer was one fitted with triple expansion engines, three cylinders, one 34in., one 45in., and 70in. with a 4ft. 6in. stroke, working at the same pressure, namely, 110 lb.; that engine exerted an engine power throughout the voyage of 1900-horse power, and she gave a mean consumption of 36 tons per day, or equal a consumption of 1·6 compared with 1·94. He thought it right to lay that before the meeting, because there seemed to be a difference upon it. With regard to Mr. Morrison's question as to what had been done with regard to forced draught, he could say that a steamer had been running and was now running between America and this country, and this for two and a-half years. The boiler that was fitted in has just one-half the heating surface that the previous boiler fitted in her had. He could not give the exact number of feet, but it had three furnaces, as compared with six furnaces of the previous boiler there. The consumption per square foot of grate in the present boiler was over 50 lb. per square foot, and, after running nearly two and a-half years, this boiler had been carefully examined, both internally and externally, and had not been found to have deteriorated in any way whatever from the rapid rate of combustion which took place in it from the forced draught. He was very pleased to hear that the Council of this Institution had determined to inquire into the mechanical working of marine engines, and he was very pleased indeed to render them all the assistance in his power, but, at the same time, he would remark that to his mind it was rather a difficult task. To measure the efficiency of a marine engine at sea was a very different matter from measuring the efficiency of an engine in a mill or factory, or an engine in a laboratory, or a locomotive engine. He had been thinking as to the best means of obtaining the diameters of the feed inlet, and of the outlet, and that was easily enough done; the temperature was easily enough done, but the volume of feed-water, and the measuring of the volume of circulating water, was to his mind somewhat difficult in a large engine, and that required to be done over some days. In some steamers that trade to this part, the feed pumps were different from the ordinary style of feed pumps. They were made very slow running, for the purpose of excluding all air. He thought to-day if they could measure those pumps carefully, and satisfy themselves that they were actually full, he could measure the revolutions or the strokes that those pumps would make, so that they measured feed-water, and perhaps Professor Kennedy and others connected with this committee could advise some other means. He was sure that steamship owners in the port of London would be very pleased indeed to give to this Research Committee all the information they could, and render them facilities for going down Channel to help them as much as they could to get this matter placed on a satisfactory basis.

Mr. Parker, in answer to Mr. Paget, said the boilers were exactly alike, except in the case of the large engines. They were large, of course, but they were identical in design.

Mr. Davey said the author of the paper had given 160ft. per second as a steam velocity, and he had been accustomed to a very general rule in land practice that for 500ft., which seemed to be about the piston speed of those engines with the steam ports, you might put one-fourteenth or one-fifteenth of the cylinder; if they took the figure given by the author of the paper, which came to one-nineteenth; and if they took the figure given in the letter which the secretary read, it gave one-fifth. There must be a very great discrepancy which wanted putting right.

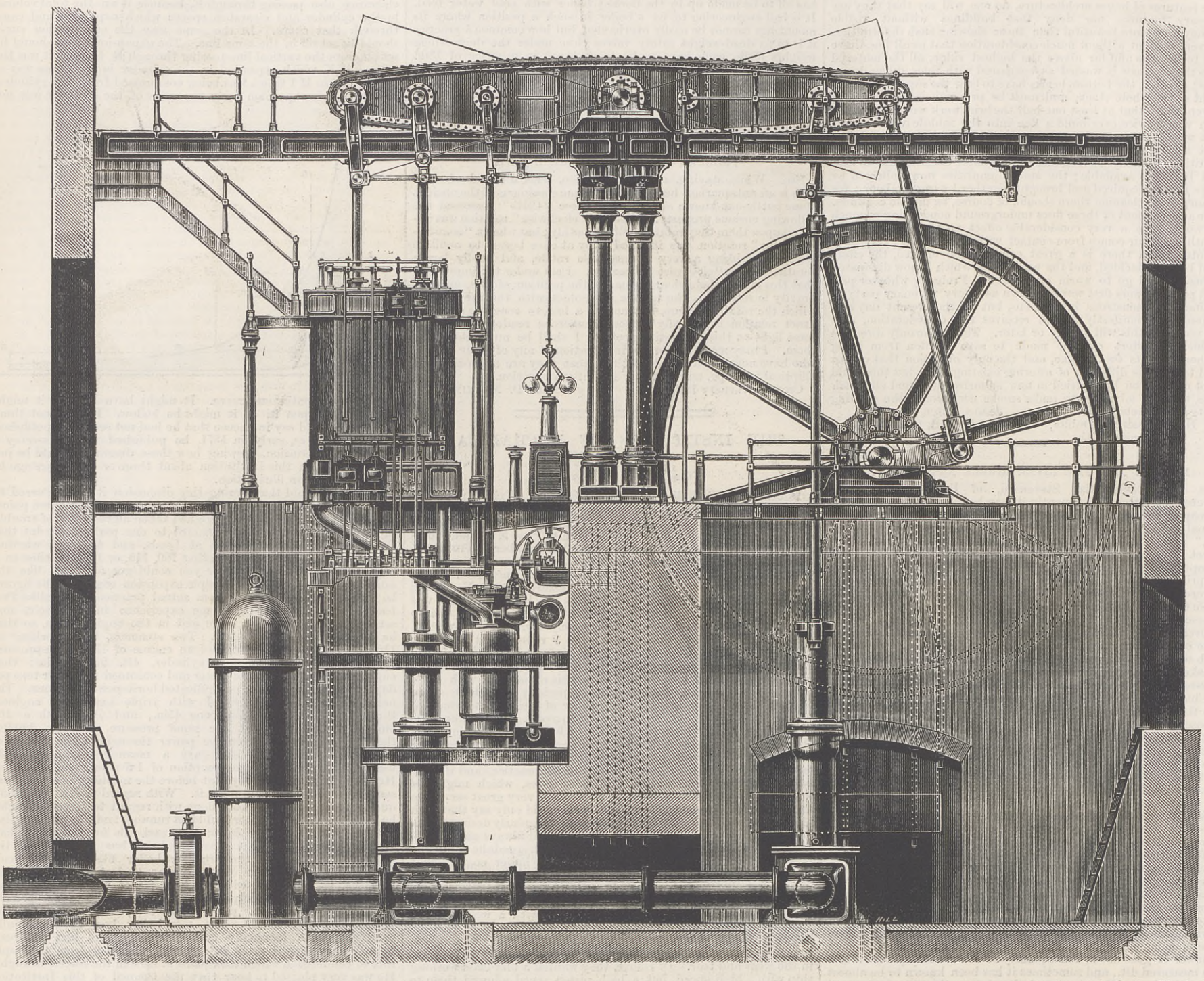
The President said it was now after ten o'clock, and they could not go on any longer, but that it would be better that the discussion should now be closed. The sooner they increased the number of their meetings the better; and the sooner they had a building of their own to meet in they would carry on their discussions more frequently. This was a very important subject which had been brought before them, and he thought they might leave it in the hands of the committee. When they reported he hoped that some gentlemen would bring forward a report, with some other papers, so that the question might be discussed again. In the meantime, he felt sure that they, all of them, would pass a vote of thanks to Mr. Morrison, the successor to, and in this matter representing, the late Mr. Wyllie.

The meeting was then adjourned.

THE tonnage of vessels commenced during the last quarter of 1886 was at the rate of 380,156 tons a year, and vessels to be laid down more than double that of either of the two previous quarters.

PUMPING ENGINES, BURTON-ON-TRENT SEWAGE WORKS.

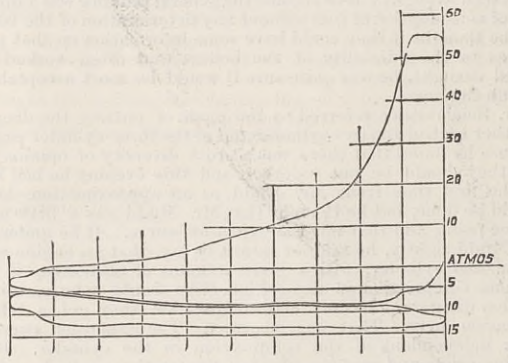
MESSRS. GIMSON AND CO., LEICESTER ENGINEERS.



PUMPING ENGINES, BURTON-ON-TRENT SEWAGE WORKS.

The engraving shows one of the compound beam engines erected for the Corporation of Burton-on-Trent by Messrs. Gimson and Co., of Leicester, under Mr. James Mansergh, C.E., of Westminster, engineer to the Corporation. The contract was for four engines to be erected in two engine houses. The following description is taken from a paper on the Burton-on-Trent Sewage Disposal Works, written by Mr. Mansergh for the Chesterfield and Midland Counties Institution of Engineers.

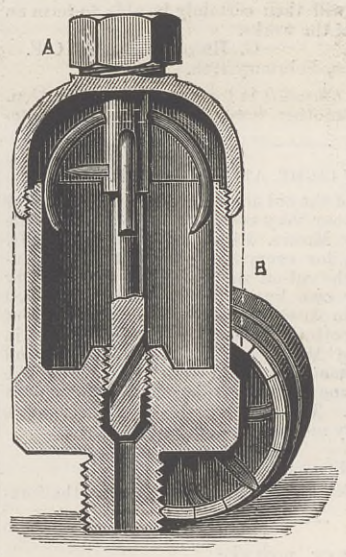
The engines are compound rotative beams, two in each house, and each engine, with its pumps, is capable of lifting at twelve strokes a minute 125,000 gallons an hour to a height of 110ft. The high-pressure and low-pressure cylinders stand together at one end of the beam, the steam exhausting directly from the high to the low-pressure cylinder. The admission and release valves are gun-metal double-beat valves, lifted by tappet cams, and falling by their own weight. By an arrangement of sliding blocks and screws on the tappet levers, the point of cut off can be varied whilst the engine is running in either cylinder. The high-pressure cylinder is 24in. diameter, and the piston has 6ft. stroke. The low-pressure cylinder is 38in. diameter, and the piston has 8ft. stroke. Omitting the area of the ports and clearance spaces, the ratio of the two cylinders is 3·5 to 1. The low-pressure cylinder is not steam jacketted. The high-pressure cylinder is steam-jacketted, the drain pipes being taken back into the boilers below the water-line. The air pump is a single acting vertical pump with piston stroke of 4ft. The barrel is 24in. diameter. The valves are vulcanised rubber discs, falling upon grated seatings. The foot valve is an inclined flap valve with gun-metal facings. The condenser has 30 cubic feet capacity. The air-pump draws its injection water from the cooling ponds outside the engine house, the overflow from the hot well returning the water back again. The fly-wheel is 24ft. diameter, and weighs 24 tons. The beam is a wrought iron built beam, of box form. The length of the beam from centre to centre of end gudgeons is 26ft. 7⅜in., allowing for a net distance of 26ft. between the centre of the low-pressure cylinder and the centre of the crank shaft. There are two sewage pumps to each engine, one directly underneath the high-pressure cylinder, and the other at the opposite end of the beam at an equal distance from its centre. They are simple ram pumps, the rams being 21in. diameter with 6ft. stroke. The suction and delivery valves are exact counterparts one of the other. Each valve consists of nine malleable iron flaps, backed with leather, and beating upon planed cast iron seating, set at an angle of 20 deg. from the vertical. The total area for the passage of sewage through one set of these valves, when the flaps are open to the stops, is 460 square inches, or one-third more than the area of pump plunger. Each pump has a separate 24in. suction pipe, drawing its sewage from the suction chambers at each side of the houses. The delivery pipe for each engine is 20in. diameter, and is common to the two pumps. This passes into an air vessel of 150 cubic feet capacity, at the end of the engine house. The ram pumps keep the air vessels charged with air by means of a Wipperman and Lewis air injector. Outside each air vessel there is a sluice valve on the delivery main, with an indicator worked from the spindle, showing on the wall of the engine house the position of the valves, and as an additional precaution an arrangement which locks the starting wheel of the engine so long as the sluice is closed. Beyond the sluice valves a breeches pipe connects the two branches from the engines into a 27in. main, and just outside the junction there is a branch with a safety valve, blowing off at a little above the maximum head when all four engines are working. These engines and pumps have been made and erected in a very satisfactory manner by Messrs. Gimson, of Leicester, and they are doing very good duty. We give two diagrams.



A test of four engines was held on December 2nd, 3rd, and 4th, 1885. Two of the engines were tested for twenty-four hours, but owing to the supply of sewage to be pumped falling short, the second two were only tested for twelve hours. The average indicated horse-power of the four engines during the trial, and the total amount of coal burnt, showed that 1·95 lb. of coal were burnt per indicated horse-power per hour. This result would have been even better but the engines never had their full work to do. The height pumped was about 100ft. instead of 110ft. As nothing was prepared at the sewage farm for measuring the amount of sewage delivered, the exact pump duty was not ascertained at these trials.

IMPROVED OIL CUP.

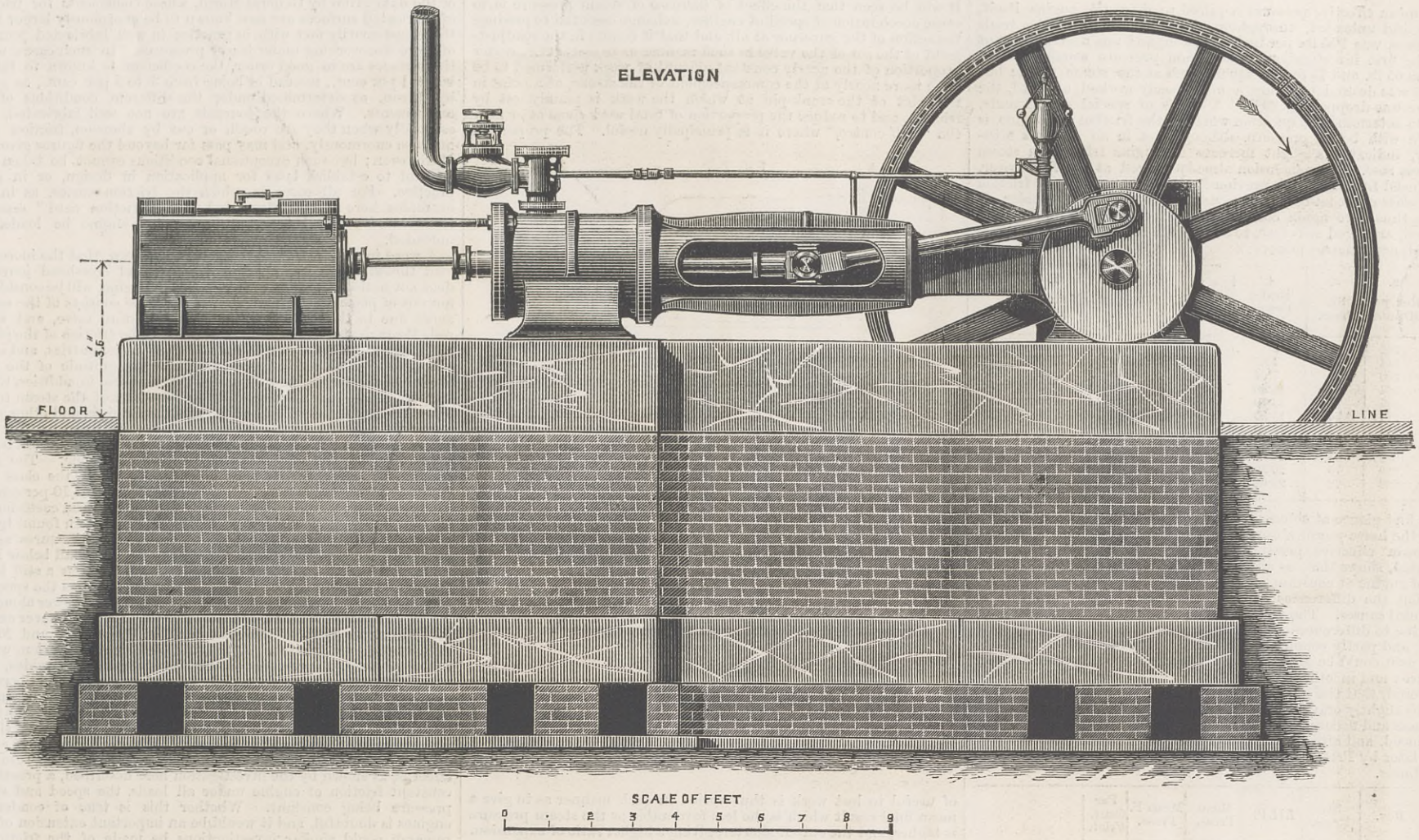
This oil cup may be applied to the journal bearings and moving parts of machinery, but is especially adapted to the lubrication of the rod and wrist pin connections of locomotive and other engines. It can be easily adjusted to regulate the feed of oil. The body of the cup is chambered to receive the oil, and has a neck by which it may be attached to the bearing. At the bottom of a central hole in the base is a tapering seat, below which is a passage through which the oil flows. The hole is threaded to receive the lower end of a spindle, which is bevelled to fit the seat. The upper end of the spindle is steadied by bent arms or elastic wires which bear against the inner part of the body. The end of the spindle has an oblique passage which communicates with the oil chamber and with the hole, the threads on the spindle below the opening being cut away, to allow the oil to escape freely. Fixed to the spindle is an index finger, or pointer, which indicates on a graduated scale, on top of the oil cup body, the extent of opening of the spindle at the seat. A recess around the bottom of the chamber forms a pocket to hold sediment and prevent its passage to the parts to be oiled. When the cup is used on a wrist pin, it is provided with a screw cap fitting air tight, the bodily swing of the cup then insuring proper feed of the oil. When the cup is used on stationary bearings, it is fitted with a slit cap or cover, having a vent hole to insure flow of the lubricant. It is obvious that the cap can be removed to replenish the oil or clean the cup without altering the adjustment of the spindle, while the index finger and scale provide for almost instantly resetting the spindle to continue the same feed of oil, should the spindle be removed for any purpose. It is the invention of Mr. Herman A. Todd, of Evanston, Wyoming.—*Scientific American.*



The tenders for the wire and other material required for the construction of a rabbit-proof fence along the South Australian border were finally dealt with on January 7th. For 111 miles of wire netting Messrs. Briscoe and Co., at £2430, were the successful tenderers, and for 5500 standards the tender of Mr. M. W. Egerton, at £1541, was accepted for colonial made articles. There were lower tenders for imported, but the Minister chose the colonial article in preference. For 22 tons of barb wire the offer of Messrs. McEwan and Co., at £462, was accepted. These, the *Colonies and India* says, were the principal tenders.

ELECTRIC LIGHT ENGINES AT THE HADFIELD MILLS.

MESSRS. MATHER AND PLATT, SALFORD, ENGINEERS.



ELECTRIC LIGHT INSTALLATION AT THE HADFIELD MILLS.

THIS installation, comprising about 1400 lamps of 16-candle power—probably one of the most extensive yet introduced into a cotton mill—is worked by a horizontal engine and two Edison-Hopkinson dynamos, specially designed and constructed by Messrs. Mather and Platt, of Salford, for the purpose. The engine, illustrated by the accompanying engraving, is high-pressure, condensing, with a single cylinder, 23in. diameter, 30in. stroke, intended to run at 100 revolutions per minute, and to work with a boiler pressure of 80 lb., and under these conditions will indicate about 170-horse power.

The cylinder is carried on an independent stand and bolted to the trunk or frame, which is of box section, and supported at the crank end on a separate foot. Both the cylindrical slide and the crank bearing pedestal are in one piece with the trunk. The piston rod and crank pin are steel, and the connecting rod, best hammered scrap. At the crosshead end the connecting rod is forked, and the wear taken up by a wedge and screw; its length is three times the stroke. The crank is of the disc form, and is shrunk and keyed on to the shaft; the crank pin is also shrunk in. The shaft is 8in. diameter, increased up to 8½in. for the fly-wheel, and at the crank end is carried in a bearing 15in. long, and at the off end, in an angle pedestal, fixed in an wall box, 12in. long and 6½in. diameter. The main bearing is adjustable both top and bottom and the sides by wedges and screws, so that the brasses can be fixed in any way while the engine is at work. The flywheel is 12ft. diameter and 27in. wide, and is prepared for two 12in. belts. It was cast whole, split and bolted together at the rim, and held with bolts and shrunk hoops at the boss; its finished weight is 5¼ tons. The main and cut-off valves are worked by two excentrics, having respectively 4½in. and 5½in. traverse. The engine is governed by a Porter's governor with steel arms, working on to the throttle valve. All the bearings, the excentrics, crank pins, &c., are lubricated from one oil tank fixed over the main bearing; and the oil is collected by suitable drippers led into a tank below, from which it is returned to the top tank by a pump. The cylinder is lubricated by Mather and Platt's improved sight-feed lubricator, requiring one plug valve only.

The air pump and condenser are combined. The pump is double-acting, worked by a tail rod from the piston, the cylinder being 10in. diameter, 30in. stroke, and has two suction and two india-rubber delivery clacks of large area at each end. The air pump and cylinder are all bolted to the same stone, and are also tied together by bolts. Throughout, all threads on bolts are fine pitch or gas threads, and in working parts have a nut of ordinary depth locked with a thin one, and in addition have a split cotter through the end of the bolt.

The two dynamos are each capable of an output of 44,000 volt-ampères or watts, equivalent to 750 lamps—110 volts, 400 ampères—at 620 revolutions. They are of the Edison-Hopkinson type, with the length of field magnets still further reduced, and bar armatures. The commutators are built up of 47 bars of copper insulated with mica, and are readily detachable from the armature. There are three brushes on each rocking arm, each separately adjustable with spring forward thrust and hold-off catch. The armature bars have a section of 0·106 square inch, and hence the load is three ampères per square millimetre. The dynamos are compound-wound, but owing to the great strength of the magnet field and small disturbance caused by the armature, twelve convolutions of series coils is sufficient to secure perfect compensation for the whole range. The following are the particulars of the resistances:—Armature, 0·00645 ohm; series coils, 0·0013 ohm; shunt coils, 17·4 ohms; showing an electrical efficiency of 96 per cent., and a commercial efficiency of from 94 to 95 per cent.

THE IRON TRADES OF 1886.—In their Iron Trades Report, Messrs. Bolling and Lowe remark:—"The iron trade never takes the lead when the flood tide of trade sets in, but follows other branches. We have to wait till consumers all over the world have regained increased purchasing powers, and a solid improvement on the produce market must be first established before our turn arrives. The latter half of 1886 shows an increase in value of from 10 to 15 per cent. in almost every article imported into Europe, and in many instances even more. As producers abroad received the benefit of this rise, they gradually became more willing buyers of iron and steel, and the volume of our exports grew proportionately in quantity and amount; but every upward move was severely contested, and indeed, we may almost say was only obtained at advances of from 6d. to 1s. per ton at a time; no better proof that this could we have of the soundness of the position of the trade. The total exports of the two past years were: Coals, tons, 23,770,957, 1885; 23,284,960, 1886; ditto, value, £10,633,151, 1885; £9,836,838, 1886; machinery and mill work, £11,086,869, 1885; £10,133,869, 1886; iron and steel, tons, 3,130,682, 1885; 3,389,197, 1886; ditto, value, £21,710,738, 1885; £21,722,951; 1886. It was in 1866 that Great Britain was connected with the United States by the first submarine cable, the importance of which to British trade can hardly be over-estimated. During the subsequent twenty years, the iron trade of this country has principally been tided over several periods of depression by demands from the United States in three distinct years, viz.—1872, 1879, and 1886. The question naturally arises, what prospects can there be for a lengthened call upon us from the United States for materials, considering the great productive powers of their iron industries, coupled with high import duties? Without venturing to express an opinion, we may, nevertheless, call attention to a few facts which bear on this point. In less than twenty years the United States have reduced their debt by about £220,000,000; they ended their fiscal year, 1886, with a surplus of about £18,000,000; they added during 1886 to their system of railways 8600 miles, making in all, 130,000 miles, worked by 27,000 locomotives, costing approximately £1,650,000,000; in six years, 1880-1886, the population increased 20 per cent., namely, from 50,000,000 to 61,000,000; in 1885 they raised 357,000,000 bushels of wheat, in 1886 they raised 457,000,000 bushels of wheat—an increase of more than 27 per cent., or equal to 100,000,000 bushels; in 1885 their shipping ports received 4,451,663 bales of cotton, in 1886 their shipping ports received 5,177,235 bales of cotton—an increase of more than 11½ per cent., or equal to 725,572 bales. In comparison with these figures the progress of all other countries becomes insignificant. The United States in 1886 took from us nearly one-fourth of our whole iron and steel exports, say:—In 1885, 397,668 tons, value, £4,106,109; 1886, 796,626 tons, value £5,592,561. Continental countries still maintain their policy of not allowing British iron and steel to enter free."

ON THE FRICTION OF NON-CONDENSING ENGINES.[1]

By Prof. R. H. Thurston, Ithaca, N.Y.

(*Concluded from page* 96.)

The mean effective pressure required to drive the engine itself, loaded and unloaded, throughout the whole range of the trials here made, was 4·55 lb. per inch of piston, and was nearly constant as in the first investigation. The steam pressure usually ranged between 65 lb. and 75 lb. per square inch at the steam chest; but when it was desired to secure a more easily worked up card, the pressure was dropped to 20 lb. A series of special experiments, made to determine the question whether the friction of engine is variable with boiler pressure, although not in all respects satisfactory, indicated a slight increase in engine friction as steam pressures rose. The conclusion already arrived at by the writer, as deduced from the work previously done, that the engine friction in this class of steam-engine is constant, or sensibly so, under all loads is thus here again confirmed. The following are the data obtained, arranged as before, to exhibit the relation of the indicated to the dynamometric powers:

1. No. of Card.	2. Rev. per Minute.	3. St. Press.	4. Brake Power. H.P.	5. Ind. H-P. per card.	6. Dif. Frict. H.P.	7. Mean F. Press.	8. Frict. per cent.
1	282	19	0·	2·26	2·26	3·70	100
2	288	65	4 87	8·43	3·56	5·56	42
3	286	66	7·61	10·95	3·33	5·25	30
4	284	65	10·30	12·93	2·89	4·13	20
5	285	71	13·10	15·99	2·61	4·25	18
6	284	76	15·80	18·79	2·99	4·71	16
7	284	74	18·55	20·73	2·65	4·18	12
8	280	67	21·00	23·73	2·73	4·37	11
9	279	65	23·61	25·95	2·33	3·73	9
10	280	75	26·39	29·95	2·36	5·38	11
11	280	72	29·03	32·22	3·19	5·15	10

The first glance at column 6 or at column 7 of the above table in which the horse-power absorbed by the friction of the engine, and the mean effective pressure corresponding to that power are presented, shows that, as already concluded, the resistance of this class of engine at constant speed is practically constant at all loads, and that the differences and irregularities observed are due to accidental causes. The variation of speed recorded here is in some cases due to differences of steam pressure, partly purposely produced, and partly coming of the fact that it was necessary to take steam as it could be obtained, and was impractible to secure steady pressure; and in other instances was due to the fact, afterward discovered, that the governor had been adjusted in such a manner as to be slightly cramped, and thus deprived of its wonderful sensitiveness and accuracy, as exhibited before this defect had been introduced, and after it had been remedied. Chronograph records, made later by Professor Anthony, exhibit the most extraordinary smoothness.

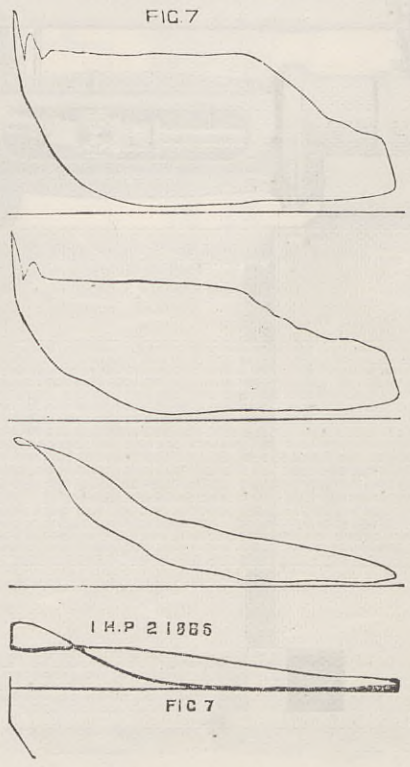
No. of Cards.	Rev.	St. Press.	I.H.P.	Mean Press.	Mean F. Press.	Per Cent. Frict.	
1	250	25	6·01	10·84	1·95	18	Ten pounds on the brake.
2	271	39	6·52	10·85	2·71	27	
3	285	42	7·17	11·35	3·03	32	
4	280	46	7·08	11·60	3·59	31	
5	271	58	6·81	11·28	3·16	28	
6	289	63	7·85	12·25	4·65	38	
7	286	68	7·77	12·25	4·90	40	
8	283	77	7·88	12·47	3·74	38	
9	296	82	7·87	12·00	4·68	39	
10	275	71	2·10	3·46	3·46	100	
11	279	66½	1·995	3·22	3·22	100	
12	277	44	1·708	2·78	2·78	100	
13	275	35	1·71	2·80	2·80	100	No load on the brake.
14	275	30	1·613	2·64	2·64	100	
15	272	25	1·876	3·11	3·11	100	
16	270	19	1·724	2·88	2·88	100	
17	270	15	1·712	2·86	2·86	100	

These variations of speed served the useful purpose of calling attention to the fact that the engine friction varied, at constant load and speed, with variations of steam pressure, and to a very noticeable amount, within the usual range of pressures met with in practice. It is seen that, in rising from 19 lb. to 76 lb. steam pressure, the pressure demanded to give the engine its normal speed unloaded ranged from below 4 lb. to above 5 lb. per square inch of area of piston, the pressure required in the cylinder rising, on the whole, though irregularly, as steam pressure rose. In order to determine whether this, which might prove to be a hitherto unobserved law, were true, the foregoing data were obtained by a series of experiments made for the purpose of settling this new question.

In the first set of experiments, here numbered 1 to 9, inclusive, the weight on the brake arm was kept constant at 10 lb.; in the remaining experiments all weight was removed. In both sets the same general effect is seen. As the steam pressure rises, the speed being the same and the resistance the same, the friction of the engine increases; from 2 lb., at 25 lb. pressure on the steam chest, to nearly 5 lb. per square inch of piston at the maximum, 82 lb. steam in the valve chest. As the steam pressure fell from this point to 15 lb. in experiments 9 to 17, the load being thrown off entirely and the speed being nearly constant, the mean pressure measuring the friction of engine falls again below 3 lb. per square inch of piston. The difference is considerably less in the last series than in the first, which apparent discrepancy is accounted for by the fact that the variation of steam pressure in the first series was accompanied by a greater change of speed of engine than in the second. The resistance is seen to increase slowly therefore with increase in speed of rotation. The effect of change of pressure is, in these cases, more marked than that of alteration of velocity of the engine.

The accompanying plates illustrate the apparatus and exhibit the facts revealed by the investigations which have now been described better than can the text. Fig. 1 shows the method of attaching the indicators, with an elevation of the engine cylinder and section at the crosshead; Fig. 2 exhibits the same arrangement in plan; Fig. 3 gives an enlarged view of the reducing mechanism and attachment to the crosshead; Fig. 5 is an outline plan of engine and surroundings, exhibiting the location of instruments; and Figs. 6 and 7 represent characteristic diagrams obtained by means of the indicator, showing the variations of steam distribution with variations of load on the brake. All these illustrations refer to the work of later date. Figs. 8 and 9 are given to exhibit the method of variation of mean friction pressures with variation of load, the variation of the percentage of friction resistance as a fraction of total resistance with varying loads, or the last investigation; and, for comparison, the same ratios as obtained in the work done at the American Institute Exhibition are given in Fig. 4. These last curves are seen to be approximately hyperbolic; while the first given is a straight line. The originals of these curves were carefully plotted by Messrs. Day and Riley from the records of original observations, and beautifully represent the law which it was the object of these investigations to reveal and establish.

After a survey of this work, it may be asked, How does it happen that rise in steam pressure produces evident increase of the frictional resistance of the engine? It was long ago shown by the writer, and is now well established by many independent investigations, that, with good lubrication, increase of pressure on a journal gives decreased coefficients of friction, and this would seem to show that the friction of engines in which the resistance caused by friction is mainly due to journals and lubricated surfaces, should become less as pressures increase, the useful load and the speed of engine remaining constant. This query is a very natural one, and is based upon a correct statement of fact, however inconsistent it may seem to be with the results above derived. The cause of the apparent discrepancy is attributable, probably, to the variation produced by the action of the governor in the distribution of steam. It will be seen that the effect of increase of steam pressure is to cause acceleration of speed of engines, a change essential to produce the action of the governor at all, and that it results in the readjustment of the set of the valve in such manner as to cause the greater proportion of the nearly constant amount of work performed to be done more nearly at the commencement of the stroke, at a point in the orbit of the crank-pin at which the work is mainly lost by friction, and to reduce the proportion of total work done at or near the "half-centre," where it is principally useful. The proportion



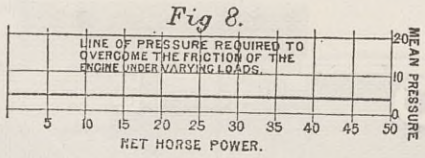
of useful to lost work is thus varied in such manner as to give a mean final result which is the less favourable as the steam pressure is higher, and the cut-off shorter, giving a higher ratio of expansion. It is also evident that, if this explanation is correct, the difference here noted will be less as the point of cut-off approaches and passes the half-stroke position of piston and crosshead. Could the valve be set with negative lead for all positions at the point of cut-off, as is considered right by some experienced engineers, the work would be more nearly performed at positions removed from the "dead points," and the variation here described would be thus reduced, while the efficiency of the engine would be increased.

Professor Rankine proposed the formula,

$$R = R_1(1 - f) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

This formula is evidently inadmissable, at least for the class of engine which was made the subject of the experiments which have been here described. Since the friction of engine is, so far as can

Fig 8.



be here seen, sensibly independent of the magnitude of the load and of the resistance produced by it, the correct formula would seem to be

$$R = R_1 + R_0 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

the total resistance met at the piston being the sum of the resistance of the engine itself and that of the load, both being determinable, both being independent, and being governed by entirely different laws.

The conclusions to be drawn from what has preceded are obviously the following:—

(1) The friction of the non-condensing engine of the class here described is sensibly constant at any given speed at all loads and is at different speeds entirely independent of the magnitude of the load.

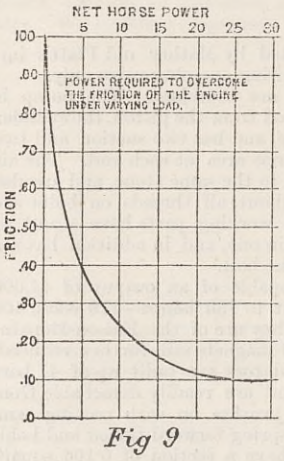


Fig 9

(2)The friction of engines of the type described is variable with variation of speed of engine, increasing as speed increases, in some ratio as yet undetermined, but probably different with every engine, and, for the same engine, with every change of conditions of operation.

(3) The friction of engines increases with increase of steam pressure, in the case of the class here referred to, in a probably similarly variable manner with that observed with alteration of speed, neither method of variation being capable of representation by any convenient algebraic expression.

(4) The total resistance measured at the piston of the engine is composed of two parts, the one sensibly constant at the working speed, the other variable with external load, and may be, for practical purposes, at least, represented by the expression,

$$R = R_1 - R_0,$$

in which R is the total resistance, as shown on the indicator diagram, R_1 the resistance due to the external load, *e.g.*, as measured by a Prony brake, and R_0 the resistance of the unloaded engine, as shown by a "friction card" taken with the steam engine indicator.

It is sufficiently obvious that these conclusions are, at present at least, only certainly applicable to one class of engine. It is not improbable that the condensing engine may be subject to quite different laws. It is to be hoped that this question may be settled by direct experiment at an early day. The custom has obtained, hitherto, of allowing a certain pressure per square inch of piston as the equivalent of the friction resistance of the engine in marine practice—this pressure being taken at from 2½ lb. in the case of engines of moderate size, to 1½ lb. with the largest engines. It has never yet been ascertained whether, or to what extent, the friction of engine is augmented by the imposition of load. The assumed figure represents from 5 to 10 per cent., usually, of the total indicated power of the engine. Isherwood has taken 7½ per cent. of the useful load as the amount of increase of friction of engine due to its action. This estimate is stated to be made on the basis of the data given by General Morin, whose coefficients for friction of lubricated surfaces are now known to be enormously larger than those customarily met with in practice in well lubricated journals of large size working under heavy pressures. In such cases, when the surfaces are in good order, the coefficient is known to fall to below 1 per cent., instead of being from 3 to 5 per cent., as given by Morin, as determined under the different conditions of his experiments. Where the journals are not well lubricated, and especially when they are rough or cut by abrasion, friction may increase enormously, and may pass far beyond the figures given by Morin even; but such exceptional conditions cannot be taken into account to establish laws for application in design, or in good practice. For all cases in which the friction varies, as in the examples here above illustrated, the "friction card" sensibly represents the correct tare, whether the engine be loaded or unloaded.

A word in explanation of the fact here shown, that the increased load thrown upon the shaft, crank pin, and crosshead journals, does not noticeably increase the friction of engine, will be considered not out of place here. The friction of engine consists of the resistances due to the motion of the various piston, valve, and other rods through stuffing boxes and in guides, the friction of the piston rings on the cylinder surface, the friction of excentrics, and often other parts which are independent of the magnitude of the load thrown upon the engine by the useful resistance, in addition to the friction of the journals transmitting the effort of the steam to the exterior resisting work, and of the crosshead guides and other parts indirectly affected by its variation. It thus happens that the resistance due to the friction of the latter may be, and often is, but a small proportion of the whole friction of engine. The total friction of engine, as has been seen, in engines of the class here studied and of the sizes described, amounts to about 10 per cent. of the total power developed when fully loaded; but the coefficient of friction of any one journal, if well lubricated, has been found by the writer, by hundreds of experiments, under such pressures as are usual on the main journals of the steam engine, to fall below 1 per cent., and the absorption of work and energy is thus a still lower proportion of the work of the steam in proportion as the speed of rubbing is less than that of the piston. The loss of power along the line of connection is thus exceedingly small. It should never exceed probably 2 per cent. of the work done, or between 10 and 20 per cent. of the total friction. Again, the coefficient of friction, within the usual range of pressures on these journals and the guides, with good lubrication, increases rapidly as pressures fall, and decreases as greatly when the pressures increase with variation of engine power and load, and this change often occurs so rapidly that the total frictional resistance, on these parts even, varies very slowly with variation of load, while the friction of the other portions of the engine, above mentioned, remains quite constant. The resultant effect is, as shown by the investigation here described, a practically constant friction of engine under all loads, the speed and steam pressure being constant. Whether this is true of condensing engines is doubtful, and it would be an important extension of this research could similar investigations be made of the friction of other forms, and especially the marine steam engine and pumping engines.

[1] A paper read at the meeting of the American Society of Mechanical Engineers, New York, November 30th, 1886.

STEAMSHIP ECONOMY.

At a recent meeting of the Engineering Section of the Bristol Naturalists' Society a paper on "Compounding Oscillating Marine Engines," of which the following is a summary, was read by Mr. J. W. J. Harvey:—

In describing the method adopted, attention was called to the fact that in the search after economy the history of these engines is somewhat unique, if not altogether exceptional, from the circumstance that no less than three separate classes of engines had been at work in the same vessel—the Juno—viz., "jet condensing," "surface condensing," and "compound," under almost identical conditions of "draught of water," "displacements," "midship area," "propeller," &c., from which probably may be drawn some useful conclusions as to the cost of motive power in steam vessels, having regard to the description of machinery employed. With the "jet condensing" engines, working with a boiler pressure of 30 lb. per square inch, an indicated horse-power of 1605 was developed on a consumption of 92 tons of coal per voyage, giving the vessel a speed of 14$\frac{1}{10}$ knots per hour. Subsequently the engines were fitted with a surface condenser and new boilers working at the original pressure of 30 lb. per square inch, when the same indicated horse-power and speed were maintained on a reduced consumption of 84½ tons of coal per voyage. At the time the above alterations were made—although it was seriously under consideration to fit the vessel with compound engines—the competition was not so keen as to warrant the heavy outlay such a change would have involved, and recourse was therefore had to the surface condensing arrangement. In process of time it is scarcely necessary to be reminded that competition in the shipping trade had become much more severe, so that the vessel had to compete with others in the same trade more recently built and fitted with compound machinery, and it is evident that she would be out of the race unless a considerable reduction could be made in the coal bill. The vessel was too good and too great a favourite to be cast aside as obsolete, and as the outlay for entirely new compound machinery would not have been justifiable, it was determined to compound the existing engines at as moderate a cost as possible, at the same time maintaining such a rate of speed as would enable her to hold her own with her more modern rivals. In carrying out this idea it was necessary to retain as much of the existing machinery as possible, and to do this it was determined to keep one of the existing cylinders as the low-pressure cylinder of the compound arrangement, and to so proportion the new high-pressure cylinder as to obtain the maximum power possible, and by this means the greater part of the existing machinery was preserved, one cylinder, the entablatures, shafts, paddle-wheels, condenser, side frames, air, circulating, and bilge pumps being retained, and the new parts required consisted only of one cylinder, two sets of link motion, two feed pumps, a steam starting engine, and, of course, a pair of cylindrical boilers working at 80 lb. pressure. The result was a compound engine having cylinders 40in. and 66in. diameter by 72in. stroke, giving 1270 indicated horse-power, and a speed of 13$\frac{4}{10}$ knots per hour, on a consumption of 49 tons of coal per voyage, the conditions as to draught of water, &c., remaining the same as before. The conclusions to be drawn are, therefore, that with 335 less indicated horse-power we have the loss of three-quarters of a knot in speed, or, in other words, it takes 335 indicated horse-power to get the last three-quarters of a knot, or about one-fifth of the whole power; that, when working with the jet condenser, the coal consumption was 92 tons per voyage; when working with the surface condenser the consumption was 84½ tons per voyage, or a saving of 8¼ per cent.; and when compounded the consumption was 49 tons per voyage, giving a saving of 46½ per cent. over the jet condenser, and 42 per cent. over the surface condenser. This result was deemed highly satisfactory, and has enabled the vessel to compete successfully with those of a more modern type, and to retain her place on the line in which, through all weathers and seasons, she has established for herself a favourable and widespread reputation.

At the commencement of 1887 the tonnage of shipping under construction was fully 61,000 tons more than it was at the commencement of the previous year.

RAILWAY MATTERS.

THE Canadian Pacific trains are expected to run into Vancouver city at the end of this month.

THE railway line from Dimboola to Serviceton on the South Australian border was formally taken possession of by the Railway Department of Victoria on January 19th.

RAILWAY matters seem to be looking up in South Africa, for a recent week's Natal railway receipts show an increase of £1223 18s. 10d., compared with the corresponding week of 1886.

IN the grounds occupied by the American Exhibition at Earl's Court, which cover nearly twenty-three acres, there will be a model of the celebrated American switch-back railway in Pennsylvania.

THE mileage of trains during the past half-year on the Midland Railway was, of passenger trains, 7,248,618 miles; of goods and mineral trains, 9,732,473 miles; the total being 16,981,091 miles, showing a decrease, when compared with the corresponding period of last year, of 391,212 miles.

A CANADA Southern Railway train was recently delayed by a peculiar cause. The engineer noticed that the water in his boiler was low, notwithstanding that the pump had been turned on. An examination of the tank showed that it was nearly full. The pipe was found to be plugged up with small fish, sucked up into the tank while it was being filled.

IN concluding a report on the collision which occurred on the 27th of last December, at New Beckenham, on the Mid-Kent section of the South-Eastern Railway, Major Marindin says, "The collision would probably not have occurred if the engine of the train had been a passenger engine, fitted with the apparatus necessary for the application of the continuous brake, with which all the vehicles in the train were furnished."

A RAILWAY from Plymouth to Dartmouth has recently been started, the Great Western branch from Brent to Kingsbridge has just been inspected, and it is expected that the immediate commencement of the London and South-Western independent line from Exeter to Plymouth, at a cost of three-quarters of a million, will cause the Great Western to double and narrow-gauge their line from Exeter to Plymouth. These important extensions will give employment to about 3000 men for over two years.

As a result of the agitation commenced a year ago by the Brush Electric Light Co. for an alteration of the railway classification as regards the carriage of dynamo and other electrical machinery, it has been decided that the Clearing House classification for apparatus of this description will now be:—Not packed, 3 Y; in cases, 2nd. The reduction of rates effected by this alteration represents a very considerable saving in the expenditure for carriage of dynamo and other electrical machinery.

To convey the iron ore from the San Juan mines, in Spain, which lie behind a mountain, to the trunk line, Mr. George Lee, of Redcar, has constructed an endless chain railway two miles in length. From the tips on the trunk line to the summit of the mountain, which is 1712ft. above them, is a distance of 2790 yards —an average gradient of 20·4 per cent.; the maximum gradient being 43 per cent. The surplus power on the one side of the mountain is utilised in hauling up the ore from the mine on the other.

As an illustration of the effects of the illiberal policy of the South-Eastern Railway Company, it is stated that during the last fifteen years, the season ticket receipts of the South-Eastern, which had been the largest of any company, have increased only 45 per cent., while the South-Western have increased 75 per cent., the Brighton 80 per cent., and the Chatham and Dover 100 per cent. Moreover, the third-class traffic, which has everywhere increased immensely, has made comparatively moderate, not to say small, improvement on the South-Eastern Railway. In numbers the third-class tickets have risen 80 per cent. on the Chatham, and 85 per cent. on the Brighton; while the South-Eastern has risen only 50 per cent. Similarly, in money, the Chatham Company has gained, in the same period, 65 per cent., and the Brighton 105 per cent.; while the South-Eastern has risen only 50 per cent.

AT the meeting of the London, Chatham, and Dover Railway Company last week, the chairman said, "Now, if we lay ourselves out and have the most efficient and the most comfortable service to the Continent, we shall participate as largely, or more largely, in the expansion of that traffic than any other company. That is the theory upon which we have been acting; but we have not been blind to the fact that on the right side and left side improvements are continually going on in the train service and in steamers." "Most comfortable service!" "Not blind!" Has the chairman ever seen any of the loop-holed packing-cases with a mediæval oil lamp glimmer which the Chatham Company have the temerity to call second and third-class carriages? Has he ever been able to see well in any of the first-class carriages, which carry an oil lamp costing twice as much per year as a gas light? It may be admitted that the company has a few new carriages.

THE following are the dates of the introduction of railways in the various countries from 1825 to 1860:—

England	Sept. 27, 1825	Peru	In the year 1850
Austria	Sept. 30, 1828	Sweden	In the year 1851
France	Oct. 1, 1828	Chili	Jan., 1852
United States	Dec. 28, 1829	East Indies	April 18, 1853
Belgium	May 3, 1835	Norway	July, 1853
Germany	Dec. 7, 1835	Portugal	In the year 1854
Island of Cuba	In the year 1837	Brazil	April 30, 1854
Russia	April 4, 1838	Victoria	Sept. 14, 1854
Italy	Sept , 1839	Columbia	Jan. 28, 1855
Switzerland	July 15, 1844	New South Wales	Sept. 25, 1855
Jamaica	Nov. 21, 1845	Egypt	Jan., 1856
Spain	Oct. 24, 1848	Middle Australia	April 21, 1856
Canada	May, 1850	Natal	June 26, 1860
Mexico	In the year 1850	Turkey	Oct. 4, 1860

IN describing an engraving illustrating two partly smashed derailed cars on the Alleghenny Valley Railway, the *Railroad Gazette* says:—"The chief interest in the case centres in the peculiar way in which the doors and the stove of the combination car behaved; and a look at the circumstances readily confirms the view expressed by competent witnesses that but for the fact that steam heat—the Martin system—was in use on the train—in place of stoves which were still in the cars, but disused—the cars must have been burned. The partition between the passenger and baggage compartments was about midway of the car, and close to it on the passenger side, in the corner, which in the engraving is on the upper side, stood the ordinary cast iron stove bolted down; and its contents, consisting of cold ashes and half burned coal, were precipitated to the other—lower—side of the car; so it requires no stretch of imagination to believe that a lively fire would have been very promptly kindled if the coals had been burning. In the baggage compartment were two men; and, curiously, the outside end door and the free side door were both warped or blocked in some way so that they could not be opened. The men got out by kicking through the door into the passenger compartment—close to the stove—and a consideration of the substantial manner in which car doors are generally made may well give colour to the statement that ten minutes elapsed before the prisoners got free. It is to be hoped that those who still love the ancient stove for its unpretending manners, and hug it affectionately for the good it has done, and those who dwell complacently on the fact that cars are very safe places to be in, in spite of their occasional little idiosyncrasies in the crematory line, will profit by it."

NOTES AND MEMORANDA.

THE six healthiest places in England and Wales last week were Derby, Leicester, Salford, Brighton, Norwich, and Nottingham.

THE deaths registered during the week ending February 19th in twenty-eight great towns of England and Wales corresponded to an annual rate of 21·1 per 1000 of their aggregate population, which is estimated at 9,245,099 persons in the middle of the year.

IN the Bulletin of the American Geographical Society, No. 2, 1886, Commander H. C. Taylor, U.S.N., describes the various projects which from time to time have been advanced for the construction of a canal across Nicaragua, and attempts to show that this is the most favourable route for a canal between the Atlantic and Pacific. Dr. G. E. Ellis gives an interesting *résumé* of the history of the Hudson's Bay Company, 1670-1870.

A FIFTH mass of meteoric iron from Augusta County, Virginia, has been described in the American *Journal of Science* by George F. Kunz. This specimen, which comes from the same place where was found the largest of the three masses first described by Professor J. W. Mallet, F.R.S., yielded, on analysis:—Iron, 90·293; nickel, 8·848; cobalt, 0·486; phosphorus, 0·243; carbon, 0·177; with traces of copper, tin, sulphur, silica, manganese, chromium, and chlorine.

AT a recent meeting of the Paris Academy of Sciences, a paper was read on the mechanism of the flight of birds studied by chrono-photography, by M. Marey. This is a further application of the author's new chrono-photographic method, already so successfully applied by him to the study of human motion. The paper is provided with four illustrations, one of which shows fifty images per second of a bird on the wing. Measured by the metric scale, the distance traversed during one complete revolution of the wing was 1·37 metre, or 6·85 metres per second, and 24,660 metres per hour.

DR. VON KLODEN recently published a list of 374 rivers, with their lengths, and other data, in which he gave the Nile as the longest river, with a length of 6470 kilometres, the Missouri-Mississippi coming second with 5882 kilometres. General von Tillo revises these estimates, and from more exact measurements concludes, says *Nature*, that the Missouri-Mississippi is the longest river in the world, with 6750 kilometres, the Nile coming next with 6470 kilometres as in Von Klöden's list. Other rivers given both by Von Klöden and Tillo with the same measurements are the Ta-Kiang, 5083 kilometres; the Amazons, 4929; the Yenisei-Selenga, 4750; the Amur, 4700; the Congo, 4640; and the Mackenzie, 4615.

IN London 2612 births and 1560 deaths were registered last week. Allowance being made for increase of population, the births were 272, and the deaths 336, below the average numbers in the corresponding weeks of the last ten years. The annual death-rate per 1000 from all causes, which had declined in the six preceding weeks from 26·3 to 17·6, rose again last week to 19·3. During the first seven weeks of the current quarter the death-rate averaged 20·9 per 1000, and was 3·4 below the mean rate in the corresponding periods of the ten years 1877-86. In Greater London 3346 births and 1981 deaths were registered, corresponding to annual rates of 32·2 and 19·1 per thousand of the population.

THE *Fireman* states that from January 1st, 1833, when the London Fire Engine Establishment was founded, to December 31st, 1886, there have been 66,158 fires in London. Of these 9397 have occurred on Sundays, 9085 on Mondays, 9587 on Tuesdays, 9632 on Wednesdays, 9538 on Thursdays, 9243 on Fridays, and 9676 on Saturdays. Dividing the 66,158 fires amongst the months, it is found that 5800 have occurred in January, 4997 in February, 5557 in March, 5087 in April, 5533 in May, 5496 in June, 5821 in July, 5820 in August, 5256 in September, 5025 in October, 5505 in November, 6261 in December. Most fires appear to take place during the hottest and coldest months of the year. The numbers given are exclusive of false alarms and chimney fires.

AT a recent meeting of the Royal Society a paper was read "On the Specific Heats of Minerals," by J. Joly, B.E., Trinity College, Dublin. The observation of specific heat is suggested as of value in determinative mineralogy. It is, with some exceptions, nearly constant for the same chemical composition, and calculable from an assumed chemical constitution, not alone in the case of simple compounds, but in the case often of the more complicated silicates, &c. No difficulty is introduced into its determination by conditions of aggregations such as looseness, &c. The method by weighing in air and steam admits of its value being very simply determined, and, if great accuracy be not required, very rapidly. The experiments made by the writer show that there is a small variation in the specific heats of minerals of the same species, accompanying slight differences in translucency, lustre, perfection of crystalline form, the tendency being for the specific heat to be a minimum in the most perfect crystals.

HERETOFORE electric telephones have been constructed on the microphone principle, depending upon variation in pressure between contact points, or upon the relative movement of bodies capable of inductive action upon each other. In those telephones known as the "magneto," which come under the latter class, the relative movement is a bodily one, as when a diaphragm is deflected by the impinging of the voice upon it. As was shown some years ago, however, by Professor D. E. Hughes, the molecules in a highly-magnetised body, however rigid in their "set," retain, nevertheless, each a small field of its own, through which each can move with excessive freedom, trembling, vibrating, or rotating through a small degree with infinitely less force than would be required to rotate it permanently on either side; so that a mechanical shock or jar is sufficient to cause a rotation of the molecules and a change in their relative positions. Hence in a disc magnetised so as to show no evident or external polarity, the jar caused by the impinging of the voice may cause a momentary unbalancing of the molecules, which is sufficient to give rise to inductive currents in a neighbouring conductor. This interesting phenomenon has been made use of in the construction of a telephone which is described by the *Electrical World*, and in which the mere bodily motion of the diaphragm creates no current in the adjacent coil. It is only when the internal molecular condition of the magnetised disc is disturbed, as by a jar, that, it is claimed, inductive effects are obtained and speech is transmitted.

ADMIRAL BOUQUET DE LA GRYE has made an interesting report to the Académie des Sciences at Paris on a series of experiments instituted by the Prince of Monaco, designed to test the velocity of currents in the North Atlantic, by means of light water-tight caskets or vessels launched into the sea at a considerable distance from the land. Some such caskets launched off the Azores in 1885 reached the land after an interval of time which indicated a daily rate of motion of from two to four miles. Later observations indicate a quicker rate of movement. Of 500 launched in deep sea off Cape Finisterre, twelve arrived at the French coast a little below Arcachon after an interval which suggests an average daily rate of travel of about six miles. Some of them were of glass, some of copper. The glass ones, floating on the surface, were exposed more to the buffetings of the waves as well as to the influence of the currents; so that it may not be easy to determine how much each of these factors may have contributed to the actual movement. The Prince carried out also a multitude of observations to determine the temperature of the ocean at different depths in various localities. In the Bay of Biscay, at a depth of 150 metres, the temperature of the water was lower than at the corresponding depth off the Portuguese coast. The differences of temperature of the deep sea help to explain the differences of the fishes and marine plants.

MISCELLANEA.

TO-MORROW the members of the Civil and Mechanical Engineers' Society will visit the new drainage and ventilation works at the Houses of Parliament, assembling at the entrance to the House of Commons at 2 p.m.

THE cotton docks at Staten Island, New York, were struck by lightning and set on fire on Friday last. A Reuter's telegram says that the damage is estimated at 300,000 dols. Thirty thousand bales of cotton were burned or damaged by fire and water, and five warehouses were destroyed. The docks are the property of the American Dock and Trust Company.

THE construction of the two ferry steamers to ply between Millwall and Greenwich has been placed by the Greenwich Ferry Company with Mr. George Skelton, shipbuilder, of Millwall. These boats will be sufficiently large and powerful to convey fifteen loaded wagons and about 1000 passengers across the river at every trip. As they will run about every ten minutes day and night, they will remove a long-felt want in the East End of London.

IT is notified that the summer meeting of the Institution of Mechanical Engineers will this year be held in Edinburgh, the members having been invited by the Senatus of the University to meet in their buildings. An invitation has been received from Sir John Fowler, K.C.M.G., and Mr. Benjamin Baker, to visit the works in progress at the Forth Bridge; and another from Messrs. Barlow and Son to inspect the new Tay Bridge. The meeting will commence on Tuesday, the 2nd of August, and will last four days.

SOME of the gas companies are accumulating an enormous quantity of coke, so they are intending to reduce the price and sell it at a profit of not more than 50 per cent. Coal on the average does not cost the London companies 7s. per ton, but suppose it did, the coal would give nearly 15 cwt. of coke, costing, say 6d. per cwt. The companies are so troubled with this accumulation that they will, in consideration of the profits on gas, tar, &c., sell this coke for, say, 9d. per cwt. Can they afford to be so very generous?

A LARGE ironclad, named the Pelayo, constructed for the Spanish Government by a French company, was launched at Toulon on the 5th inst. Commenced in April, 1885, the vessel is 105 metres long by 20 wide, and of 9900 tons. The two engines are of 6800-horse power, which can be increased to 8000, and the two screws, each weighing 7500 kilogrammes, give a maximum speed of 16 knots an hour. The cost is 14,500,000f., exclusive of that of the hydraulic apparatus and artillery, and the ship will be completely equipped in another year.

A COURSE of free lectures on matters connected with building will be delivered at Carpenters' Hall, London Wall; each lecture to commence at 8 o'clock p.m. March 2nd, "English Carpenters and Foreign Competition," by Mr. Warden Banister Fletcher, F.R.I.B.A.; March 9th, "Girders and Beams," by Professor A. B. W. Kennedy, M.I.C.E.; March 16th, "Joinery," by Mr. Francis Chambers, F.R.I.B.A.; March 23rd, "Half Timbered Houses," by Mr. Lacy W. Ridge, F.R.I.B.A.; March 30th, "Bricks and Brickwork," by Professor T. Roger Smith, F.R.I.B.A.; April 6th, "Wood—its Chemistry, its Decay, and its Preservation," by Professor A. H. Church, M.A.

THE Gloucester Chamber of Commerce held an important extraordinary meeting on Wednesday, and decided upon promoting a comprehensive scheme of canal and dock improvement between Birmingham and the Bristol Channel. The estimated expenditure is about a million and a quarter. It is proposed that the Municipal Corporations of Gloucester, Birmingham, Wolverhampton, Kidderminster, Stourbridge, and other Midland towns, and also Cardiff and Swansea, should combine in purchasing and improving the Gloucester and Sharpness and the Birmingham and Worcester Canals, and that a new entrance should be constructed in the Channel five miles below the present docks at Sharpness, direct communication being obtained to Gloucester by constructing a new ship canal to the mouth of the Gloucester and Sharpness Canal. The project is being heartily supported by merchants and traders in Birmingham and Gloucester, as well as the various Midland towns, which will be affected by the success of the scheme, under which vessels of two thousand tons would be able to enter upon any tide and navigate the Channel direct to Gloucester.

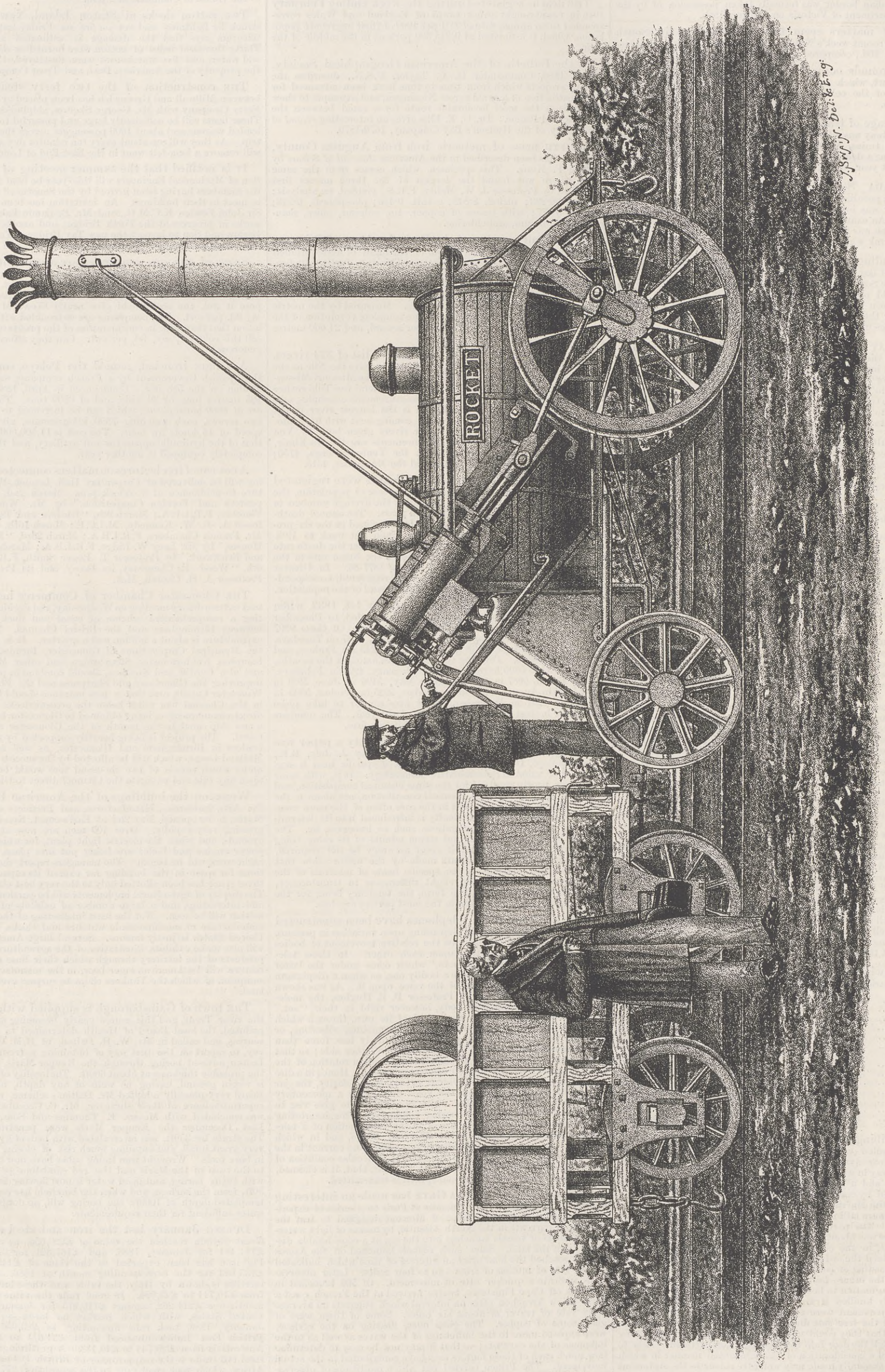
WORK on the buildings of the American Exhibition of the Arts, Industries, Manufactures, and Products of the United States, to be opened May 2nd at Earl's-court, Kensington, is progressing very rapidly. Over 400 men are now at work on the grounds, and when the electric light plant, for which a 600-horse power engine and boiler are being put into place, is completed, night work will be begun. The managers report that the applications for space in the building far exceed its capacity, and from these space has been allotted only to the very best class of exhibits. The display of agricultural implements will be particularly complete and interesting, and a large number of exhibits of machinery in motion will be seen. Not the least interesting of these will be the manufacture of machine-made watches and clocks, for which the United States is justly famous. Several large American railroads will also make exhibits, illustrative of the agricultural and mineral products of the territory through which their lines run. Another feature will be American lager beer, in the manufacture and consumption of which the Yankees claim to surpass even the "Vaterland."

THE town of Gainsborough is supplied with water from the river Trent, and this source yearly becoming more and more polluted, the local Board of Health determined to seek for other sources, and called in Mr. W. H. Dalton, of H.M. Geological Survey, to report on the best way of obtaining a fresh supply. Mr. Dalton advised boring through the Keuper Marls, and estimated the probable thickness at about 600ft. The locality of Gainsborough is virgin ground, having no wells of any depth, and the Local Board very pluckily adopted Mr. Dalton's scheme, and under the superintendence of their surveyor, Mr. C. Greenhalgh, a tender was concluded with Messrs. E. Timmins and Sons, of Runcorn. Last December the Keuper Marls were penetrated at 725ft. The strata for 350ft. was intercalated with beds of gypsum, causing very great infall, and entailing much risk of closing and fastening in bore tools. Wrought iron lining tubes have now been put down to the base of the Marls and the red sandstone penetrated 20ft. with 10¼in. boring, and good water is now flowing into well about 50ft. from the surface, and when the borehole has reached the contemplated depth of 1000ft. the boring will, no doubt, be yielding water sufficient for their requirements.

DURING January last the iron and steel exports from Great Britain reached the value of £220,050, as compared with £114,484 for January, 1886, and £161,321 for January, 1885. Pig iron has been exported to the value of £149,377, against £135,003 for the corresponding month of 1886. The greatest increase is shown by Italy, the value sent there having advanced from £10,711 to £23,924. In steel rails the value exported last month was £214,262, against £110,215 for January, 1886. The United States, with which market no business was done in January, 1886, took rails amounting to £63,650 last month; British East Indies advanced from £34,674 to £57,036; and Australasia from £20,744 to £40,183. A gratifying feature of the steel rail trade is the reappearance of British Possessions in South Africa, which took steel rails to the amount of £7777 last month against *nil* for January, 1886. Brazil fell from £16,012 to £2375, and the Argentine Republic from £24,811 to £5766. In steel—unwrought—the increased business shown last December is more than maintained. The value exported in January, 1887, was £136,284, against £73,083 for January, 1886. To the United States was sent a value of £78,262, against £22,545 in January, 1886.

THE "ROCKET" AT THE LIVERPOOL EXHIBITION.

(For description see page 153.)



FOREIGN AGENTS FOR THE SALE OF THE ENGINEER.

PARIS.—Madame BOYVEAU, *Rue de la Banque.*
BERLIN.—ASHER and Co., 5, *Unter den Linden.*
VIENNA.—Messrs. GEROLD and Co., *Booksellers.*
LEIPSIC.—A. TWIETMEYER, *Bookseller.*
NEW YORK.—THE WILLMER and ROGERS NEWS COMPANY, 31 *Beekman-street.*

CONTENTS.

THE ENGINEER, February 25th, 1887. PAGE

SCREW PROPELLER EFFICIENCY. No. VI. .. 141
ABSTRACTS OF CONSULAR AND DIPLOMATIC REPORTS. No. VII. .. 142
HOTEL SALOON CARRIAGES. (Illustrated.) .. 143
LETTERS TO THE EDITOR—Equipollent Arches—The Vyrnwy Waterworks—Smoke Conduits .. 144
Preston and the River Ribble Navigation—The Electric Light at Whiteley's—Donkey Boilers—Problem in Practical Mechanics 145
THE INSTITUTION OF MECHANICAL ENGINEERS .. 145
PUMPING ENGINES, BURTON-ON-TRENT SEWAGE WORKS. (Illustrated.) 146
IMPROVED OIL CUP. (Illustrated.) .. 146
ELECTRIC LIGHT INSTALLATION AT THE HADFIELD MILLS. (Illus.) .. 147
ON THE FRICTION OF NON-CONDENSING ENGINES. (Illustrated.) .. 148
STEAMSHIP ECONOMY .. 148
RAILWAY MATTERS—NOTES AND MEMORANDA—MISCELLANEA .. 149
THE "ROCKET" AT THE LIVERPOOL EXHIBITION. (Illustrated.) .. 150
LEADING ARTICLES—Smoke Prevention—Railway Legislation in America .. 151
The Ambleside Railway Bill—The Current Half-year of Railways—Fire-escapes—Mechanism in the Battle-field .. 152
The Great Eastern Steamship .. 153
LITERATURE .. 153
COMBINED "LIGHTFOOT" DRY-AIR REFRIGERATOR AND "OTTO" GAS ENGINE. (Illustrated.) .. 154
COMPOUND LOCOMOTIVE, NORTH-EASTERN RAILWAY. (Illustrated.) .. 155
PRIVATE BILL LEGISLATION .. 156
CHILLED CAST IRON .. 156
CONTRACTS OPEN—Indian State Railways—North-Western Railway .. 157
INSTITUTION OF CIVIL ENGINEERS .. 157
LAUNCHES AND TRIAL TRIPS .. 158
AMERICAN ENGINEERING NEWS .. 158
FILTER PRESSES FOR THE TREATMENT OF SEWAGE SLUDGE .. 158
THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS .. 159
NOTES FROM LANCASHIRE .. 159
NOTES FROM SHEFFIELD .. 159
NOTES FROM THE NORTH OF ENGLAND .. 160
NOTES FROM SCOTLAND .. 160
NOTES FROM WALES AND ADJOINING COUNTIES .. 160
NOTES FROM GERMANY .. 160
AMERICAN NOTES .. 161
NEW COMPANIES .. 161
THE PATENT JOURNAL .. 161
SELECTED AMERICAN PATENTS .. 162
PARAGRAPHS.—Junior Engineering Society, 142—The Iron Trade of 1886, 147 Association of Birmingham Students of the Institution of Civil Engineers, 154—British Iron Trade, 154—King's College Engineering Society, 161.

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.*

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

J. S. (Salford).—*We know of no trustworthy estimate of the whole power in steamships and on land.*

LETTER PRESSES.

(To the Editor of The Engineer.)

SIR, Could any of your readers give me the addresses of firms who make the manufacture of letter presses a speciality? T. A.

KNITTING MACHINES.

(To the Editor of The Engineer.)

SIR,—Could you or your readers favour me with an address or addresses where I could obtain prospectus and price lists of knitting machines?
Woolwich, February 21st. J. C.

GUNSTOCK MACHINERY.

(To the Editor of The Engineer.)

SIR,—Can any of your readers favour me with the names of firms supplying machines for making gunstocks and other articles of that class?
London, February 21st. B. F.

PATENT FUEL MACHINERY.

(To the Editor of The Engineer.)

SIR,—Kindly enable me to inquire, through the medium of your columns, the name of the makers of machinery used in the manufacture of patent fuel in form of pressed blocks. J. R. B.

GALVANISING IRON.

(To the Editor of The Engineer.)

SIR,—I shall thank any of your correspondents to tell me what arrangements and apparatus, &c., I require to galvanise constantly small pieces of iron—say, of the uniform size of 1½in. square and $\frac{1}{16}$in. thick.
February 22nd. FERUM.

SUBSCRIPTIONS.

THE ENGINEER *can be had, by order, from any newsagent in town or country at the various railway stations; or it can, if preferred, be supplied direct from the office on the following terms (paid in advance):—*

Half-yearly (including double numbers) .. .. .. £0 14*s.* 6*d.*
Yearly (including two double numbers) .. .. .. £1 9*s.* 0*d.*

If credit occur, an extra charge of two shillings and sixpence per annum will be made. THE ENGINEER *is registered for transmission abroad.*

A complete set of THE ENGINEER *can be had on application.*

Foreign Subscriptions for Thin Paper Copies will, until further notice, be received at the rates given below:—Foreign Subscribers paying in advance at the published rates will receive THE ENGINEER *weekly and post-free. Subscriptions sent by Post-office order must be accompanied by letter of advice to the Publisher. Thick Paper Copies may be had, if preferred, at increased rates.*

Remittance by Post-office order.—Australia, Belgium, Brazil, British Columbia, British Guiana, Canada, Cape of Good Hope, Denmark, Hawaiian Islands, Egypt, France, Germany, Gibraltar, Italy, Malta, Natal, Netherlands, Mauritius, New Brunswick, Newfoundland, New South Wales, New Zealand, Portugal, Roumania, Switzerland, Tasmania, Turkey, United States, West Coast of Africa, West Indies, Cyprus, £1 16s. China, Japan, India, £2 0s. 6d.

Remittance by Bill on London.—Austria, Buenos Ayres and Algeria, Greece, Ionian Islands, Norway, Panama, Peru, Russia, Spain, Sweden, Chili, £1 16s. Borneo, Ceylon, Java, and Singapore, £2 0s. 6d. Manilla, Sandwich Isles, £2 5s.

ADVERTISEMENTS.

*** *The charge for Advertisements of four lines and under is three shillings, for every two lines afterwards one shilling and sixpence; odd lines are charged one shilling. The line averages seven words. When an advertisement measures an inch or more the charge is ten shillings per inch. All single advertisements from the country must be accompanied by a Post-office order in payment. Alternate advertisements will be inserted with all practical regularity, but regularity cannot be guaranteed in any such case. All except weekly advertisements are taken subject to this condition.*

Advertisements cannot be inserted unless Delivered before Six o'clock on Thursday Evening in each week.

Letters relating to Advertisements and the Publishing Department of the paper are to be addressed to the Publisher, Mr. George Leopold Riche; all other letters to be addressed to the Editor of THE ENGINEER, 163, *Strand.*

MEETINGS NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS, 25, Great George-street, Westminster, S.W.—Session 1886-87. Tuesday, March 1st, at 8 p.m.: Ordinary meeting. Paper to be read, with a view to discussion:—"Dredging Operations and Appliances," by John James Webster, M. Inst. C.E. Friday, March 4th, at 7.30 p.m.: Students' meeting. Paper to be read:—"Propelling Machinery of Modern War Ships," by Sidney H. Wells, Wh. Sc., Stud. Inst. C.E.

SOCIETY OF ARTS, John-street, Adelphi, London, W.C. — Monday, February 28th, at 8 p.m.: Cantor Lectures. "Building Materials," by W. Y. Dent, F.C.S., F.I.C. Lecture III.—Lime—Kilns used in the calcination of limestone—Mortar—Cements—Manufacture of Portland cement—Utilisation of blast furnace slag—Plaster of Paris. Tuesday, March 1st, at 8 p.m.: Foreign and Colonial Section. "The Colonial and Indian Exhibition," by Edward Cunliffe-Owen, C.M.G. Wednesday, March 2nd, at 8 p.m.: Ordinary meeting. "The Cultivation of Tobacco in England," by E. J. Beale; Sir Edward Birkbeck, Bart., M.P., vice-president of the Society, will preside. Friday, March 4th, at 8 p.m.: Indian Section. "Our Trade Routes to the East," by Major-General Sir F. J. Goldsmid, K.C.S.I., C.B.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY.—Wednesday, March 2nd, at 7 p.m.: Ordinary meeting. Paper to be read:—"Wave Percussion," by B. Haughton, C.E.

THE ENGINEER.

FEBRUARY 25, 1887.

SMOKE PREVENTION.

THE National Smoke Abatement Institution continues its labours. We gather, however, from its annual report for 1886 now lying before us, "that the last year has not been marked by any great event in the history of smoke prevention." This, we feel certain, is not the fault of the Institution, which works in season and out of season to compel people to burn smoke or prevent its evolution. The objects of the Institution are commendable. It is enthusiastic; but all reformers are enthusiastic. It causes itself to be very much disliked by ignorant people who will persist in using coal that is not smokeless; but this is rather a testimony to the activity of the society than a thing to be deprecated. The worst feature in the policy of the Institution is that it ignores facts. The report before us laments that small progress is being made in putting an end to the smoke nuisance, and holds that the Home Secretary is at fault. He will not receive deputations from the Institution, and he will not cause the Smoke Nuisance Acts to be administered with sufficient vigour. The total number of convictions during the year 1885 was only 120, and in 55 per cent. of the cases the fine was below the minimum prescribed by the Act—namely, 40s. For this evasion the magistrates are responsible. Proceedings were taken in 124 cases. The total amount of fines inflicted was £275 10s. One fine of £40 was inflicted, and seven of £10 each. "No proceedings whatever appear to be taken to enforce the conditions of the Acts as regards steamers on the river Thames, and this is a point which the Council consider of special importance."

We cannot help sympathising with the Smoke Abatement Institution. A cold and ungrateful world either passes it by without notice, or regards it as in itself a worse nuisance than smoke. All this might be forgotten if only the Institution could score a success somewhere. This is, however, precisely what it does not do. The truth is that it has taken upon itself an impossible task. It acts on an erroneous assumption which underlies and controls all its operations. The assumption is that smoke is only produced by wilful perversity—that, in short, nothing is easier than to burn coal without smoke. We find in the report before us all the old platitudes about house fires. The fact that they are reproduced is a bad sign. It goes to show that the Institution cannot learn. Some years ago the Institution held at South Kensington an exhibition of domestic and other fires which were to burn their own smoke, and the Institution was threatened with legal proceedings—with indictment for nuisance, in fact—by the householders in the immediate neighbourhood of the Horticultural Gardens. That exhibition demonstrated as clearly as possible that a domestic fire grate cannot be smokeless unless it burns smokeless coal. It was indeed possible for inventors and exhibitors, by the exercise of great skill and caution, to prevent the evolution of smoke from grates more or less complicated and expensive, but nothing which the general public would use was smokeless. Desperate efforts were made to induce householders to burn smokeless Welsh anthracite. A very short experience was sufficient to prove that anthracite, or even smokeless Welsh steam coal, is quite unsuitable for domestic use. We doubt if a single ton of such fuel has been burned this winter in metropolitan house fires. The Institution, however, seems to be as confident as ever that smokeless grates can be used. It is useless, perhaps, to argue with people so certain that they are the only wise men. The editor of the *British Medical Journal* suggested that some experiments should be made by the Institution to test the relative value of slow and quick combustion grates. We find, however, that although the officers of the Institution approved of the suggestion and entered vigorously into the work, they could not raise the necessary funds. Letters were written to the press, applications were sent out widely to the professions and trades interested, and letters were addressed to numerous leading men, and to those who had taken an interest in the Smoke Abatement Exhibition; but the fund has not yet reached sufficient dimensions to justify the Council in commencing the tests. It is not easy to see what is to be gained by testing "stoves," some of which have open grate bottoms, and some of which have close fire-clay bottoms. This seems to be the principal difference between quick and slow combustion stoves. Possibly this is the reason that funds are not forthcoming. The Council seem to regret that a large number of houses are being fitted with slow combustion grates though nothing is known of their efficiency and economy. The truth is that builders and the public care nothing at all about efficiency or economy. The old-fashioned fireplace is popular because it suits the the Victorian Queen Anne style of architecture. The public act on the same principle as the old lady, who, coming into money, ordered a library, and being asked what kind of works she would like—history, travels, fiction—replied that she did not care what the books were, "so long as they had good handsome kivers." "Slow" and "quick" combustion means nothing to the metropolitan householder. He wants chimneys that will not smoke, a handsome fireplace, and a fire that will warm him more or less. This is very sad, no doubt, but it is a hard fact. The Smoke Abatement Institute plays, we fear, the part of Mrs. Partington and her mop, public opinion in the matter of stoves, and grates, and house fires, and coals, filling the *rôle* of the tide.

Leaving house fires and turning to manufacting operations, we find the same persistent silence as to facts; the same dogged reiterations of opinions. Steamers on the river need not produce smoke, factories need not smoke, and so on. All this may be freely conceded. We admit that in making steam, and many manufacturing processes, it is quite possible to prevent the production of smoke. We do not find fault with the Institution for any statement it makes under this head. We do criticise it because it makes no allusion to the fact that very great difficulties are constantly met with in preventing smoke. If the thing were as easily done as the Institution seems to suppose, there would be no reason for the existence of the thousands of patents which have been taken out to secure the required object. If it was all clear gain to prevent smoke, everyone in his senses would at least do all in his power to prevent it. But as a matter of fact, when bituminous coal is burned, it is next to impossible to prevent smoke without the aid of more or less expensive appliances, managed by skilled men. If the officers of the Institution will make a pilgrimage through London, we venture to assert that in ninety-five cases where the chimneys are smokeless, or nearly so, either smokeless steam coal or coke is being used. In the remaining cases grates of the Jukes or some analogous type will be found in connection with large boilers. There are thousands of small Cornish or "London" and vertical boilers in use in the metropolis. It is practically impossible to avoid prosecution if such boilers are fired with bituminous coal. Why should the Smoke Abatement Institution be silent on this point? The object of the Institution is, as we have said, laudable in the highest degree. To ignore facts—to assume that steam users *will* not prevent smoke—is not the way to enlist the public or to inspire respect. To say that because in a great brewery or flour mill it is possible to make steam with slack, without the evolution of smoke, it should also be possible for a man working, say, a 10-horse boiler to prevent smoke, is simply to ignore the facts. To fine the great brewer may be right enough. It does not follow that it is equally right to fine the little steam user.

As to the steamers on the river, it is equally well known that bituminous coal cannot in practice be burned without the evolution of smoke. All the efforts of all the engineers who have worked for the last forty years at achieving the task have not succeeded. Our great Atlantic liners and our men-of-war alike give off volumes of smoke unless they burn Welsh coal. In the endeavour to prevent smoke evils of much greater importance are introduced. So long as dense black smoke is not evolved, we may rest well content. If the Smoke Abatement Institution can produce any definite scheme for making steam with north-country coal, which shall be free from reasonable objections, by all means let it be produced. The Institution apparently has no such scheme, and if the Smoke Nuisance Act can only be complied with by abandoning the use of north-country coal while the steamer is in the river, the facts should be looked straight in the face. We do not deny that there are numerous and most meritorious inventions in daily use for diminishing the evolution of smoke. To name one might seem invidious to others, but there is no invention which can be regarded as universal in its application, or uniformly efficient and contenting in its operation. The Smoke Abatement Institution would do much better work than it is doing if it would look facts in the face; and before it insists that smoke can be prevented by the use of acceptable devices, would ascertain what percentage of such devices is accountable for the smokeless boiler chimneys to be found by the score in the metropolis.

RAILWAY LEGISLATION IN AMERICA.

THE passing of a very stringent measure controlling the railway traffic of the United States, known as the Inter-State Commerce Bill, will afford some encouragement to railway reformers in this country. We cannot hold it up as a model for close imitation, as it is badly drafted, while some of its most important sections are so loosely worded that able lawyers are divided as to the correct interpretation of them, and it is feared that this uncertainty will lead to a great deal of litigation which might have been avoided if more care had been bestowed upon the drafting of the measure. There is reason to fear, moreover, that in their desire to reform the glaring abuses of the American railway system at one stroke, the majority of the Legislature have attempted too much. However this may be, the Bill has now become an Act, having received the President's assent, and by this time probably the five Commissioners who are to administer it have been appointed. They will be looked to for guidance as to the interpretation of doubtful provisions, and, as the Act is to come into operation sixty days after its passing, they will not have much time to lose if they are to do what is expected of them in the first instance.

The Act has no application to railway traffic within the limits of any one State, that being under the control of the Railway Commission of each State as heretofore; but it applies to every common carrier engaged in the transportation of passengers or goods wholly by rail or partly by rail and partly by water from one State or territory to another or to or from a foreign country. The first general principle laid down in the Act is that any "unjust or unreasonable" charge is prohibited and unlawful. Next it is provided that there shall be no unjust discrimination between one customer and another by means of "any special rate, rebate, drawback, or other device," all

charges for a like and contemporaneous service in the transportation of "a like kind of traffic under substantially similar circumstances and conditions" being required to be equal. This is intended to be a stringent provision against preferential charges, but it is one of the portions of the Act about which there has been most discussion, and it is believed by many authorities that there will be no difficulty in evading it. Circumstances and conditions vary so greatly that it is thought there will be endless disputes over this section, unless the Commissioners lay down some definite rules as an authoritative interpretation of it. Companies are further forbidden to favour any locality or any particular description of traffic at the expense of another. There are two sections dealing with undue preference—the first prohibiting unequal charges under like conditions, and the second preferential or prejudicial advantage of any kind whatever. What is known in America as the "long and short haul section" has given rise to a great deal of adverse criticism. This fourth section declares it to be unlawful to charge more "in the aggregate" for conveyance "of passengers or of like kind of property, under substantially similar circumstances and conditions, for a shorter than for a longer distance over the same line, in the same direction, the shorter being included within the longer distance." It is somewhat awkwardly added that "this shall not be construed as authorising any common carrier within the terms of this Act to charge and receive as great compensation for a shorter as for a longer distance." Here railway companies are first told that they must not charge more for a part than for the whole of a given distance, and then that they are not to assume that they are thus authorised to charge equally. It would have been simpler to state that the charge for the part should not be greater than, or equal to, that of the whole. As it is, the equal charge is not actually prohibited. A question arises also as to the meaning of the words "in the aggregate." They might mean the aggregate of receipts for all kinds of traffic; but this would be a *reductio ad absurdam*, as it would be no consolation to an aggrieved person to be assured that the total charges on the traffic were not excessive while the charges on goods that he sent were. What is intended, it may be assumed, is the total charge, including terminals, on each class of goods. It will be noticed that this does not amount to an equal mileage rate for all distances, that idea having been generally abandoned as impracticable. The charge for part of a distance must not be greater than that for the whole, and probably it will not be allowed to be equal; but it may be only a little less for all that this section says to the contrary. Experts declare that the principal effect of the section will be to keep up through rates, in which there has been a great deal of cutting among competing companies. This will be advantageous to railway shareholders, as the cutting has gone on to a ruinous extent in recent years. On the other hand, it is complained that the virtual prohibition of extremely low through rates for wheat, for instance, will be injurious to the agricultural interest, distant wheat fields having been developed only by the advantage thus afforded. There is, of course, an answer to this objection, namely, that the advantage given to growers of wheat in settlements far from the seaboard and from the great centres of population have been afforded at the expense of growers less distant, large numbers of whom have been driven out of the competition. However, the development of new lands has always been a favourite object with the American Government and the people at large, and a proviso has been added to the section which may operate generally enough to render it in many cases a dead letter. The Commissioners are authorised to set the rule aside "in special cases," and to allow a company to charge less for a long distance than for a short one. The dispensing power thus given is unlimited, and the general impression is that it will put too much responsibility into the hands of the Commissioners, exposing them to great temptations and to the suspicion of favouritism and jobbery.

The next section, which is only less important than that just referred to, declares it unlawful for companies to enter into combination "for the pooling of freights of different and competing railroads, or to divide between them the aggregate or net proceeds of the earnings of such railroads, or any portion thereof." The object of this section is obviously a good one. It is to prevent companies combining to keep the public from getting the benefit of competition between them. It is not at all certain, however, that the object will be accomplished. As one of the best judges of railway business points out, there is nothing in the section to prevent companies from making any arrangement for the maintenance of rates which they deem desirable, so long as they stop short of actually pooling the money for division on an equal basis or dividing percentages. Pooling, it is contended, has worked well on the whole by promoting steadiness in rates, whereas traffic arrangements between companies, which are certain to take the place of pooling, have led to frequent disagreements and sudden fluctuations in rates, which are very injurious to commerce. If through rates over two or more lines are not to be prohibited—which is out of the question—it is obvious that some arrangement for the division of receipts must be come to between the companies; but whether pooling is, on the whole, advantageous or disadvantageous to the public is an intricate question, which we cannot pretend to decide. The effects of its prohibition in America will be watched with interest. Upon the remaining sections of the Act there has not been much controversy on the other side of the Atlantic, and they appear to be equitable and desirable. Every company is required to post for public inspection at the several stations printed lists of fares, rates, and terminal and other charges, with other information necessary for the guidance of their customers. Similar schedules are to be sent to the Commissioners. No rate or charge is to be raised without ten days' notice, and immediate notice of any decrease, which may come into operation at once, is to be posted up. Complaints of the infringement of the Act may be brought before the Commissioners or any district or circuit court in the United States, and the offending company, on conviction, may be fined in a sum not exceeding 5000 dols., and condemned to pay damages, if any. The Commissioners, five in number, are to be appointed by the President, under approval of the Senate, for a term of six years, except in the first instance, in which the terms are to be for two, three, four, five, and six years respectively. The President will have power to remove a Commissioner for inefficiency, neglect of duty, or malfeasance. Not more than three of any political party may be appointed; and no one connected with a common carrier. The Commissioners are given full powers for investigating the arrangements of companies, and for making rules and regulations for carrying out the provisions of the Act. The Circuit Courts are to have full powers of deciding cases and awarding penalties; but an appeal is to be allowed to the Supreme Court of the United States when the dispute affects either party to the extent of 2000 dols. or more.

From the summary of the principal provisions of this Railway Act, it will be seen that a bold and well-intended attempt has been made to correct the abuses of the railway system in the United States. It is a pity that a little more care was not taken to render its terms more precise and simple, as well as more certainly effective. There is too much discretionary power allowed to the Commissioners, who will need to be more than mortal to avoid serious mistakes in administering the Act. It is to be regretted, too, that the most important provisions are not better guarded against evasion than they appear to be. But in criticising a measure of this important and comprehensive character, the great difficulties of its framers should be borne in mind. That their Act will require amendment may be taken for granted. Possibly, however, it may work more smoothly than its adverse critics expect, or pretend to expect; and there is no doubt that if the Commissioners are prudent as well as capable men, they will be able to clear away many of the supposed difficulties. The Act makes an attempt to do everything, or pretty well everything that any recognised body of railway reformers in this country demands, and if the methods adopted are not to be in all cases imitated, they are at least instructive either as guides or as warnings.

THE AMBLESIDE RAILWAY BILL.

Of all the railway Bills being promoted this session, the Ambleside Railway Bill will almost certainly arouse the greatest and most diversified extent of feeling for and against. At the compliance with Standing Orders stage no opposition was offered, but on the motion for the second reading of the Bill in the House of Commons a warm debate arose. This Bill seeks to incorporate a company with power to make a railway from Windermere to Ambleside, and to enable it and the London and North-Western Railway Company to enter into working and traffic agreements. The proposed railway is thus described: —"A railway four miles six furlongs and three chains in length, commencing in the parish of Applethwaite by a junction with the Kendal and Windermere branch of the Lancaster and Carlisle Railway of the London and North-Western Company at or near the centre of the bridge carrying the said branch railway over Orrest Lane, and terminating in the parish of Ambleside, at a point in the field belonging to Colonel Godfrey Rhodes sixteen yards or thereabouts south of the fence dividing the said field from the road leading through Ambleside to Stock Ghyll, and forty-eight yards or thereabouts, measured in a south-westerly direction, from the south-west corner of Stock Ghyll Bobbin Mill." It is also sought to enable the promoters to make a roadway and footway in connection with the railway viaduct over the Troutbeck, and to widen and improve the gradients. The capital is placed at £165,000, in £10 shares, and the promoters propose to take power to pay interest during construction at the rate of 4 per cent. per annum. Immediately this project became matter of public knowledge, it was vigorously denounced from many quarters, and the Lake District Defence Association instituted an organised opposition. Their objection, of course, rests on the argument for preserving the picturesque beauties of the Lake district from desecration by the introduction of a railway and its necessary accompaniments, engines—possibly shrieking engines—and smoke; and it is not necessary to say that they have found numerous strong supporters. The contest recalls the battle over the Thirlmere water scheme, which has been rapidly advancing It is contended that the proposed railway is quite unnecessary, the district being thinly populated; that there would be no traffic during nine months of the year, and therefore the line could not pay; that the region being purely agricultural and pastoral, there are no industries to benefit; that the railway would, by its course and the conditions of construction, cut off access to the best stretches of woodland and mountain; and that the scheme is only a contractor's speculation. On the other hand, it is insisted that the inhabitants of the district desire and require the line, and certainly there have been very strong expressions of public approval of the Bill. For example, in view of the second reading, an address, signed by many influential inhabitants of the district, was presented to Parliament. In this petition they say that the proposed railway is "promoted to accommodate a resident population exceeding 7000 in number, besides a tourist population of from 90,000 to 100,000 in the season. At present Ambleside is five miles distant from a railway station. For want of railway facilities there are numbers of residences unoccupied in the district, except where situated within easy reach of the present station at Windermere, notwithstanding the former in many cases command finer views of the Lake district, and in other respects are more eligible. The great increase of permanent residences at Windermere and Bowness since the construction of the Kendal and Windermere Railway shows the advantage to be derived from and the appreciation in which the proximity of a station is held by the general public; and there can be, therefore, no just reason why Ambleside, the acknowledged capital and centre of the southern Lake district, should be deprived of railway accommodation. Before adopting the present project, it was considered by a large representative committee of the inhabitants of the district, especially with regard to any injury it might inflict on the landscape, and it was considered that, by the route adopted, with the contour of the ground, and the line being chiefly in cutting, there would be no appreciable injury to the scenery. It is further urged that Parliament has allowed a railway to be constructed for three miles along the shores of Bassenthwaite Lake, and that another railway passes for nearly two miles within a short distance of and within sight of Coniston Lake. It is not pretended that either of these railways have injured the scenery they pass through. The proposed railway to Ambleside will not be visible either from the road or the lake: by far the greater portion of the entire distance of five miles. Between Windermere and Troutbeck it will be either in tunnel, covered way, or cutting, and it is only really at two or three points between Troutbeck and Ambleside, where the contour of the ground is broken by small depressions, that the trains, as they pass along the railway, will be capable of being seen at all. Only three or four counter petitions have as yet been lodged against the Bill. Mr. Bryce moved the rejection of the Bill on the motion for second reading, and Mr. Howorth supported him; but several members supported the Bill, and eventually the second reading was carried by 189 to 177. This only gave the narrow majority of twelve, and it is certain that there will be a vigorous fight when the Bill comes before a Select Committee.

THE CURRENT HALF-YEAR ON RAILWAYS.

There are visible indications of the fact that the change in the course of trade, which last year affected beneficially some railways, is now beginning to benefit most of the railways of the country. In the first seven weeks of the current half-year the chief companies have shown more general increases in traffic than they did. In the past half-year the Lancashire and Yorkshire and the London and North-Western Railway were the two which had the most marked augmentation of traffic. In the seven weeks this year for which the returns are available, the London and North-Western had the large increase in traffic receipts of £30,871, and the Lancashire and Yorkshire had also a substantial enlargement, £18,269. But the next in order is noticeable, the North-Eastern Railway has an increase of £15,777, although there have been the serious strike in the coal trade, and that now closed in the steel trade in its district. The change is the more remarkable because there was a serious decrease in the last half-year on the North-Eastern Railway. Other companies which have enlarged their returns are the London, Brighton, and South Coast, by £6901; the London, Chatham, and Dover, by £3303; and the Metropolitan, the Furness, and the Maryport and Carlisle. There is one important exception, the Midland Railway has, for the weeks named, a decrease of £9645, but this is small in its ratio to that of the same company in the past year; and in the latest week nearly every one of the great companies had to record enlarging receipts, so that the tendency of the figures is unmistakeable. There is a very marked increase in the receipts for goods and mineral traffic on many of the lines, more than even in passengers; and the increase is the more noticeable when it is remembered that the rates for the carriage of some classes of goods have been sensibly reduced during the last year. The conclusion is an irresistible one—the trade of the country is growing, and that in parts which are served by many of the great systems of railway in the land. When the wool trade first indicated the possibility of this it chiefly benefitted two lines serving the Bradford and Lancashire and Yorkshire district; but now that minerals, chemicals, and other industries have responded to the advance there is a remarkable growth in the volume of traffic and travel which in its turn will benefit the trades. The railways have of necessity been obliged to give out orders for rails because the price of the latter was rising, and so they have given out orders for new locomotives. The tide of trade has decidedly turned, and the increase in the volume of traffic may be expected to go on for some time. An outbreak of war would have its effect on the outlook—indeed the apprehension of it is having its effect—but whilst this country kept out of it, it is a moot point whether it would gain or lose by the hostilities between nations which are growing more and more our producing rivals, and which would, to some extent, lessen industrial production.

FIRE ESCAPES.

Captain Shaw's recently issued report on the work of the Metropolitan Fire Brigade is possessed of much interest. We gather from it, however, that there is much still to be done towards perfecting the appliances for saving life at fires. Our attention has been particularly drawn to the unhandy design of the fire escapes in use. Not only are these machines most cumbrous, as well as from their great height very difficult to move from point to point with any speed, but it has repeatedly been found that even that height is inadequate to reach to the upper stories of the many buildings of great altitude which are now so commonly erected. It has struck us that all these disadvantages could be obviated by a lattice combination on what is generally known as the "lazy-tongs" system. When out of use the bars could be lowered so as to lay flat within a very moderate compass, while a very limited amount of screw movement would elevate the standards with great rapidity. There could be no mechanical difficulty, we should say, in combining the movement of three or four standards, which when erect would form a sufficiently rigid and hollow structure, within which the sliding bag would be contained. The similar principle might also, we believe, be usefully applied for portable observation towers for campaigning parties, and it might also receive application for the purposes of surveyors, who would thus have with them the means of obtaining observations from a height which must otherwise be sought by, possibly, a long journey to find a spot possessed of the required altitude in very flat countries.

MECHANISM IN THE BATTLE-FIELD.

In the report made by the commander of the Italian troops which suffered so much recently on the east coast of Africa, we see it written that at a most important juncture in the engagement the mitrailleuse accompanying the troops could not be worked. We have not seen it stated from what cause this unfortunate disability arose; but it certainly is not the first time by many that such weapons have failed at critical times. Against a horde of savage warriors such a weapon as the mitrailleuse may be said to double the fighting power of the party possessing it, and it is probable that had it in this case been available we should not have heard of the massacre, the news of which has caused such widespread regret. The more we refine on the weapons intended for active service in the field, the more there is reason to think we shall be liable to breakdowns of this description. With every weapon dependent not alone upon accurate workmanship in construction, but upon scientific knowledge in its handling, there must always be the risk of disarrangement under the conditions which attend service in the field. We hear on every side demands for improved field arms which involve increased complication in their mechanism. The advantage of these must be great while their efficiency remains perfect; but before their adoption it should be well considered how far that efficiency can be guaranteed under all conditions of service. If it fails in a single instance, it may do so again and

again, and we may have to pay a high price for the adoption of arms unsuited to the men in whose hands we place them.

THE GREAT EASTERN STEAMSHIP.

THE Great Eastern steamship's career has entered on a new phase. On Thursday week she was sold by auction, in Liverpool, for £26,000; almost precisely the sum paid for her twelve months ago by Mr. De Mattos. She was purchased by Mr. Thomas Brown, for the London and Australian Steamship Company. The great ship is still lying at Dublin, from which port she will proceed to Glasgow, where she will be taken in hand by Messrs. John Elder and Company and entirely refitted. She will be supplied with new triple-expansion engines, her paddles will be removed, and it is confidently expected that she will attain a speed of twenty knots. For this it is not likely that less than 18,000-horse power will suffice; and we are disposed to think that her future speed is a good deal over-estimated. However, time will show. The ship has beautiful lines; and it is said that she once attained fifteen knots with paddle and screw indicating together about 6000-horse power. Assuming that the power varies as the cube of the speed, then 11,200-horse power would be needed for twenty knots. Judging by the performance of the Etruria and other ships in the fast Atlantic trade, however, 11,000-horse power could not propel the Great Eastern at anything like twenty knots, notwithstanding her beautiful lines. The ship is to be employed in the Australian trade, for which she was built; and nothing more remarkable will be found in the history of shipping if Brunel's experiment should be carried to a successful issue for the first time, nearly thirty years after his death.

LITERATURE.

Minutes of Proceedings of the Institution of Civil Engineers; with other Selected and Abstracted Papers. Session 1885-86. Vols. lxxxiii. to lxxxvii. Edited by JAMES FORREST, Assoc. Inst. C.E., Secretary. London: The Institution. 1886.

Now that four of these volumes of engineering and scientific literature are published every year, the task of reviewing the work of the Institution has become almost too lengthy to permit us to attempt it, though it would remain as great a pleasure to the reviewer as ever. Most of our readers have learned from our pages something of the papers read during the session covered by the volumes before us. This they will have gathered from the abstracts of the papers which we publish during the session; but these really comprise but a small part of the contents of the "Proceedings," which include the discussions on the papers read, sometimes of more value than the papers themselves. They also contain papers contributed to the Institution, but which have not been read and discussed, either because the time did not permit or because they were not on subjects likely to lead to useful discussion; and it may be claimed for the Institution of Civil Engineers that its discussions have a real value.

The first paper in vol. lxxxiii. is one on "The Theory of the Indicator and Errors in Indicator Diagrams," by Professor Osborne Reynolds; a paper on the results of "Experiments on the Steam Engine Indicator," by Mr. H. W. Brightmore, accompanying it. The two were discussed at the same time, and the discussion added in a most important degree to the value of the papers; for although Mr. Brightmore's experiments were of interest, and in some respects novel, Professor Osborne Reynolds had so far under-estimated the work of others that he did not appear to advantage.

Two papers followed these, the one on "High-speed Motors," by Mr. J. Imray, and the other on "Modern Continuous Current-Dynamo Electric Machines and their Engines," by Mr. Gisbert Kapp. These two papers were discussed together, and although that of Mr. Imray called attention to the balancing of engines and the effect of the inertia of reciprocating parts on the performance of the engines, it did not contain much that was new, the subjects having been well treated by Rigg and others. The discussion, however, on the points he raised brought out others of much interest. Mr. Kapp's paper was of importance, inasmuch as it dealt with the recent great advances in the mechanical construction of dynamo machines; and, secondly, it put into practical form some of the theoretical deductions which experience in dynamo construction had enabled him to make, and electrical engineers are much indebted to Mr. Kapp for useful applicable theory. That part of his paper which dealt with engines showed his preference for double-acting engines, whether high speed or not, rather than the single-acting engines which have become common.

"Construction in Earthquake Countries," by Professor J. Milne, formed the subject of the fifth paper that was read and discussed. This paper, though of much occasional local importance, was of limited interest. It gave the results of instrumental observations in Japan, and like some other writers from that country, the author gave the impression that he was under the belief that seismology only arrived at importance when he began to understand it, and made for his own use some improved forms of seismographs. However, Professor Milne has done some good by drawing attention to the means which might be taken in earthquake countries to prevent the most disastrous of the effects in towns, and in this repeated the advice of Mallet, the founder of seismology, given fifteen to twenty years ago.

Among the other selected papers is one of much interest by Mr. G. C. Cunningham on "The Energy of Fuel in Locomotive Engines," and giving the results of an investigation into the consumption of coal per unit of work done on four American railways. Great pains seem to have been taken to secure really trustworthy and useful figures, and although the author has to make some assumptions as to weights of cars and as to accuracy of annual reports, the figures are instructive. The pounds of coal consumed per passenger train mile range from 77·12 on the Canada Southern to 90·15 on the Michigan Central; and it is noteworthy that the pounds per passenger car mile are respectively 18·14 lb. and 16·27 lb. respectively. In all cases a good deal more than a ton of train is moved per passenger, and the pounds of coal per passenger mile reach 1·86, while on the same line the pounds per ton moved reach only 1·13. The pounds of coal consumed per freight train mile reach 121·77; per freight car mile, 7·04; and per ton of freight moved one mile as high as 0·99 lb. Other of the selected papers not read are on "The Karachi Waterworks," by Mr. J. Strachan; on "The Design and Construction of Railway Rolling Stock in Italy," by S. Fadda; "Experiments on the Measurement of Water over Weirs," by B. Donkin and F. Salter. A short but pregnant paper on "Removal of Shoals by Propeller-sluicing on the Columbia River, Oregon, U.S.," by Mr. H. Hangood, gives a good idea of the amount of channel-making work which may be done on shoals and banks by moored screw ships. "Concrete Building at Simla," by Mr. W. Smith; "Lighting Vessels Under way at Night," by Mr. B. Leslie; "The Oil Wells of Baku," by F. Vasilieff; and "The Salt Industry of Stassfurt," by H. Bauerman, are the subjects of other useful papers selected for publication though not read. Of the abstracts of papers from foreign transactions and periodicals, it is not necessary to say more than that they present to every member of the Institution an epitome of the useful engineering and scientific periodical literature of the world.

The second of the four volumes of the session contains three papers and discussions thereon, and six papers not read. The first of the former is upon "Gas Producers," by Mr. F. J. Rowan; the second on "The Injurious Effect of a Blue Heat on Steel and Iron," by Mr. C. E. Stromeyer; and the third on "The River Seine," by Mr. L. F. Vernon-Harcourt. Mr. Stromeyer's paper attracted a great deal of attention, and although the injurious effects of working even high-class irons at about a blue heat had been known for a great length of time, the extent to which mild steel is similarly affected was not generally understood; and Mr. Stromeyer's paper not only contained the results of a very large number of experiments and observations, but many of those who took part in the discussion materially added to these. The subject was well thrashed out, and the paper is one of those which do great good by calling attention to and spreading knowledge on an important subject. Mr. Vernon-Harcourt's paper is also of much interest as bearing upon a branch of hydraulic engineering, on the results of which great issues have often hung, and by which great things have been effected. These are not, however, always certain, and the more the training of rivers with wide and shallow estuaries is discussed, the greater will be the probability of the prevention of the failures or only half success that have attended some operations. The features and circumstances of the Seine are to some extent similar to those of one or two river estuaries of England that much require some improvement. Great difference of opinion exists with reference to the proper works for any such river mouths, and this is the case, to some extent, with the Ribble, now very much under discussion in consequence of the works in progress. If the river alone had to be considered, the work would be easy; but to improve a river, and do nothing to the detriment of towns that have grown up on its broad shoaly estuary, is a very different matter. With respect to the Ribble, there seems very little doubt that an extension of training walls much farther out to sea than at present authorised will have to be made.

The third of the four volumes contains five papers which were read and discussed and ten selected papers. The first paper read is one on "The Explosion of Homogeneous Gaseous Mixtures," by Mr. D. Clerk. This is a very interesting and useful paper, and gave rise to an important discussion. Mr. Clerk gave the results of very numerous experiments with mixtures of gases in a closed vessel, the mixtures being chiefly coal-gas and air as used in gas engines. The discussion was opened by Mr. Imray, who is one of the disciples of the hypothesis of unmixed layers of gases and air in a gas engine cylinder, and he considered the paper interesting scientifically, but utterly unpractical. If all scientific investigations bearing on practical subjects were condemned for no better reasons than those put forward by Mr. Imray, very little scientific progress would be made of any kind. The objectionable point in Mr. Clerk's paper was chiefly that which showed that combustion and the spread of flame in homogeneous mixtures occurred in the same manner as supposed unhomogeneous mixtures. Air and gas pass into the cylinder of a gas engine at rates varying from forty to eighty miles an hour the cylinder already containing inert gases resulting from the recent combustion of a charge, and yet Mr. Imray and a few others believe that the mixture in such a cylinder is sufficiently far from homogeneity to behave as a series of gases in a stratified relation. This, however, will not pass as a general proposition before a scientific society.

This paper was followed by papers on "The Economical Construction and Operation of Railways in Countries where Small Returns are Expected, as Exemplified by American Practice;" on "The Principles to be Observed in Laying-out and in the Construction and Equipment of Railways in Newly-developed Countries;" and on "The Construction of the Canadian Pacific Railway," respectively by R. Gordon, J. R. Mosse, and G. C. Cunningham. The three papers were taken together in the discussion, a good deal of which only served to show how difficult it is to get men to see that what may be perfectly good practice in one country may be bad or wasteful practice in another, just as our Board of Trade regulations, which are very well for main line railways, are very bad when applied to light country or agricultural district railways, and are doing immense harm in this country by preventing the growth and extension of the light, cheap railway system, which might afford such valuable aid in the development of agriculture and trades, or in reducing the present costly rates of transit. The discussion showed that there are many things that we might learn from Americans with regard to bridge-building practice, but not in much else in railway work; but it did not add anything noteworthy on the subjects of the papers, namely, the construction and working of cheap railways. The next paper read was by Dr. Percy Frankland, and dealt especially with the microbe investigations and hypotheses of Dr. Kock; and although it was brought forward with the intention of showing the importance of microbe study with reference with potable waters, it really showed that to be of practically no importance at all, and that the best means of removing micro-organisms from drinking water are just those which waterworks engineers have for many years adopted, namely, well-made filter beds, duly renewed.

The first of the read papers in vol. lxxxvi. is on "Brick-making," by Mr. H. Ward, followed by Mr. F. Fox's description of the "Mersey Railway," the late Mr. Rich's on the great hydraulic lifts in the stations on the same line, and a paper on "Modern Machine Tools," by Mr. W. Hulse. These are all descriptive papers, and were followed by useful discussions and correspondence; but although they contain a good deal of practical information and in some respects novelty of detail in design or practice, none are remarkable for novel departures. Exception must, however, be made in favour of the paper by Mr. Fox on the Mersey Tunnel and Railway. This not only described the first big underwater railway tunnel then open to the public, but a number of the interesting and difficult problems that had to be solved in devising and carrying out the best systems of construction and of working the line at the least cost. An interesting question in the economic working of lines with stations at short distances apart is presented by that part of the Mersey line which is between the two underground stations. There is a rather steep dipping gradient between them, so that gravity helps to get up speed at starting, and to stop the train at the other station. Coal has thus to be burned in considerably less quantity than if the line were level. Mr. Baker stated that he had found that on the Metropolitan Railway, of 36 lb. of fuel burned per mile, about 15 lb. were used in overcoming frictional resistance; that is, in doing the work of hauling the train, while 21 lb., or 60 per cent. of the whole, were consumed in getting up speed, and by the brakes in pulling up.

Two valuable papers by students of the Institution are published with the other selected papers, one on "The Stability of Voussoir Arches," by H. A. Cutler, and the other on experiments on the "Relative Strength of Cast Iron Beams," by E. C. de Segundo and L. S. Robinson. Other selected papers are "On the Horizontal Range of Tidal Rivers," such as the Orwell, with reference to sewage discharge, a paper which describes experiments, leading to the conclusion that in any case all floating *debris*, mineral, and putrescible matter, should be separated from the sewerage before discharging it into the river, and that where the quantity to be turned into a river exceeds 1 per cent. of the tidal volume at the point of discharge, it should be clarified by land filtration or otherwise treated before discharge. A paper entitled "Experiments on a Direct-acting Steam Pump" is given by Mr. J. G. Mair, describing a series of tests of a large Worthington compensation action pump, and showing how, with a considerable range of expansion in the steam cylinder, a nearly uniform pressure on the pump plunger is obtained.

Of the numerous and very useful abstracts of foreign transactions and periodicals, we can only say that every one of our readers having also access to these volumes is robbed of every excuse for ignorance of anything that is going on in the engineering and scientific world as far as scientific progress relates to any branch of civilian engineering. The volumes contain from 500 to 600 pages, and not only are they got up in the best possible style, but everything is done by references, good index, well selected type, and good lithography to make these "Proceedings" the best of their kind and the most complete. A noteworthy point concerning them is the promptness and regularity with which they are published. Full as they are of precise and original matter needing the most careful revision, they are prepared and published with despatch that might be commended to any Government Department were it not for fear of killing the whole of its officers with fright. For instance, it may be mentioned that vol. lxxxvii. was issued in the first week in February. It contains 605 pages, ten lithograph plates, and a large number of other engravings, fourteen original papers, seven of which were discussed at length at meetings and by correspondence, much of which is from abroad. The first of these papers was read on the 16th November and the last not until the 7th and 14th December, after which the discussion by correspondence was written, much of it abroad. Besides these papers it contains no less than eighty-eight abstracts from foreign periodicals. Mr. Forrest has thus shown what may be done with well directed energy and an excellent though not large staff.

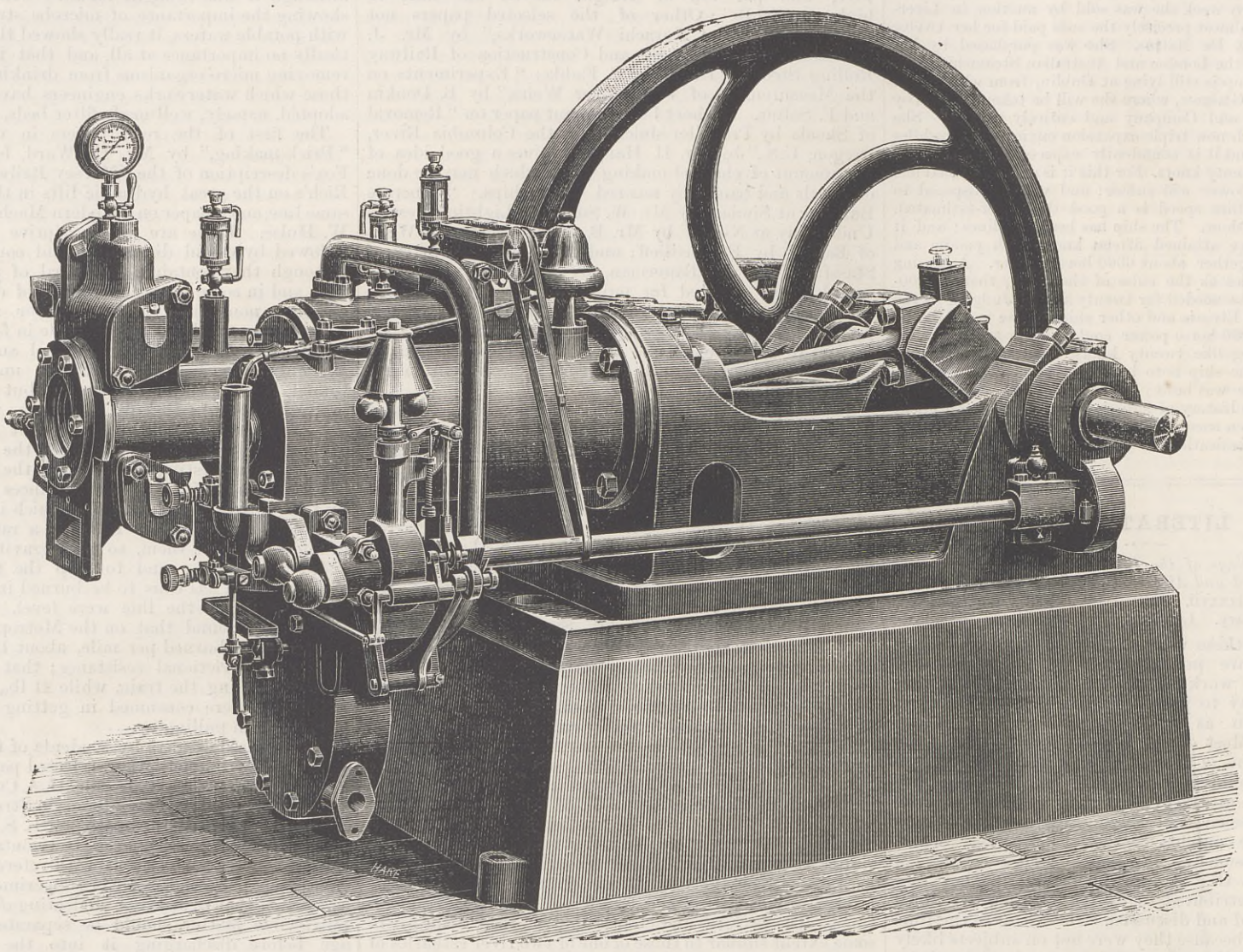
THE ROCKET AT THE LIVERPOOL EXHIBITION.

MR. WEBB had a model of the Rocket, full size, made last year, in wood and iron. The model was shown at the Liverpool Exhibition, and attracted a good deal of attention. Before it was sent to Liverpool it was photographed at Crewe Works, and our engraving on page 150 has been prepared from the photograph. Mr. Webb spared no pains to make his model perfectly accurate, and inasmuch as he had access to every available source of information, there can be no doubt that our engraving is conclusive as to what the Rocket really was. Our readers will, no doubt, remember how keen a discussion on this vexed question took place in our correspondence columns not long ago. The Rocket may be compared with another old engine, the Comet, which we illustrate on page 154.

NAVAL ENGINEER APPOINTMENTS.—The following appointment has been made at the Admiralty:—Mr. William H. Matthews, chief engineer to the Caroline, reappointed on promotion, to date February 5th.

COMBINED "LIGHTFOOT" DRY AIR REFRIGERATOR AND "OTTO" GAS ENGINE.

MESSRS. CROSSLEY BROS., MANCHESTER, ENGINEERS.



COMBINED DRY AIR REFRIGERATOR AND OTTO GAS ENGINE.

To meet a want that has long been felt by butchers, poulterers, fishmongers, chocolate makers, and others, for a cheap, simple, and efficient means of cooling, Messrs. Crossley Bros., Manchester, have recently brought out the machine which we illustrate above. It consists of one of their latest type of Otto gas engines, combined with a Lightfoot's patent dry air refrigerator of similar construction to that which obtained the gold medal at the International Health Exhibition. The air cylinders are combined in the usual way—as previously illustrated in The Engineer—and are placed alongside the gas cylinder, the two sets being bolted up to a neat frame. The air cooler with drying apparatus is in the pedestal below, the arrangement being such that the water passes first through the cooler, then through the jacket of the compressor, and finally through the jacket of the gas cylinder; water vessels are therefore dispensed with. In the refrigerator, as well as in the gas engine, the simplest and most straightforward design has been followed, in order not only to reduce first cost, but to enable every part to be readily accessible and easily kept in order. The air valves are of the Corliss pattern, with positive action, allowing the apparatus to run at a high speed with economy and efficiency. It has been found after several years of experience that these valves last well and require no attention beyond lubrication, matters of great importance, when, as is frequently the case with gas-driven machines, the plant is left to itself during the greater part of the day, and is only occasionally looked after by an unskilled attendant.

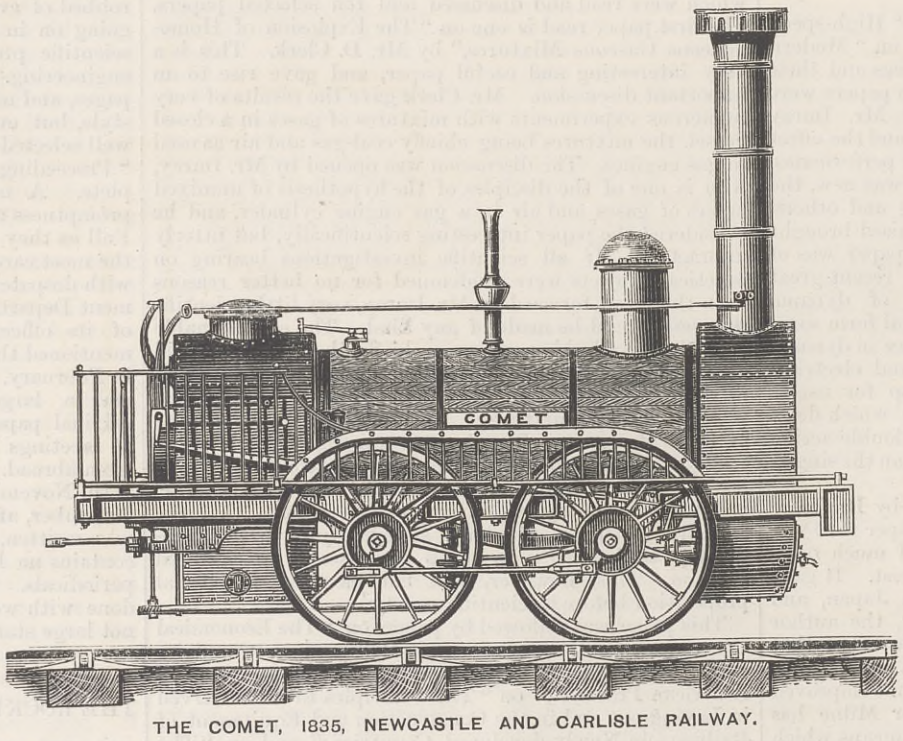
The machines are made in several sizes to deliver from 2000 to 6000 cubic feet of dry cold air per hour, but smaller and larger combinations can be made if required. The gas engine can be disconnected from the refrigerator, so as to be applied to other purposes when cooling power is not required.

We may mention that a gas-driven refrigerator on Lightfoot's system has been in constant operation for about two years in the vaults of Messrs. J. S. Fitter and Sons, Leadenhall Market, where it has given the greatest satisfaction. There are four chambers capable of together holding some twenty tons of meat. It has been found that about six hours working per day suffices, and there is no difficulty in maintaining a temperature below freezing during the night, and from Saturday to Monday, without running the machine after ordinary hours. In winter the water, after performing its cooling dutiesin the refrigerator and gas engine, is used for heating the offices. During the two years this machine has been at work no repairs have been required beyond the occasional setting up of the brasses.

The principal advantages of such a combination as we have described are—economy in first cost and in space occupied, cleanliness, convenience, and saving in attendance, as no skilled labour is required. The machine is practically noiseless in action, and is readily started and stopped at a moment's notice. We need hardly add that it is of great importance that machines of the kind should run without risk of breaking down, and in this respect the Lightfoot refrigerator has proved most satisfactory.

THE COMET.

The accompanying engraving from a photograph kindly placed at our disposal by Mr. Clement E. Stretton illustrates the Comet, a locomotive built by Messrs. Hawthorn and Company in the year 1835. This engine hauled one of the passenger trains on the opening of the Newcastle and Carlisle Railway, March 9th, 1835. The dimensions of the engine were:—Engine No. 2, cylinders, 12in. diameter by 16in. stroke; wheels, four-coupled, 4ft. diameter; boiler, length, 7ft. 6in. by 3ft. diameter; fire-box, length inside, 1ft. 10in.; breadth, 3ft. 6in.; depth from crown to top of fire-box, 3ft.; heating surface, deducting area of tube ends and 1·134 square feet for fire-hole door, 35·180; tubes, number, 66, 8ft. long by 2in. diameter by 12 w.g.; area through each 2·405in.; total area, 158·730in.; internal circumference of each, 5·497in.; total heating surface of tubes, 237·284 square feet; pressure of steam per inch of valve, 60 lb.; horse-power, 103·08; time of delivery, March 8th, 1835; capacity of tender tank, 680 gallons.



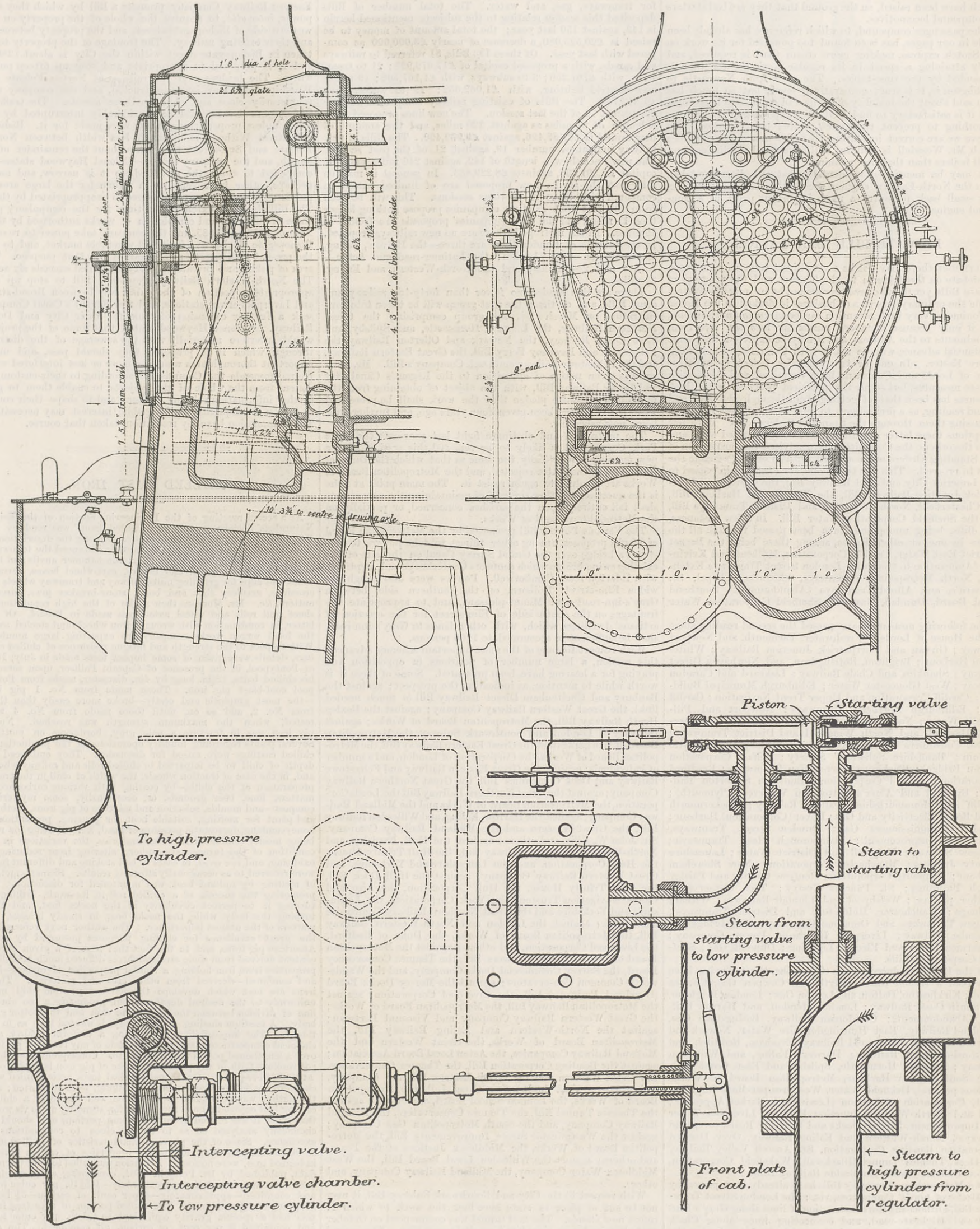
THE COMET, 1835, NEWCASTLE AND CARLISLE RAILWAY.

Association of Birmingham Students of the Institution of Civil Engineers.—At a meeting of the above Association, held at the Colonnade Hotel, Birmingham, on Thursday, the 10th inst., a paper, prepared by Mr. Joseph Pickering, Stud. Inst. C.E., on "The Sewerage of Towns," was read. The President of the Association, Mr. Pritchard, M. Inst. C.E., occupied the chair. The author, in introducing the subject, showed the importance of sanitary science, the beneficial results which have arisen from it, and the evil of sacrificing health and life from mere financial considerations. In the author's opinion, the water-carriage system for the sewerage of towns is based on a sound principle, having in view the speedy removal of all deleterious matter before decomposition can take place. The question of the admission of rainfall into the sewers was exhaustively dealt with, the conclusion arrived at being "that as the dilution of sewage by water deteriorates its value, though possibly to a small degree, water—that is, of a comparatively clean condition—which can be otherwise dealt with, should not be discharged into the sewers, although it might be found advisable to consider the balance of convenience and expense in dealing with rainfall, which, if not admitted into the sewers, would necessitate a second house connection, the cost usually being in excess of the extra cost incurred by the larger sewers and disposal at outfall." Subsoil drainage in its entirety was advocated, and the common practice of erecting dwellings on soil irrespective of its character strongly condemned. It was urged that more uniformity of opinion should exist relative to the data on which to base the sizes of sewers, the diversity of opinion strikingly presenting itself when examining a competitive scheme of sewerage, the sizes under similar circumstances not unfrequently doubling and trebling each other. The various materials applied to the construction of sewers were described, and their advantages and disadvantages clearly set forth. The subject of pipe joints was dwelt upon at some length, the author feeling its vital importance to the success of any sewerage scheme, considering that in a single mile of pipes there are usually upwards of 2000 joints, and that a defect in the system of jointing might have a disastrous effect. The ordinary spigot and socket joint was condemned, on the ground that it offered a ready means for the workmen to scamp their work without immediate detection. Twenty-five different forms of pipe joints were described and illustrated by diagrams, some, in the author's opinion, affording no advantage over the ordinary joint, and others in satisfactory ground being almost perfection. It was agreed that the object of nearly all the inventions was to form an absolutely rigid joint, but that such a joint was useless in ground liable to subsidence, the unequal subsidence tending to alter the line of sewer by its deflection, resulting either with the snapping of pipes or breakage of their joints. After suggestions had been given as to the line and courses to be adopted in laying out a system of sewers, their ventilation and cleanliness was dwelt upon. The numerous devices to free the sewers of the dangerous gases generated therein were described, the author's conclusion being "that if a system of sewer is properly constructed in connection with the method of ventilating through surface gratings, and with periodical flushing with clean water, the result is the highest modern attainment of a complete sewerage system."

British Iron Trade.—In the British Iron Trade Association's statistical report for 1885, it was announced that there had been a diminished make of Bessemer steel in every district except South Wales and Sheffield, where, however, the increase was so substantial—being not less than 45,386 tons—that the total make for the year showed an increase of 4451 tons on the make of 1884. The position of affairs at the close of 1886 was, as regards the quantity produced, much more favourable than that recorded for 1885. There has been an increase of make in every district. The greatest increase appears to have occurred in the Cleveland district, where it amounts to 117,039 tons; while the next largest increase appears in the new Bessemer steel-making districts of South Staffordshire, Shropshire, and Scotland, where it is not less than 86 745 tons.

COMPOUND LOCOMOTIVE, NORTH-EASTERN RAILWAY.—DETAILS.

MR. T. W. WORSDELL, GATESHEAD, ENGINEER.



COMPOUND GOODS ENGINE.

In our last impression we gave a double-page engraving showing Mr. T. W. Worsdell's compound goods engine on the North-Eastern Railway in longitudinal section. We now give above cross and longitudinal sections through the smoke-box, and an enlarged view of the details of the starting gear.

If a compound locomotive with two cylinders stopped with the high-pressure crank at or near the dead centre, it could not be started unless some provision were made for admitting steam to the low-pressure cylinder. This is effected in a very simple and ingenious way by the use of one handle only on the foot plate. The detail engraving shows the gear very clearly. The small lever on the front plate of the cab being drawn back, opens the starting valve, which admits steam to act on the small piston. The steam, flowing in the direction of the arrows, pushes the little piston out of its way, and so opens a port leading to the rectangular pipe—shown in section—which unites the high and low-pressure valve chests. Steam is thus admitted to the low-pressure cylinder. Unless some provision were made to prevent it, however, the steam would also find its way through the bridge of the high-pressure valve into the high-pressure cylinder, where it would oppose the effort of the low-pressure piston to start the train. To prevent this a flap valve is provided, marked in the engraving with the words "intercepting valve." This is coupled by a lever and rod to the little piston just mentioned, and the piston pushes the flap valve up on its seat, and so prevents steam from passing back into the high-pressure cylinder.

The moment the engine begins to move ahead the driver releases the little lever on the cab front, when the conical valve is automatically sent on to its seat by the spiral spring. The engine going on for half a revolution of the driving-wheel, the high-pressure cylinder exhausts into the low-pressure cylinder, which has previously exhausted, the piston having completed its stroke, and the exhaust from the high-pressure cylinder instantly blows the intercepting valve open, pushing the little piston back to its original position, and so things remain until the engine has again to be started with the high-pressure crank on a dead centre. No reducing valve is used, but two spring-loaded water valves are fitted to the low-pressure cylinder ends, which open if the pressure exceeds 100lb. on the square inch. The drivers, however, manipulate the little levers with such skill that these safety valves, as we may call them, seldom come into action. It generally suffices to admit just a puff, so to speak, of steam to the low-pressure cylinder, the large piston in it operating very powerfully to move the engine and turn the high-pressure crank over the dead centre. From personal

observation we can say that this starting-valve is perfect in its action, and is a great improvement on the starting-valve fitted to Mr. Worsdell's first compound on the Great Eastern Railway, which was worked by two handles, one for the intercepting valve and the other for the starting valve. The latest arrangement, which we illustrate, disposes effectually of all the objections which have been raised, on the ground that they are bad starters to compound locomotives.

The passenger compound, to which reference has already been made in our pages, has been found too powerful for its work on the Scotch express, making more steam than is required, and easily attaining a speed in its regular work greater than is demanded by the time-tables. The road from Newcastle to Darlington is, it is true, comparatively level; but so much has been said about the inability of compound engines to keep time, that it is satisfactory to find that in compounding *per se* there is nothing to prevent the fastest trains being worked. We believe we are correct in stating that the new express engines which Mr. Worsdell is building will have smaller cylinders and small boilers than that now running.

It may be mentioned incidentally that the diagrams taken from the North-Eastern engines are very satisfactory, showing very small back pressure—a most important point in a compound engine.

PRIVATE BILL LEGISLATION.

Although there may not be a very direct connection between the debate on the Address to the Throne and the progress of private Bills, yet the two processes cannot be entirely dissociated. While the ordinary progress of business is blocked in the House of Commons, very little attention can be given to anything else, and if only because members' minds are now set free from amendments to the Address, and it may be expected that some substantial advance will be made with Committee-room work before Easter. In one or two instances, Select Committees both of Lords and Commons have examined and dealt with private measures, but so far the principal progress with these measures has been that of getting them through the first and second reading, as a preliminary to reference to Committee, and in passing them through the Standing Orders tests. With few exceptions these latter conditions have been complied with, and as to the others, the Committee have advised the suspension of the Standing Orders not complied with in order to enable the Bills to proceed. This has been done, for example, in regard to the Limerick City and Port Railway Bill, the Girvan and Portpatrick Junction Railway Bill, the Whitehaven Harbour Bill, the Chesterfield, North Wingfield, and District Tramways Bill, and the Sheffield Corporation Water Bill. In a few instances, too, Bills, being unopposed, have been passed through all the stages in one or other House, among these being the Barnet District East Water, Carlisle Corporation, Hillhead and Kelvinside (Annexation to Glasgow), London Street Tramways Extension, North Metropolitan Tramways, Skegness, Chapel, St. Leonard's, and Alford Tramways (Abandonment), Southend Local Board, Dundalk Gas and Sheffield Corporation Water Bills.

The following measures have passed the second reading stage in the House of Lords:—Freshwater, Yarmouth, and Newport Railway; Girvan and Portpatrick Junction Railway; Whitehaven Harbour; Brighton, Rottingdean, and Newhaven Direct Railway; Shanklin and Chale Railway; Liskeard and Caradon Railway; West Gloucester Water; Edinburgh Municipal Buildings; Cardiff Corporation and Upper Trent Navigation; Cardiff Gas; Edinburgh Northern Tramways; Newport and Pillgwenlly Water; Northampton Gas; Sheffield Water; Chesterfield, Hasland, and North Wingfield and District Tramways; Bristol Consumers' Water; Aberdeen Infirmary and Lunatic Asylum; Banffshire Solicitors' Society; Belfast Corporation (Lagan Bridge); Blackburn Corporation Tramways; Bradford Corporation; Bristol Corporation; Budleigh Salterton Railway; Burnard and Alger's Cattedown Wharves (Plymouth); Cardiff and Monmouthshire Valleys Railway; Cockermouth Local Board Electricity and Gas; Dover (Corporation) Harbour; Dundalk Commissioners Gas; Dundee Street Tramways, Police, and Improvement; Flamborough Head Tramways; Glasgow Subway; Holywell and District Water; Lancashire County Justices; Manchester Corporation; New Shoreham Harbour; Plymouth Corporation; Renfrew County and Paisley Burgh Buildings; St. Pancras Vestry; Tees Conservancy (further powers); Welshpool and Llanfair Railways; Witham Drainage; Manchester, Middleton, and District Tramways; Glasgow Tramways and Omnibus Company; Kingsbridge and Salcombe Railway; Liverpool Hydraulic Power Company; Cockermouth Gas and Electric Lighting; Dundalk Gas; Sheffield Corporation Bills.

Of the Bills introduced in the Commons, the following have been read a second time:—Blyth and Cowpen Gas, Chelsea Water; Kirkheaton, Dalton, and Lepton Gas; London, Brighton, and South Coast Railway; London, Hendon, and Harrow Railway (Abandonment); Caledonian Railway, Basingstoke Gas, Highland Railway, East Huntingdonshire Water, Newark and Ollerton Railway, Easingwold Railway; Evesham, Redditch, and Stratford-on-Avon Railway; Harrow, Ealing, and Willesden Railway; Lineden, Horncastle, Spilsby, and East Coast Railway; Southampton Harbour, Metropolitan Board of Works (various powers), Uckfield Water, Weston-super-Mare Improvement, Corporation of London (Leadenhall Market Approach), Hull and North-Western Junction Railway, Liverpool Water and Improvement, Mersey Docks and Harbour Board (overhead railways), North-Western and Ealing Railway, Over Darwen Corporation, Reading Corporation, St. Austell Valley Railway and Dock, Thames Tunnel (Blackwall), Wakefield Corporation, Sutton District Water, Ambleside Railway Bills.

Two Metropolitan Tramway Bills have already been passed by the House of Lords' Committee, viz.: the London Street Tramways Bill, authorising the construction of lines along Gray's Inn-road and Highgate-road, and connecting lines along Chalk Farm-road, Ferndale-road, and Crowndale-road, to shorten the existing route to the City; and the North Metropolitan Tramways Bill, which provides principally for the construction of a tram line along Commercial-street and Great Eastern-street, forming a direct connection between the lines from the East-end, terminating at Whitechapel, and the lines on the North and West London system. The lessees of Spitalfields Market opposed this portion of the Bill. Power is taken to use electricity as a motive power on a portion of the line at West Ham. A House of Lords' Committee has also passed the Barnet District Gas and Water Bill, which was one of the measures suspended by the last general election. The Finchley Local Board opposed the Bill, but the Committee refused them a *locus standi*. The Carlisle Corporation Bill has also been passed in the Upper House; and another measure, the Tees Conservancy Bill, has likewise been assented to by a Lords' Committee. The object of this was to limit and define the obligations of the Conservancy Board with respect to the construction and maintenance of certain embankments and other works, and to extend the time for completing the works.

A Parliamentary paper has been published containing the report of the Board of Trade upon all the railway, canal, tramway, subway, gas, and water Bills of the present session, together with statements relating to applications for provisional orders for tramways, gas, and water. The total number of Bills deposited this session relating to the subjects mentioned herein is 143, against 150 last year; the total amount of money to be raised is £20,525,080, a decrease of nearly £3,000,000 as compared with last year. Of these 143 Bills, 81 referred to railways and canals, with a proposed capital of £17,079,928; 21 to tramways, with £701,250; 3 to subways, with £1,167,500; 19 to gas and electric lighting, with £1,062,652; 19 to water, with £1,513,750. The Bills of existing railway companies number 62, against 70 of the last session. The new lines proposed show a length of 8[illegible] miles as against 120 miles, and the amount of new capital is £8,488,496, against £9,939,400. The Bills of new railway companies number 19, against 21 of the past session. The new lines show a length of 142, against 246 miles, and the capital £8,591,432, against £8,229,883. In general it may be said that the works now proposed are of limited extent as compared with those in previous sessions. This will be seen from the fact that existing companies propose nothing longer than 11 miles, and the new companies' proposals are from 3 to 19 miles. In the metropolis there are no new railways proposed. In the suburbs of London there are three—the Harrow, Ealing, and Willesden lines, 7¼ miles; the Latimer-road and Acton—Nos. 1 and 2—8 miles; and the North-Western and Ealing, 3½ miles.

There are this session no fewer than forty-two railway and canal Bills, and of these the first group will be taken into consideration on March 1st, the group comprising the Great Northern Railway, the Lincoln, Horncastle, and Spilsby, and East Coast Railway, the Newark and Ollerton Railway, the Felixstowe and Bawdsey Ferry Bill, the Great Eastern Railway, and the Felixstowe Railway and Dock Company's Bill. Mr. Lawson has given notice of opposition to the Regent's Canal City and Docks Railway Bill, with the object of obtaining from the promoters a definite pledge that the work shall be proceeded with, power having been given four years ago, and further time being now asked for.

The protracted and obstinate fight last year over the Hyde Park Corner Bill is likely to be renewed this session, for the new measure is practically the same as that which the Duke of Richmond's Committee rejected, and the Metropolitan Board of Works are resolved to again resist it. The main point at issue is the question whether the cost of maintaining the new streets shall fall entirely upon the parishes concerned, or partially on the Metropolitan Board of Works.

The Various Powers Bill promoted by the Metropolitan Board of Works proposes, among other things, to take powers to construct a bridge over the Grand Surrey Canal on the site of the existing swing bridge which connects Canterbury-road, Deptford, with Ilderton-road, Camberwell. Powers were also sought to widen Elm-street, Holborn, on the southern side, between Gray's-inn-road and Mount-pleasant, and to appropriate the frontages on the south side of Elm-street for the erection of artisans' dwellings, which, with other lands in Gray's-inn-road, shall be sufficient to accommodate 1200 persons.

With respect to some of the more important schemes advanced this session, a large number of petitions in opposition and praying for a hearing have been presented. Some of these it is worth while to mention, as indicating the prospect: against the Banbury and Cheltenham Direct Railway Bill (a much needed link), the Great Western Railway Company; against the Bexley Heath Railway Bill, the Metropolitan Board of Works; against the City of London and Southwark Subway, the Metropolitan Board of Works; against the Great Eastern Railway Bill, the Metropolitan Board of Works, the Corporation of London, and a number of individuals; against the Great Eastern Railway and Felixstowe Railway and Dock Companies' Bill, the Great Northern Railway Company; against the Great Northern Railway Bill the Leeds Corporation, the Metropolitan Board of Works and the Midland Railway Company; against the Harrow, Ealing, and Willesden Railway Bill, the Great Western and the Midland Railway Company, Sir John W. Ellis, and others; against the Hull, Barnsley, and North-Western Junction Railway Bill, the Hull Trinity House, the Hull Corporation, and the Lancashire and Yorkshire, and Great Western Railway Company; against the Hull Dock Bill, the Hull Trinity House, the Hull Corporation, the Aire and Calder Navigation Trustees, the York Corporation, the Lancashire and Yorkshire and the Great Northern Railway Companies and others; against the London and North-Western Railway Bill, the Metropolitan Board of Works, the Duke of Bedford, the Liverpool Corporation, and others; against the Metropolitan Board of Works Various Powers Bill, the Thames Conservancy Board, the Surrey Commercial Docks Company, and the Wandsworth Common Conservators; against the Mersey Docks Board (Overhead Railways) Bill, the Liverpool Corporation; against the Metropolitan Railway Bill, the Metropolitan Board of Works; the Great Western Railway Company and Viscount Portman; against the North-Western and Ealing Railway Bill, the Metropolitan Board of Works, the Great Western and the Midland Railway Companies, the Acton Local Board Association; against the Reading Corporation Bill, the Thames Conservancy, the Great Western and the South-Eastern Railway Company, and others; against the Regent's Canal Bill, the Metropolitan Board of Works, the London School Board, and others; against the Thames Tunnel Bill, the Thames Conservators, the Midland Railway Company, and the South Metropolitan Gas Company; against the Westminster Street Improvements Bill, the Metropolitan Board of Works, the Middlesex Justices of the Peace, and others; against the Willesden Local Board Bill, the West Middlesex Water Company, the Midland Railway Company, and others.

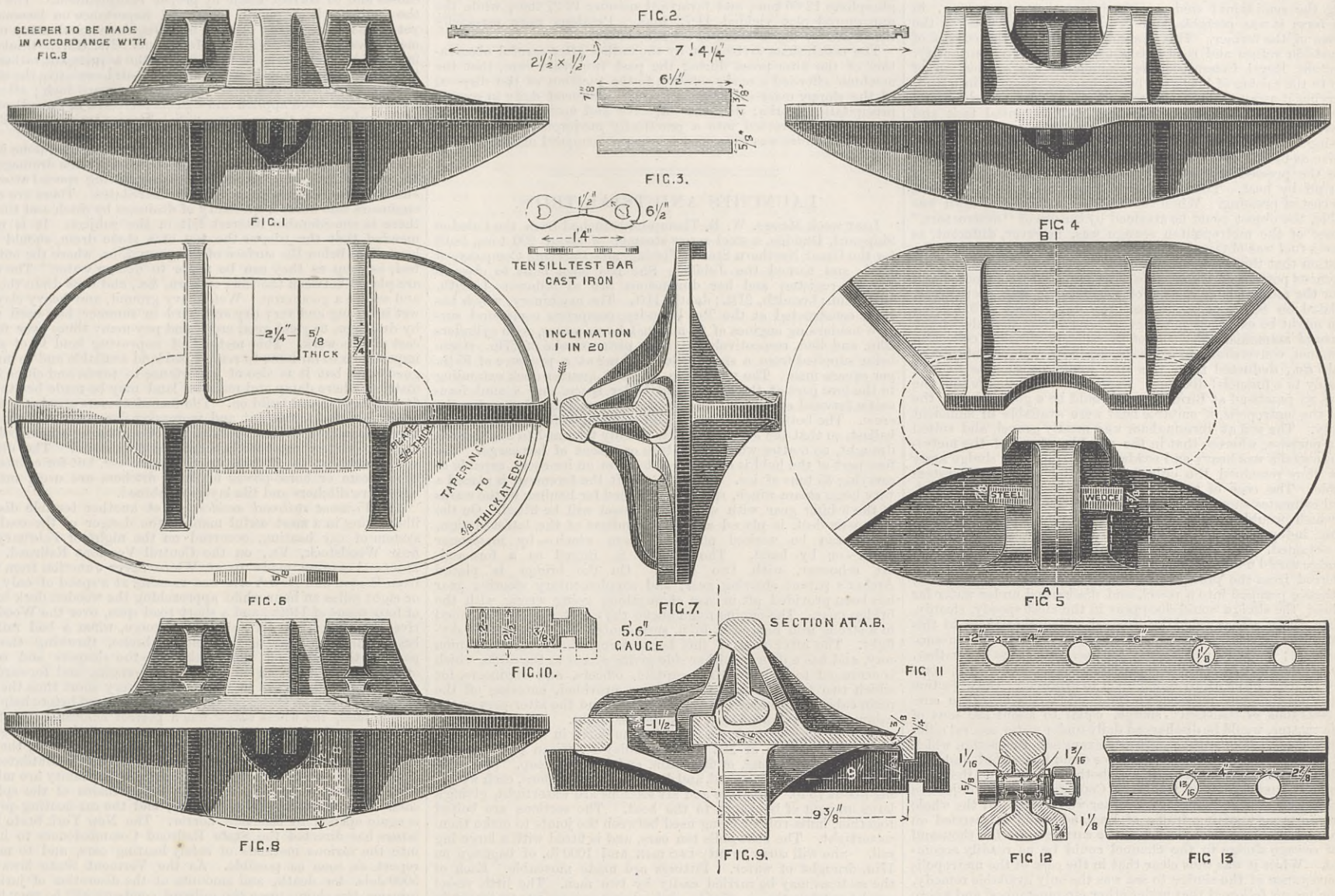
With respect to the City and Southwark Subway Bill, it may not be out of place to state here how the work to which it refers now stands. The first tunnel was commenced on October 28th last, and was completed on February 12th. The second tunnel has been started and is in rapid progress; and the remainder of the work consists in laying the rails and fitting the rope cables for drawing the trains through. The original Thames tunnel took 17 years to complete and the cost was half a million, against £20,000 for the new tunnel. The promoters of the new undertaking aim at having a station at London Bridge, but they have yet to obtain the assent to that of the London, Brighton, and South Coast Railway Company. Their first station will be at Great Dover-street, and the object of their Bill in Parliament is to obtain power to extend the tunnelling from the Elephant and Castle to Kennington and Stockwell.

Colonel Haywood engineer to the City Commission of Sewers, has submitted a report to that body on the several Bills in Parliament, in respect of which notices had been served on the Commission. These are five in number. The first is a Bill promoted by the Corporation for straightening and improving the existing street from Lime-street to Leadenhall Market. By the second, the City of London and Southwark Subway Company seek power to extend their authorised subway from the Elephant and Castle to Kennington and Stockwell, and to acquire additional lands in the City at the south-east corner of Arthur-street East and King William-street. The Great Eastern Railway Company promote a Bill by which they seek power, *inter alia*, to acquire the whole of the property on the western side of Bishopsgate-street, and the property between it and their existing railway. The frontage of the property to be taken in Bishopsgate-street within the City is about 1380ft., and it is proposed to appropriate and stop up fifteen public ways. The bridges over the railway at Norton Folgate and Worship-street may be reconstructed, and the company may temporarily close and stop up those streets. The traffic of Bishopsgate-street would be considerably interrupted by the works unless proper arrangements were made for it. Bishopsgate-street Without is of much less width between Norton Folgate and Sun-street than throughout the remainder of its length, and the company should—Colonel Haywood states—be compelled to widen the street where it is narrow, and make, perhaps, other improvements in return for the large area of public way—over an acre—proposed to be appropriated by them. The Bill also seeks extension of time for the compulsory purchase of property and completion of works authorised by their Acts of 1882 and 1885, and the company take power to re-open Bishopsgate Market as a fruit and vegetable market, and to use the present Bishopsgate goods station for that purpose. The area of public and private property scheduled exceeds six acres. The North-Western Railway promote a Bill to stop up and appropriate a portion of the public way between Broad-street and Liverpool-street stations, and the Regent's Canal Company seek a further extension of time for their City and Docks Railway. Colonel Haywood stated that some of the projects would interfere materially with the sewerage of the districts through which it is proposed they should pass, and many important thoroughfares would be more or less interfered with. He recommends the Commission, according to their custom, to dissent from the whole of the projects, to enable them to gain further information relating to them, and to shape their course of action subsequently as the public interest may necessitate. The Commission have, by resolution, taken that course.

CHILLED CAST IRON.

At a recent meeting of the Engineering Section of the Bristol Naturalists' Society a paper on "Chilled Iron" was read by Mr. Morgans, of which we give an abstract. Among the descriptions of chilled castings in common use the author instanced the following: Sheet, corn milling, and sugar rolls; tilt hammer anvils and bits, ploughshares, "brasses" and bushes, cart-wheel boxes, serrated cones and cups for grinding mills, railway and tramway wheels and crossings, artillery shot and bolts, stone-breaker jaws, circular cutters, &c. Mr. Morgans then spoke of the high reputation of sheet mill rolls and wheel axle-boxes made in Bristol. Of the latter, in combination with wrought iron wheels and steeled axles, the local wagon works company are exporting large numbers. With respect to the strength and fatigue resistance of chilled castings, details were given of some impact tests made in July, 1864, at Pontypool, in the presence of Captain Palliser, upon some of his chilled bolts, 12¾in. long by 4in. diameter, made from Pontypool cold-blast pig iron. Those made from No. 1 pig iron—the most graphitic and costly—broke more easily than those from No. 2, and so on, until those made from No. 4 were tested, when the maximum strength was reached. No. 4 pig iron was in fracture a pale grey, bordering on mottled. Several points regarding foundry operations in the production of chilled castings were raised for discussion. They embraced the depth of chill to be imparted to chilled rolls and railway wheels, and, in the case of traction wheels, the width of chill in the tread; preparation of the chills—by coating with various carbonaceous matters, lime, beer grounds, or, occasionally, some mysterious compost—and moulds, selection and mixture of pig irons, methods and plant for melting, suitable heat for pouring, prevention of honeycombing, ferrostatic pressure of head, &c. Melting for rolls being mostly conducted in reverberatories, the variations in the condition of the furnace atmosphere, altering from reducing to oxidising, and *vice versâ*, in cases of bad stoking and different fuels, were referred to as occasionally affecting results. Siemen's method of melting by radiant heat was mentioned for discussion. For promoting the success of a chilled roll in its work, lathing or turning it to perfect circularity in the necks first, and then turning the body while the necks bear in steady brasses, are matters of the utmost importance. The author next referred to the great excellence for chilling purposes possessed by some American pig irons, and to the fact that iron of a given carbon content derived from some ores and fluxes differed much in chilling properties from iron holding a similar proportion of carbon—free and combined—derived from other ores and materials. Those irons are best which develope the hardest possible chill most uniformly to the desired depth without producing a too abrupt line of division between the hard white skin and the softer grey body. A medium shading off both ways is wanted here as in all things. The impossibility of securing a uniform quality and chemical composition in any number grade of any brand of pig iron over a lengthened period was adverted to. Consequent from this a too resolute faith in any particular make of pig iron is likely to be at times ill-requited. Occasional physical tests, accompanied with chemical analysis of irons used for chilling, were advocated; and the author was of opinion it would be well whenever a chilled casting had enjoyed a good reputation for standing up to its work, that when it was retired from work some portions of it should be chemically analysed so as to obtain clues to compositions of excellence. Some of the physical characteristics of chilled iron as well as the surprising locomotive properties of carbon present in heated iron, were noticed. Attention was called to some German data, published by Dr. Percy in 1864, concerning an iron which before melting weighed—approximately—448¼lb. per cubic foot, and contained—approximately—4 per cent. of carbon—3¼ being graphitic and ¾ combined. The chilled portion of a casting from this had a specific gravity equivalent to 471 lb. per cubic foot, and contained 5 per cent. of carbon, all combined. The soft portion of the same casting weighed 447¾lb, per cubic foot, and contained 34·5 per cent. of carbon—31·5 being graphitic and 3·5 combined. Mr. Morgans doubted whether so great an increase in density often arises from chilling. Tool steel, when hardened by being chilled in cold water, does not become condensed but slightly expanded from its bulk when annealed and soft. Here an increase of hardness is accompanied by a decrease of density. The gradual development of a network of cracks over the face of a chilled anvil or bit while being used in tilt hammers was mentioned. Such minute cleavages became more marked as the chill is worn down by work and from grinding. Traces of the same occurrence are observable over the surface of much-worn chilled rolls used in sheet mills. In such cases the sheets get a faint diaper pattern impressed upon them. The opening of crack spaces points to lateral shrinkage of the portions of chilled material they surround, and to some release from a state of involuntary tension. If this action is accompanied by some actual densification of the fissured chill, then we have a result that possibly conflicts with the example of condensation from chilling cited by Dr. Percy.

CONTRACTS OPEN.—PERMANENT WAY FOR INDIAN STATE RAILWAYS.



CONTRACTS OPEN.

INDIAN STATE RAILWAYS. — NORTH-WESTERN RAILWAY, 5FT. 6IN. GAUGE.

THE work required under this specification consists of the construction, supply, and delivery, at one or more of the ports named in the conditions and tender, of 17,537 tons of cast iron plate sleepers and jaws, to drawing; 2210 tons of wrought iron tie-bars, to drawing; 207 tons of steel wedges, to drawing; for cast iron plate—Leslie's—sleepers for 75 lb. double-headed rails. The drawings referred to are reproduced in our engravings. Conditions of contract are as usual for Indian State Railway specifications. Tenders in by 1st March, 1887.

INSTITUTION OF CIVIL ENGINEERS.

SEWAGE SLUDGE AND ITS DISPOSAL.

AT the ordinary meeting on Tuesday, the 25th of January, Mr. Edward Woods, President, in the chair, the first paper read was on "Sewage Sludge and its Disposal," by Mr. William Joseph Dibdin, F.C.S., F.I.C., Metropolitan Board of Works.

The author stated that as the subject of this paper was "sewage sludge," it was not proposed to consider other than water-carried sewage. Sewage varied according to the water supply per head of population; quantity of subsoil water; distance it had to be carried before arriving at the works; number of times it passed through pumps, &c. This latter consideration was important, as the greater the agitation the greater the division of the solid matters, and the consequent solvent action of the water. It would be most desirable if measures could be adopted for the deodorisation of fœcal matters before their discharge into the sewers. If this could be brought about a complete revolution would be effected in the character of all effluent waters after chemical precipitation. The main characteristic of water-carried sewage was its division into two portions, the liquid and the solid. The quantity of the latter depended upon the treatment the sewage received in the sewers. Great agitation meant fewer solids, and those in a finely-divided state. It was no doubt due to this fact that so many persons were misled in their ideas of what sewage must necessarily be. The average quantity of suspended matter in a dry state in London sewage was about 27 grains per gallon; but in many towns it was more than double or treble that quantity. Of the 27 grains about 54 per cent., or 15 grains, were of an organic nature. The liquid portion of the sewage contained, in solution, about 60 grains of solid matters, 33 per cent. of which, or 20 grains, were of an organic character. Solubility of a portion of the suspended matters in solutions of lime seemed to have been entirely overlooked by writers on the subject. The use of an excessive quantity of lime, while affording a rapid settlement of the sludge, and a more or less clear effluent, dissolved a by no means inconsiderable quantity of the offensive matters previously in suspension. To test this, carefully washed sewage sludge was diffused in clean water, the mixture was agitated for five minutes, and a sample withdrawn; an excess of lime was then added, and the mixture again agitated for another five minutes. The limed liquid, instead of containing less dissolved oxidisable organic matter, was found to absorb about three times the quantity of oxygen required by the unlimed liquid. The well-known objectionable character of the liquid pressed from sludge, which had been treated in the usual way with lime, was a striking instance of its action on the solid matters. With respect to dissolved impurities and their partial removal, the author had conducted special experiments for the elucidation of this important point, and had tabulated the results of the examination of varying samples of sewage and of other solutions. The author's experiments showed that strong solutions of organic matter were more readily amenable to treatment than dilute ones. The results of an exhaustive examination fully confirmed the fact that no practical process of chemical precipitation was capable of removing more than a limited quantity of the oxidisable organic matters in solution in London sewage. They further demonstrated the superiority of iron over alumina for sewage purification. By the use of iron sulphate in conjunction with lime as much work was effected, on the basis of the London sewage, for £31,000 per annum as would be obtained by an expenditure of £82,000 for alumina and lime. Alumina was valuable chiefly for its effect in removing some of the colour from the effluent, and thus appealing to the eyesight, while the matters actually dissolved were there nevertheless. Experiments with animal charcoal showed that when this substance was used to the extent of £182,500 worth per annum, the benefit would be practically *nil*. In order to test the differences of opinion expressed by various authorities as to the reduction of dissolved solids by different processes, and to show that no benefit was derived from the use of an excessive quantity of chemicals, the results of a series of experiments on solutions of clear mutton extract were given. These results showed that the same quantity of chemicals was capable of removing from 46 to 90 per cent. of the total oxidisable matter, according to the strength of the solution, and that a large increase in the quantity of the chemicals was of no advantage. These considerations pointed to the general conclusion, that where it was intended to treat sewage by chemical means the following rules should, as far as practicable, be observed, viz.: That the sewage should be diluted as little as possible; that the flow of sewage should be adjusted, so that the agitation of the particles in suspension should be of a minimum character; and that, unless absolutely necessary, no pumping should take place before precipitation. The peculiar conditions affecting the metropolis were exceptional. The want of fall, combined with the necessity for removing the excreta from densely-populous districts with the greatest rapidity, combined to insist upon a modification of these rules. The various methods proposed from time to time for separating the sludge from the liquid sewage were next discussed. The sum and substance of nearly all of them was comprised in the use of lime, either alone or in conjunction with the sulphates of iron and alumina, or of one or both of those salts, alone or in combination with charcoal. The author objected to an antiseptic treatment of sewage, and discussed the question from the bacteriological point. The method generally adopted for applying lime to sewage was to use it in the form of "milk of lime," in which condition only a small portion was dissolved, and the remainder was in a solid form, in which state it was chemically inactive. If the whole of the chemically effective strength of the lime was to be utilised, it must be in solution and not in suspension. If this precaution was observed, a few grains of lime would effect as much work as three or four times the quantity when used in the usual form of "milk of lime." When it was considered advisable to increase the effect of the lime, either sulphate of alumina, or sulphate of iron, or both of these substances, in various proportions, were best adapted for the purpose. Alumina salt afforded a less coloured effluent than iron, while the latter was apt to lead to deceptive appearances when used in excessive quantities, In choosing between the salts of alumina and iron, it was desirable to bear in mind the different chemical changes which took place with the hydrated oxides of these metals when precipitated by lime. Oxide of alumina was precipitated only in the fully oxidised form. On the contrary, oxide of iron was precipitated as ferrous oxide, or the lower state of oxidation, and ferric oxide or the higher state, according to the condition in which the sulphate existed. The peculiar property of hydrated ferrous oxide was that it rapidly changed its condition from a lower to a higher stage of oxidation in the presence of air. The salt known as protosulphate of iron, or more generally as "green vitriol," afforded ferrous hydrate. This was rapidly converted into ferric hydrate by combination with the oxygen dissolved in the water. In this condition it had the remarkable power of parting with the oxygen thus taken up, and of giving it to the sewage matters. Having thus been reduced to the ferrous state, it was again ready to combine with fresh atmospheric oxygen, which it again yielded up to the sewage, and, acting as a carrier of the oxygen dissolved in the sewage liquid, became an agent for oxidising the more readily attacked foul matters within the limits of the quantity used. The alternative to precipitation was filtration. This system had been advocated in many different ways; but unfortunately the outcome of them all was the same. Rapid choking of the filters, frequent cleansing, heavy manual labour, unmanageable quantity of sludge mixed with filtering material, &c. As regarded the question of sludge, it was generally admitted that filtration was out of the question. As effecting the further purification of the clarified sewage, filtration was without doubt a rational process in all respects save expense. If further purification was desirable, and suitable land could be obtained, the use of the effluent after filtration for farming was to be commended. In searching for a material which would remove the odour peculiar to all effluents, by destroying those products of putrefaction which were its source, sanitarians were limited practically to chloride of lime and permanganic acid. The former was open to the objection that, after its first effects had ceased, an unpleasant after-odour was created. It also caused a serious difficulty by reason of its poisonous character both to animal and vegetable life. On the other hand, permanganic acid was harmless; it had no odour of its own to set up in place of the one destroyed; it was an instantaneous and complete deodoriser; and in doing its work was itself destroyed. Its method of action was the reverse of that of antiseptics, for it destroyed the putrescent matters presented to it. The objection that the quantity of permanganate that could be added within financial limits was only a trifling quantity of that required to oxidise the whole of the matters in the effluent was true, but it only dealt with the first stage of an oxidation scheme. The matters in an actual putrescent state were the only ones which required immediate destruction, and these were but insignificant compared with the total organic matter present. Consequently, the quantity of permanganate required was only a fraction of what would be necessary for its complete destruction. Aeration had recently been put forward under the title of "oxidation." This was a misnomer. True, the ultimate object was oxidation; but if the idea was to be retained, that a very partial aeration of a strong alkaline effluent was equivalent to complete aeration of a neutral effluent, free from actual putrescent matters, a powerful blow would be struck at the system, which, when properly carried out, was incontestably one of the utmost importance. Of the various systems of aerating large bodies of water when artificial means were necessary, there could be little doubt as to the superiority of the aquarium or "jet" system. By this means air was introduced into the water in an exceedingly fine state of division, instead of being in large bubbles, as in the blowing system. The numerous patents taken out for the utilisation of sewage sludge showed that the subject was one of peculiar fascination. The idea pervading the minds of inventors seemed to be that local authorities should undertake trading operations, instead of strictly confining their functions to the prevention of nuisance. Such systems might be dismissed with the observation that, if an inventor had a process by means of which he could more than repay the cost of working expenses, doubtless he would pursue the usual course adopted by business men, and, after obtaining the sludge for nothing and paying working expenses, put a handsome sum in his pocket. If the quantity of sludge were small, and suitable land available, it should be dug in; but when land was unattainable, or, even if attainable, unsuitable, other means must be adopted. The recent successful introduction of sewage sludge presses, for converting the sludge into a semi-dry portable form, at first sight appeared to be eminently suited for the purpose. Doubtless they were so under many conditions. If farmers wanted the sludge for manurial purposes, the presses were all but necessary. For small quantities they were manageable, and, as far as the subject would permit, cleanly. Strenuous efforts had been made to reduce the cost, but apparently without success. Unfortunately, the hopes of sanitarians and agriculturists on this point seemed to be doomed to disappointment, and in place of the farm, in many cases the furnace appeared to be the ultimate destination of the unwholesome matter. Beyond doubt the wants of farmers should be most carefully considered. So long as they removed the sludge, so long should sufficient be pressed to meet their demands. When the quantity of sludge was small, a ready and economical method of reducing it to a portable condi-

tion was to mix it with freshly-slaked lime, as for pressing, and then to run it out on to porous beds, and allow it to rest. In a few days the sludge would have attained a consistency sufficient to enable it to be cut out with a spade and removed. By this means the water was reduced to some 70 per cent. Another good plan was that adopted at Southampton, which consisted in mixing the semi-liquid sludge with dry road sweepings, &c., in which form it was portable, and in a suitable condition for the purposes of the farmer. This system necessitated the control of the dust-bin refuse and road sweepings by the sewage authority. The recent Royal Commission recommended the application of sludge to the raising of low-lying lands, burning, digging into land, or carrying it away to sea. If the land were to be raised with it, pressing must be resorted to. This involved the inital task and cost of the presses, which, coupled with the cost of transit, spreading on the land and covering with earth, made up a total so excessive as to render the consideration of other methods desirable. Before the pressed sludge could be burnt, the water must be driven off by heat. This involved expense for fuel in addition to the cost of pressing. When the dust-bin refuse of a town was available, the object could be attained by the use of "destructors." The case of the metropolitan sewage was, however, different, as no excess fuel was obtainable without considerable expense. The suggestion that the ammonia, afforded by the combustion of the nitrogenous portion of the organic matters could be collected and sold for the reduction of a part of the expense had been made. Calculated on 800 tons of "cake" per day, about £70,000 per annum might be expected as the gross return from the sale of the sulphate of ammonia. The cost of pressing, distillation, collection of ammonia, conversion into sulphate, business charges, interest on capital, &c., deducted from this sum would be such as to lead inevitably to a financial disaster. Digging the wet sludge into the ground, as practised at Birmingham, would be a good plan in the case of the metropolis, if suitable land were available in sufficient quantity. The soil at Birmingham was mostly gravel, and suited for the purpose, whereas that in the neighbourhood of the metropolitan outfalls was heavy and sodden. Carrying the sludge away to sea thus remained the only tangible and economical system available. The cost of transit had of course to be considered. Careful estimates showed that the expense would fall far short of that which would be necessary for the preliminary process of pressing, independent of the further cost of disposing of the cake when obtained. The great advantage of this method was that the sludge would never be seen. Precipitated in covered reservoirs, transferred from the precipitating tanks to special settling tanks, from thence pumped into a vessel, and discharged under water far from land, the sludge would disappear in the most speedy, cleanly, and safe manner that could be devised. The objections to this system were: waste of valuable manure; possibility of nuisance on the coast; and, delay in transit by fogs and stress of weather. If the commercial manurial value of the sludge was a fact, commercial men might be safely relied upon to utilise it. The objection as to the possibility of nuisance on the coast was a mistaken one. Some 3000 tons of "settled" sludge, equal to about 150 tons of organic matter, would be discharged daily under water several miles from the coast. The author critically examined the action which would follow, contended that no nuisance could be created, and held that the system was in accordance with both the letter and the spirit of the recommendations of the Royal Commission. The objection as to delay by fogs and stress of weather was trivial. If the whole of the enormous maritime traffic of England could be carried on with almost mathematical precision, the carriage of a few thousand tons of sewage sludge to the channel could be as readily accomplished. While it was thus clear that in the case of the metropolis the conveyance of the sludge to sea was the only available remedy, it by no means followed that under other circumstances, and where local conditions were favourable, other systems were undesirable. Each case must be dealt with on its own merits, and according to local requirements.

FILTER PRESSES FOR THE TREATMENT OF SEWAGE SLUDGE.

The second paper read was on "Filter Presses for the Treatment of Sewage Sludge," by Mr. William Santo Crimp, Assoc. M. Inst. C.E., F.G.S. The author observed that in breweries, sugar factories, sewage precipitation and other works, large quantities of semi-fluids, or of fluids containing various quantities of solid matter held in suspension, were produced, and it was often necessary to separate the solids from the liquids; this object might generally be attained by filtration, either natural or mechanical, or by evaporation. In the case of sewage works, where chemicals were the agent for precipitating the solids, difficulties had arisen from the large masses of sludge to be disposed of being in a sloppy and very offensive condition. Engineers had therefore endeavoured to effect a reduction in the quantity, by getting rid of as large a portion of the liquid as possible. The earliest method tried was that of exposing the sludge to the atmosphere in specially-constructed filters. At Wimbledon, filters had been constructed of screened town-ashes carefully under-drained, and to further aid in the desiccation of the glutinous mass more ashes were mixed with the sludge. During the winter, however, evaporation was feeble. The author found that after exposure, between September, 1883, and March, 1884, the sludge still contained 77·5 per cent. of moisture, and was very offensive. In hot dry weather, although the sludge dried more quickly, there was much more risk of creating a nuisance, unless the material was ploughed into the ground, as at Birmingham, in its fresh condition, a method which was inapplicable in many cases. In towns of only moderate size, large areas were required for the exposure of the material, and this gave rise to a nuisance after a few days' exposure, unless the works were remote from dwellings and highways. Machines had at various times been introduced for drying sewage by the application of heat; but as sewage-sludge contained in its normal condition 90 per cent. of moisture, the cost of fuel had prohibited the use of such apparatus. Millburn's drying machine, for instance, was stated to have been tried at Oldham by the Carbon Fertiliser Company, when 1 lb. of coke evaporated 6·80 lb. of water. Thus, in order to reduce 100 tons of normal sludge to 20 tons with 50 per cent. of water, about 12 tons of fuel would be required.

The paper dealt more particularly with the filter-press as now adapted to this purpose. Filter-presses had been employed at Wimbledon during the last two years. The present weekly production of sewage sludge at Wimbledon was 250 tons, and this quantity was reduced by means of two of Johnson's filter presses to 50 tons of sludge cake, containing 50 per cent. of moisture, at a cost of 2s. 6d. per ton, for labour, lime, fuel, cloths, &c., to which should be added interest on the original outlay, and depreciation, equal to 1s. per ton more. The precipitation of the matters held in suspension in the sewage was effected by lime and sulphate of alumina, the average quantity used daily being, for both pressing and precipitating, equal to 0·91 ton. It had been ascertained that the quantity of solids which would be produced, if the moisture were all evaporated, would be equal to 1 ton weekly for 1000 persons. In the case of the metropolis, assuming the population draining to the outfalls to be 3,800,000, the amount of pressed cake produced daily, calculated upon this basis, would be 1086 tons, or 186 tons in excess of the estimate of the Royal Commissioners on Metropolitan Sewage Discharge. The actual quantity would doubtless be less in consequence of the small quantity of lime used; but, on the other hand, the road detritus must form a considerable portion of the solids in wet weather. Taking the amount at 1000 tons daily, the annual cost of pressing would, in the opinion of the author, amount to £45,000, exclusive of the charge on capital account. In consequence of the proximity of Wimbledon to the metropolis, where enormous quantities of stable manure were produced, some difficulty was experienced in selling the sludge, although the experiments of the author, which had been confirmed by Professor Munro, of the Royal College of Agriculture, Downton, proved that the pressed sludge was of more value than stable manure of good quality.

In the author's experiments sludge-cake was tried with superphosphate and with farmyard manure, the crops grown being hay, potatoes, mangolds, cabbages, and swedes, the average production per acre being in the case of sludge-cake 13·15 tons, superphosphate 12·60 tons, and farmyard manure 12·27 tons, while the unmanured plot yielded 11·72 tons. Potatoes were especially benefitted by the dressing of sewage-sludge.

The conclusions arrived at by the author after careful observation of the filter-press during the past two years were, that the machine afforded a ready solution to the question of the disposal of the sloppy mass of putrescent mud produced daily in sewage precipitation works; that the offensive and useless masses might be quickly converted into a practically inodorous manure; and that the manure was superior to ordinary farmyard manure.

LAUNCHES AND TRIAL TRIPS.

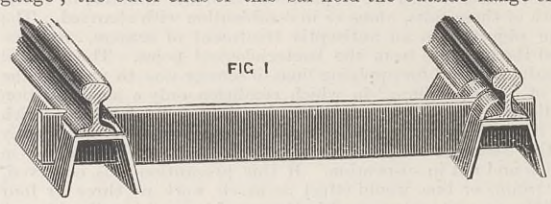
Last week Messrs. W. B. Thompson launched from the Caledon Shipyard, Dundee, a steel screw steamer of about 200 tons, built for the Great Northern Steam Fishing and Carrying Company, of Hull, and named the Jubilee. She has been built to class in Lloyd's register, and her dimensions are as follows:—Length, 134ft. 6in.; breadth, 21ft.; depth, 11ft. The machinery, which has been constructed at the Tay Foundry, comprises compound surface condensing engines of 60 nominal horse-power, with cylinders 20in. and 40in. respectively, having a piston stroke of 27in., steam being supplied from a steel boiler working at a pressure of 95 lb. per square inch. The vessel has a raised quarter-deck extending to the fore part of the engine and boiler space, and a sunk forecastle forward admits of very comfortable accommodation for the crew. The bottom of the main hold is arranged for carrying water ballast, so that the Jubilee can be readily trimmed to any desired draught, no matter what the nature or extent of her cargo. The fore part of the hold is divided off to form an ice-room, capable of carrying 35 tons of ice. On deck, abaft the foremast, is placed a very large steam winch, specially designed for hauling in the warps of the fishing gear with which the vessel will be fitted. On the forecastle deck is placed a handy windlass of the latest design, which can be worked off the steam winch—by messenger chain—or by hand. The Jubilee is rigged as a fore-and-aft schooner, with two masts. On the bridge is placed Archer's patent steering gear, and supplementary steering gear has been provided aft in case of anything going wrong with the bridge gear. The engine room above the quarter deck is enclosed in a strong iron house 6ft. high, surmounted by a large teak skylight. The after part of this house forms the cabin companion way, and has a door on either side giving access to the cabin, which is arranged to accommodate captain, officers, and engineers, for which two separate rooms have been provided, entering off the main cabin. Cushioned lockers extend round the after-part of the cabin, which is lighted by a large teak skylight.

Messrs. Forrestt and Son recently completed in thirteen working days, for the use of Mr. H. M. Stanley's African party, a steel whale boat, 28ft. long, of 6ft. beam, and 2ft. 6in. deep. It is built of Siemens' steel galvanised, and divided into 12 sections, each weighing about 75 lb. The fore and aft sections are watertight, giving a large amount of buoyancy to the boat. The sections are bolted together, india-rubber being used between the joints to make them watertight. The boat pulls ten oars, and is fitted with a large lug sail. She will carry twenty-two men and 1000 lb. of baggage on 17in. draught of water. Fittings are made moveable. Each of the sections may be carried easily by two men. The little vessel can be put together in 35 min. and taken to pieces for transport in 22 min.

AMERICAN ENGINEERING NEWS.

New war ships for the United States Navy.—As a result of the consideration of various bills for the construction of new naval vessels, the sub-committee on naval affairs has prepared a Bill providing for the construction of two steel cruisers, of 4000 tons, similar to the Newark, now being constructed, at a maximum cost of 1,300,000 dols. each, to be equipped with the best type of engines and boilers; also four steel gunboats of 1700 tons, similar to No. 1 now being constructed, at a maximum cost of 525,000 dols. each; also one cruising steel torpedo boat of about 150ft. length, at a maximum cost of 100,000 dols., to have a maximum speed of not less than 24 knots per hour, and capable of steaming 20 knots an hour for six hours, with armament and coal for sea service. The Secretary of the Navy advocates the adoption of triple expansion engines for the new vessels now being built or in contemplation for the navy. The matter of coal economy is most important for war ships, and for this reason especially the use of this type of engine is advisable; and this economy would soon overbalance the extra first cost. Gunboat No. 1, being built by Messrs. Cramp and Son, of Philadelphia, will have triple expansion engines designed by the builders, in place of the compound engines originally contemplated. Cruiser No. 1, the bids for which were all rejected as too high, will also probably have triple expansion engines; the plans for which are now being prepared, instead of the compound engines included in the original design.

Railroad sleeper.—One of the latest metal ties is that patented by E. L. Taylor. It is of the "pot sleeper" type, consisting of chairs with a cross section like the lower part of an A (⌐); they are made of ⅜in. plate iron, and have a lug stamped out of the bearing surface to clasp the inside flange of the rail. A tie bar of flat iron connects each pair of chairs and maintains the gauge; the outer ends of this bar hold the outside flange of the



rails; where greater bearing surface is required this bar may be an inverted tee iron (⊥). The advantages claimed are automatic clamping, elimination of all bolts and spikes, interchangeability of parts, cheapness, durability, economy of maintenance and adaptability. The sleepers may be made as continuous longitudinals.

Bradshaw's A B C Guide to the United States is being severely and deservedly criticised; it is simply absurd. It gives but one route to Chicago, and that only from Buffalo, whereas there are about half-a-dozen trunk lines from New York alone. Minneapolis, Minn., is described as reached by one railroad only, from St. Paul. Duluth is mentioned as reached by only one line, from a small town, whereas it is one of the great railroad centres of the North-west. In almost a majority of cases where but one route is mentioned out of a large number, the least important and least known is selected.

Regular use of the indicator.—Mr. R. Harris, superintendent of the New York Locomotive Works, Rome, N.Y., states that there is more to be gained by judicious and regular use of the indicator than many engineers believe. On nearly all steamships an indicator is provided, and the chief engineer is generally required to take diagrams on every voyage and include the results in his report. By this means he is enabled to detect defects due to wear or other causes and to correct them by proper readjustment. The use of the indicator is of special value and importance on locomotives, yet very few railroads have it used regularly, and many master mechanics do not recognise its full value. Mr. Harris thinks that in many bad steamers the fault is with the adjustment rather than the boiler. On some tests of a compressed air locomotive the storage pressure fell from 600 lb. to 150 lb. per square inch; after the indicator had been applied and defects corrected in the adjustment of the valve gear, the pressure, with a heavier train, only fell from 600 lb. to 195 lb.

Drainage.—A very large amount of work is being done in this country as to draining farms and other land by tile drainage. In Illinois, Indiana, and Ohio this work is receiving special attention, and it is also being introduced into other States. There are expert engineers who make a speciality of drainage by ditch and tile, and there is considerable interest felt in the subject. It is recommended that the tile, or the top of a stone drain, should be at least 40in. below the surface of the ground, or, where the outfall is bad, as deep as they can be made to deliver water. The drains are placed between the rows of corn, &c., and thus drain the roots and secure a good crop. Wet heavy ground, and heavy clay very wet in spring and very dry and hard in summer, has been made, by drainage, to yield good crops and pay many times over for the cost of the work. This method of improving land is of special importance to farmers, to render bad land available and to improve good land, but it is also of importance to towns and cities in flat districts where damp and malarial land may be made healthy and fit to live near and build on. Tile manufacturers are doing a good trade and find a constant and increasing demand for their ware; they have shown themselves wise in not organising a monopoly and fixing exorbitant rates while there is such demand. The ditchers are very expert in ditching to the grade set, but for economy of time steam or horse-power machine ditchers are used, many of which are ditchers and tile layers combined.

The Vermont railroad accident.—Yet another terrible disaster, illustrating in a most awful manner the danger of the coal stove system of car heating, occurred on the night of February 4th, near Woodstock, Vt., on the Central Vermont Railroad. The Montreal express, made up at White River Junction from trains from Boston and New York, was running at a speed of only seven or eight miles an hour while approaching the wooden deck bridge, of four spans of 140ft., and a short road span, over the Woodstock river, at a height of 42ft. above the gorge, when a bad rail—the break showing flaws in the rolling—broke, throwing the rear part of the train off the track, and the sleepers and several other cars fell down on to the ice, the engine and forward cars reaching the abutment in safety. In a very short time the overturned and broken stoves set fire to the wreck, and before help could be obtained, the whole wreck was a perfect holocaust, the flames swept up to the bridge, and that, too, was totally burnt. Between fifty or sixty persons were killed or roasted to death, the temporary morgue is littered with scattered limbs and mutilated and charred bodies, while charred fragments of humanity are mingled with the twisted mass of ironwork that remains of the splendid cars. Investigations are being held, and the car-heating question is again opened by this new horror. The New York State Legislature has directed the State Railroad Commissioners to inquire into the various methods of safely heating cars, and to make a report as soon as possible. As the Vermont State laws allow 5000 dols. for death, and amounts at the discretion of juries for injuries, the claims upon the railroad company will be very heavy. Later investigations disclose some peculiarities in the fracture of one of the axles, that lead to the belief that the axle may have broken first—it is broken at the middle—and the wheels of the derailed car-truck then shattered the rail. The closest investigation will be made.

Elevated railroad.—The Chicago Rapid Transit and Elevated Railroad Company, of Chicago, Ill., will commence the construction of its elevated road this season. There will be twenty-two miles of road, with stations at intervals of half a mile. The trucks will be over the cable railroad, 18ft. above the surface of the street; they will be carried by columns placed on the curb line and set 70ft. apart. The entire structure will be of steel. The company was organised in 1885, and has a capital stock of 12,000,000 dols.

Electric motors.—The Sprague electric motor is meeting with much favour, and standard types are built to facilitate manufacture.

Underground railroad.—At Philadelphia, Pa., an underground railroad, to be operated by electricity, is projected. The speed will be twenty miles per hour between stations; the stations will be placed every third of a mile in the suburbs, and every quarter of a mile in the city. The cars will seat thirty-eight persons each, and will have side doors. In New York City a legal decision has been given which practically frees the Arcade Railroad Company from further interference, and it is reported that work will be commenced on the tunnel before very long. There are four corporations holding franchises for underground railroads in this city, all of which are controlled by the United States Subway Company. This company declares its intention of commencing work as soon as a permit is granted by the Public Works Department. The charter to be operated under only allows for a double track road; other charters were for four tracks, two for express and two for way trams. There will be two tunnels occupying a space of 15ft. high, by 35ft. wide. Though well supplied with street railroads (tramways) and elevated railroads, the city can supply abundant traffic to an underground line.

New express locomotive.—The New York, Providence, and Boston Railroad has just had a new and improved express engine built, by the Rhode Island Locomotive Works, of Providence R.I., for hauling the fast express on the section where the quickest time is made. The schedule time at present for this section is 62·5 miles in seventy-seven minutes; the new engine is to make this in 62·5 minutes, including one stop. The train will consist of eight cars, four of which will be Pullman cars. The engine is an anthracite burner, of the standard American "eight-wheel" type, with four coupled wheels 6ft. in diameter, and a four-wheeled leading truck. Its main dimensions are as follows. Cylinders, 18in. by 24in.; drivers, 6ft.; driving-wheel base, 7ft.; total wheel base, 21ft.; weight on drivers, 72,000 lb.; on truck, 24,000 lb.; total weight, 96,000 lb.; 218 tubes, 2in. diameter and 10ft. 5in. long; heating surface (tubes), 1186·6 square feet; fire-box, 165·5 square feet; total, 1352·1.; grate area, 37·6 square feet; boiler pressure 180 lb.; boiler of ½in. Otis steel.

A lake steamer.—A large steel steamer was launched recently at Cleveland, Ohio, for service on the lakes, she is 300ft. long, 39ft. beam, 24ft. depth of hold. The plating is $\frac{11}{16}$in. thick, and the lightest material is ½in. iron. She is provided with numerous bulkheads; the engines are of the triple expansion type; high-pressure cylinder, 24in.; intermediate, 38in.; low-pressure, 61in.; stroke, 42in.; the crank angles are set at 120 deg. Steam reversing gear is provided. There are two boilers of 1⅛in. Otis steel, they are 12ft. in diameter by 14ft. long; each boiler has three furnaces of 40in. diameter. The ship was built by the Globe Ironworks, Cleveland, Ohio, the steel being from the Otis Iron and Steel Company, and the iron from the Cleveland Rolling Mill Company. The value is estimated at about 200,000 dols.

Water supply of New York City.—It has been finally decided to construct the immense Quaker Bridge Dam for the new supply. The dam will form an impounding reservoir, or lake, of the Croton watershed, and will be in connection with the great New Croton Aqueduct, now in course of construction, which is to give the city an abundant additional water supply. The total cost of the dam, including land, &c., is about 6,750,000 dols.

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

(*From our own Correspondent.*)

BUSINESS in manufactured iron since last report has exhibited features of a good deal of irregularity. This arises out of the difficulty of determining how far the common ironmakers intend to adhere to the resolution of a week ago in Birmingham to advance prices 10s. per ton. There is much uncertainty as to what that advance really leaves prices at. Some firms had anticipated the decision and have been quoting a nominal advance of from 5s. to 10s. per ton on bars, hoops, and strips, since the January quarterly meeting, and such firms do not this week profess to make any further advance.

Up to last week, unmarked bars might have been bought at any price, according to the quality of the metal, between £6 and £5, and, occasionally, even below this. The decision of the Birmingham meeting must be mainly regarded as an organised attempt to raise the price of common iron generally into somewhat nearer relations with the standard for marked iron. The old-fashioned difference between marked iron and common bars was only about £1 per ton, but the difference has now become as large as £2 and even £2 5s.

The comparative quietude in the demand is the main difficulty which makers have to surmount before the 10s. advance can be obtained. With a brisk market and a strong demand success would be assured; but at present merchants' and consumers' orders are not abundant, and buyers state this week that they are paying the advance in only a few cases.

South Staffordshire cannot afford to reckon without the neighbouring, and to some extent competing, districts of North Staffordshire and Lancashire, and their concurrence in the Birmingham arrangement has not been obtained.

The large number of the firms engaged in the South Staffordshire trade is a great obstacle in the way of unanimity of action. Nominally, common bars are advanced to £5 5s. to £5 10s.; hoops, £5 10s. to £5 12s. 6d., and on to £5 15s.; hinge strip, £6 5s.; and gas and nail strip, £5 5s. to £5 7s. 6d., and on to £5 10s.

Sheets are less affected by the Birmingham resolution than is any other section of the trade. The sheet makers had been able to fully anticipate the declared advance by reason of the excellent inquiry from the galvanisers and other buyers; their prices, therefore, remain firm at the former figures of £6 to £6 5s. for 20 gauge; £6 10s. to £6 12s. 6d. for 24 gauge; and £7 10s. to £7 12s. 6d. for 27 gauge.

Galvanisers this week report that orders continue to arrive with a fair amount of freedom, and that they are realising more profitable rates. Events of the past few days which have tended to lessen the local supply are assisting to strengthen prices. South Staffordshire firms quote £10 5s. to £10 10s. per ton for 24 gauge corrugated sheets in bundles f.o.b. Mersey, but some Birkenhead firms are understood to be selling at £10 2s. 6d. and even £10.

Marked bar makers are in receipt of rather more orders, but there is abundant room for further improvement, the competition of steel being severe. £7, with £7 12s. 6d. as the Earl of Dudley's price, remains the standard.

Buying in the pig iron trade is rather quieter, but quotations are maintained at very near the recent maximum. The slackening down of demand is due to consumers having already bought, some firms having covered their requirements for nine and twelve months forward. Furnace owners, on their part, have plenty of contracts on the books, and will not depart from late rates. Northampton pigs are 40s. to 41s. delivered; Derbyshires are 41s. 6d. to 42s. 6d.; and Lincolnshires 42s. 6d. to 45s. The Thorncliffe brand is quoted 50s. There is only a small sale for best native pigs, the competition of steel and of hematites having largely monopolised the market. Hot blast all-mines are quoted 52s. 6d. to 55s., and part-mine and cinder pigs range from 42s. 6d. down to 30s.

Some good inquiries are again on the market for work in connection with the Indian State Railways. They include steel transverse sleepers, cast iron sleepers, and fish plates and fish bolts for both flat-flooted and double-headed rails.

A new scheme has been laid before the Cradley Heath chainmakers for their relief. Lieutenant Mansfield Smith and Colonel Stewart have this week attended some meetings, and urged the importance of procuring State-aided emigration. There were too many workmen in the trade, and the only remedy was to emigrate to Canada. With a view of forwarding such a scheme, it was decided to petition the House of Commons.

Mr. William Woodhall, M.P., in his presidential address at the annual meeting of the North Staffordshire Mining Institute, on Monday, alluded to the advantages which England possessed in regard to mining and mechanical engineering, and pointed out the new conditions of trade generally. He observed that the powers of production had enormously increased, and necessitated caution to prevent the evils arising from leaps and bounds experienced fifteen years ago.

The scheme which has been proposed by the South Staffordshire and Birmingham District Steam Tramways Company for undertaking the collection, conveyance, and distribution of goods, will be facilitated by the invention of a wagon to run on rail or road, which has been specially devised by Mr. A. Dickinson, the general manager of the company. The body of the wagon is similar to an ordinary railway lorry, the front wheels acting on the swivel or bogey principle when on the road, but when on the rails the principle is dispensed with by means of a locking-pin. The road wheels are placed at the ends of the main axles and the rail wheels are inside. To raise the rail wheels or lower the road wheels, the main axle is so constructed as to be made to turn by an arrangement of screw and cog wheel, thus causing the arms or projections to which the rail wheels are attached to be brought perpendicularly under the main axle. The wagon has undergone a thorough test in Birmingham this week, with every success.

The London and North-Western Railway Company is about to undertake some engineering work outside Birmingham, for which £35,000 have been voted. At present the traffic on the line to Aston and Walsall is much hindered by a junction with the main line to Saltley and by a crossing level, after the bifurcation, which gives access from the Curzon-street goods station to the main line. The difficulty is to be overcome by separating the Aston from the main line at a point much nearer to New-street station, and by raising the Aston line upon an embankment and a viaduct, so that the Curzon-street traffic may pass beneath it. There will be no engineering difficulties about the work, which will necessitate the erection of a stretch of girder bridges, the raising of the existing viaduct parallel with the Vauxhall-road, and possibly the re-building of the bridge over Erskine-street.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—Business in the iron trade of this district remains in a dull, inanimate condition, and certainly no reflection can be found here of the improvement which is reported from other iron centres. There is a continued general indisposition on the part of users of iron here to operate beyond actual pressing requirements, and there is apparently so little confidence in the future that even low prices do not tempt buyers. Makers, as a rule, realising that just at present it is practically useless to attempt to force business, abstain from pressing sales, and nominally, in prices generally, a fairly steady tone is maintained. There are, of course, sellers who, whatever the condition of the market, are compelled to seek after business, and in this direction there is a source of weakness which enables buyers, who have orders to give out, to place them on more favourable terms. In some of the district brands of pig iron prices have been taken during the past week which are getting very near to the old rates; hematites are also easier, and in manufactured iron, although an advance upon the low prices which were ruling some time back is still maintained, makers have had to give way considerably upon the rates they have been asking recently.

The Manchester iron market on Tuesday was fairly well attended, but business was very slow. There was very little inquiry stirring for any description of iron, and where sales were reported they were only of very small weight. For Lancashire pig iron, iron makers still quote 39s. 6d. to 40s. 6d., less 2½, for forge and foundry qualities delivered equal to Manchester; but at these figures they are only booking occasional very small parcels. In district brands 39s. 6d. to 40s. 6d., less 2½, delivered equal to Manchester, also remain about the average prices for the principal Lincolnshire irons; but there are one or two brands offering at 1s. 6d. per ton under these figures, and during the past week Lincolnshire foundry iron has been sold at as low as 38s. 6d., less 2½, delivered into the Manchester district. Outside brands offering in this market were firm, but in Scotch iron makers have not followed the upward movement in Glasgow warrants, and were selling at prices certainly no higher than last week; except, however, occasional sales of Middlesbrough, good named foundry brands of which ranged from about 44s. 4d. to 45s. 10d. net cash, delivered equal to Manchester, there has been comparatively little or nothing doing.

In hematites there is very little buying going on; makers are indifferent about selling except at current rates, and these consumers say they cannot afford to pay, the result being that business is for the present practically at a standstill. Nominally quoted prices remain at about 58s. 6d., less 2½, for No. 3 foundry qualities, delivered into the Manchester district.

Manufactured iron is very dull, and some of the local makers report that there is no new work of any weight coming forward. Common bars are getting back to low prices, and it is only in exceptional cases that more than £5 per ton is being got for delivery into the Manchester district, only the best local brands fetching £5 2s. 6d.; hoops average about £5 7s. 6d., and sheets £6 10s. to £7 per ton, delivered into the Manchester district.

There is still an absence of any appreciable improvement in the condition of the engineering trades of this district. There are exceptions here and there, as I pointed out last week, where more activity is reported; but generally works in this district are barely kept going from hand to mouth. They manage to keep going, but they have no work ahead, and the anxiety to replace orders as they run out engenders a keenness of competition that keeps prices down not only at the unremunerative point, but in many cases work is taken which can only leave behind it an absolute loss.

The newly constituted Board of the Manchester Ship Canal Company have lost no time in making fresh efforts to push forward the scheme to a successful issue, and one or two of the leading members have expressed themselves confident that before very long the project will be placed on a satisfactory footing. During the past week I understand negotiations have been going on in London with regard to the floating of the scheme, and on the Manchester Exchange there have been various rumours as to the result of these negotiations. At present, however, there is no information of an authoritative character, and all that can be said is that a very hopeful feeling prevails.

Messrs. Walter T. Glover and Co., of Salford, have brought out a fuel economiser, in which Mr. Bell has re-introduced the zigzag arrangement of pipes which years back was abandoned by other makers as an inefficient form of construction. The difficulty which stood in the way of the successful working of the above arrangement has, however, been successfully overcome by reducing the diameter of the pipes and allowing ample space between the centres, so that whilst the heat passing away to the flue is made to impinge upon the surface of each pipe, the draught is not throttled. The inside diameter of the pipes has been reduced from 4in. to 3in., and 9in. space is allowed between the centres, which leaves about 5¼in. between the outside surfaces of the pipes, thus allowing a clear space of about an inch on each side of the intersecting pipe in the next row. The draught is thus provided with a free passage, and the heat as it passes away to the chimney has to strike against each pipe. In the scrapers for the pipes an improvement has also been introduced. These are made in three sections, slightly overlapping each other, and they have a double cutting edge at an angle of about 40 deg., thus giving to the scrapers the action of a knife. They are hung on specially designed carrying bars, with inclined slots, which, whilst giving the surface a free action, keeps them close to the surface of the pipes, and they are held in position by a drop catch, so that they can be easily fixed or removed as required. These economisers are being constructed for either rapid or slow circulation, and the first which has been made has been put up at the works of Messrs. Thomas Briggs at Pendleton. This economiser has forty pipes 9ft. in length, and works on the slow circulation principle. It is used to heat the feed-water for a boiler evaporating 900 gallons per hour, and, after a thorough test, most successful results have been obtained, the firm using it stating that it has saved somewhere over 30 per cent. of the fuel previously consumed. Another of these economisers, with seventy pipes, on the rapid circulation principle, is now being constructed for abroad. Mr. Bell has also introduced an improvement in his high and low-pressure filters for works purposes, which are manufactured by Messrs. Glover and Co. In these filters, and, in fact, in a large number of the filters that are now made, a layer of asbestos cloth on the face of the filter beds has been used as a strainer for the dirt before the water passes to the filtering material proper. After an extended trial, Mr. Bell has now decided to abandon the use of asbestos cloth, and he has replaced this with woven copper wire of a very fine mesh and a layer of openly-woven galvanised wire, which is placed immediately between the filter beds and the iron plates which hold them in position, and the perforations of which plates have also been very considerably enlarged. By this arrangement the perforations of the plates are much less liable to become blocked up with dirt, and the intervening layer of galvanised wire allows what may be termed a breathing space between the filter bed and the plate, so that when the filter has to be cleansed the accumulated filth can be blown out with much greater ease. By an ingenious arrangement of valves the water can be passed through either one or two filter beds as desired, and any number of these filters can be connected and placed side by side, and they can be worked either vertically or horizontally as desired.

In the coal trade, except that there is some falling off in the demand for house fire classes of fuel, there is generally a fairly steady business doing, and pits are mostly kept on pretty near full time. The local demand for steam and forge purposes is still only limited, but this is more than counterbalanced by a continued extra demand for shipment, which is taking away the surplus supplies of the lower qualities of round coal that would otherwise be thrown upon the market, and engine classes of fuel are also moving away without difficulty, very few collieries being at present troubled with excessive supplies of slack, except it is in some of the common qualities. Prices, if anything, show a tendency to ease down somewhat, but there is no quotable change upon late rates, and at the pit mouth best coal averages 9s.; seconds, 7s. 6d.; common round coals, 5s. 6d. to 6s.; burgy 4s. 6d. to 5s.; best slack, 3s. 6d. to 4s., and common 2s. 9d. to 3s. per ton. For shipment prices are firm at about 7s. 3d. to 7s. 6d. per ton for steam coal delivered at the high level, Liverpool, or the Garston Docks.

The decision of the South-West Lancashire coalowners not to entertain the application of the men for a ten per cent. advance of wages has been followed by a prompt abandonment of this portion of the miners' programme, but they still show some semblance of adhering to their proposed restriction of the output. The colliery proprietors, however, will not accept any dictation from the men on this point, but it is more than probable that the men will not find work so plentiful that they need be anxious about doing too much.

The 31st annual report of the Manchester Association of Engineers shows that the society continues to make good progress both in respect of membership and finances. The Society has now standing to its credit a balance of £2627 as compared with £2531 last year, showing a surplus of £96 on the year's working, after paying the sum of £100 to a member permanently incapacitated from work. To the membership roll during the year there have been added fourteen honorary annual members and fifteen ordinary members; but taking into account the loss by death, resignation, and erasure, the effective addition to the membership roll amounted to 17, bringing the total number of all classes of members to 302, viz., 27 honorary life members, 71 honorary annual members, and 204 ordinary members. The annual dinner of the Association was held on Saturday at the Grand Hotel, Manchester, Alderman W. H. Bailey, the president, occupying the chair, and Sir J. C. Lee being the principal guest of the evening. In proposing "prosperity to the Association," Sir J. C. Lee remarked that speaking to them as a merchant of long standing, and having an intimate connection with manufacturing, he thought the mechanical engineer, to many manufacturers and merchants, was to be considered as a man who destroyed assets, and who was the cause of the shrinkage of capital, and of all those things which went to make the assets of a manufacturing concern. To those who did not use the best appliances he was certainly a great bugbear, but to those who looked ahead and accepted the new inventions that were constantly being brought forward he was a source of great strength, as he enabled the manufacturing portion of the community to compete against the most absurd tariffs of other countries. The mechanical engineer, however, made sad havoc amongst those who did not move quick enough for him. The chairman, in responding to the toast, pointed to the many important improvements which had been effected in engineering, especially of late years in marine engineering, and believed that if only peace were maintained in Europe the mechanical trades of this country had a great future before them. Other toasts followed, including "The Engineering Industries," proposed by Mr. W. Thomson, and responded to by Mr. Leader Williams, "Success to the Manchester Royal Jubilee Exhibition," proposed by Mr. Thos. Ashbury, C.E., and responded to by Sir J. C. Lee, who stated that the Exhibition would be the most extraordinary one ever held in this country; and the section devoted to mechanical engineering would not be the least extraordinary part of it.

Barrow.—The tone of the hematite pig-iron trade is steady and firm, and orders have lately been well placed. Makers are exceedingly busy, and are not only sold forward to a very large extent, but are increasing their output all round, with a view of meeting the improved demand, and taking advantage of the improved state of the market, especially in the face of a further tendency in the direction of an advance. Prices are firm at 50s. per ton net f.o.b. for parcels of mixed samples of Bessemer iron, and 49s. for No. 3 forge and foundry qualities. Stocks are large, but are not increasing; they are mainly held by merchants who anticipate a rise in values. The chief feature of the demand is American, and this may be said also of steel; but several good Continental orders are offering, and it is probable that during the season very heavy parcels of iron and steel will be delivered to American, colonial, and continental markets. There are indications that a large increase in output will be brought about with the opening of the spring season. Steel makers are exceptionally well off for orders. Rails are especially brisk, and makers are well sold forward to American, Canadian, Australian, colonial, and continental buyers, while some large contracts for delivery are held on account of home railway companies. Prices this week show an advance of 2s. 6d. per ton, the price for ordinary heavy sections being now given at £4 5s. per ton net f.o.b.; blooms and billets are in brisk demand at improving prices, and bars are also in good inquiry, this department of local steel works being busily engaged. The only department which is quiet in the steel trade is that in which plates, angles, and other classes of steel for shipbuilding purposes are produced, but even in this department there are signs of new life, and in the course of a short time it is believed there will be a better trade. Shipbuilders and engineers are short of orders, and although there are undoubtedly some good orders offering they are slow in coming forward. It is confidently expected, however, both in shipbuilding and marine engineering there will be an active trade in the spring, summer, and autumn seasons of the current year. Iron ore is in brisk request and prices have advanced to from 12s. to 13s. 6d. per ton net at mines for ordinary qualities. Coal and coke are steady, but there is no advance in prices. Shipping is busier and there are more cargoes offering, while freights are all round much better than they have been for some time. At many of the iron and steel works in the district advances have either been made in workmen's wages or have been promised at an early date. There has been some difficulty about this, however, because, although as a matter of fact, prices of iron and steel have advanced to a fair extent, makers are now mainly employed in the delivery of orders booked prior to the advance which has been made. The same fact applies to the iron ore trade, but an arrangement has been made with the miners which will in all probability lead to an understanding to the mutual advantage of themselves and the mineowners.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

THE answer of the Secretary for War to Mr. Howard Vincent's question in the House of Commons on Monday has caused some doubt to be expressed here. "A Steel-maker" whom I know to be an expert in military material, writes to the local papers on the subject. While admitting that the War Secretary's statements was honestly made by him, "a Steel-maker" recalls the public promises held out to Sheffield steel-makers that no further extension of steel-making would be permitted at Woolwich Arsenal. He points out that the Secretary for War admits that in the Woolwich gun factory it is conceded they can cast up to 15 tons weight. In 1884 it is doubtful if they could have cast half that weight. He asserts that if the members for Sheffield would insist on having the tonnage output at the gun factory for 1884 and 1887, and a similar return from the Royal Arsenal, they would find that an entirely new steel plant had been erected, and that by the manufacture of steel there, Sheffield, during the last twelve months, had probably lost the sale of £300,000 worth of steel, which the Arsenal had manufactured for themselves instead of coming to Sheffield for it. "A Steel-maker" adds that the permanent officials who furnished the information to the Secretary of State for War "must or ought to have known perfectly well that nearly 3000 tons of steel were probably manufactured in the departments at the Arsenal last year where steel was not formerly manufactured at all."

I have to announce the death of Mr. Walter Scott Davy, which took place last Friday. Mr. Davy was one of the founders of the firm of Messrs. Davy Brothers, engineers, Park Ironworks. He served his apprenticeship there, and upon the firm becoming a limited company, he was made a director, and took a leading part in the management. In 1882 he accepted a three years' engagement with the Barrow Hematite Steel Company at £3500 per annum. At Barrow, where he undertook the management of the works, he thoroughly re-organised the great establishment, and on the expiration of his agreement was presented by the directors with a cheque for £1000. His health was considerably impaired by the strain of the duties at Barrow, and since his return to Sheffield he has lived in comparative retirement at Silverdale, Abbeydale, where he died in the 58th year of his age.

In the plated and cutlery trades a large number of jubilee novelties are being produced at nearly all the better-known establishments. The refusal to register any purely "Jubilee" designs has caused

considerable disappointment to firms, who had put themselves to great trouble and cost to get their productions up to a high standard. Some of the works which have been brought out by silver and plated firms are remarkably beautiful, and apart from the special event which has suggested them, have high artistic merits. It must be admitted, however, that the majority of the articles are entirely devoid either of originality or skill in adaptation, many manufacturers deeming it sufficient simply to mark their wares with a portrait of the Queen or a sceptre and the date of Jubilee Year.

The Midland Railway Company has placed part of its rail contracts with two local companies. The price has not transpired, but the quantity is believed to be about 3000 tons in each case. Raw material is now at a price which makes steel rail production exceptionally difficult at anything like the rates recently quoted—£4 5s. to £4 10s. per ton.

Cutlery firms doing a South American business find the cholera regulations somewhat embarrassing to their representatives, who are subjected to all sorts of inconveniences in getting to and from markets on the La Plata river. It is hoped that the plague will be of brief duration; otherwise a most important market will be prejudicially affected for the whole season. Australia has not yet recovered from the disastrous drought of successive seasons. Though last year was a good one, and 1887 also promises well, the squatters had mortgaged their wool in advance, and are only now beginning to reap the benefit of the upward tendency in price.

I had shown to me, the other day, a new thing in cutlery which has just been placed upon the market by Messrs. William Gregory, Sons, and Co., of the Otto Works, Howard-street, Sheffield. It is a butter knife for grocers' use, being specially made to cut butter in the lump, guaranteed not to rust with the salt and to keep the colour. This important point is effected by its being manufactured in a new metal, to which has been given the name of "Spanish silver." It has a bright and pleasant appearance. This firm report that butchers' and cooks' knives are in exceptionally strong demand.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

A SOMEWHAT improved feeling was apparent at the Cleveland iron market held at Middlesbrough on Tuesday last. It seems as though the fall in prices, which has been steadily progressing for nearly a month, has at last ceased. On, and previous to the 15th inst., the price of No. 3 G.M.B. had fallen to 35s. 9d. per ton for prompt delivery, and on the 18th small lots were being sold at 35s. 3d. Since then a reaction has taken place. Buyers have shown more disposition to operate, and No. 3 had risen to 35s. 9d., although a few merchants are still willing to take 3d. less. Makers will not, however, entertain these figures at all, and consequently they are completely out of the market for the time being. For delivery over the second quarter of the year 36s. 6d. is the lowest price which merchants will at present take. There is but a small supply of forge iron on offer at the moment; merchants ask for it 34s. 6d., and makers about 35s. per ton.

Messrs. Stevenson, Jaques, and Co.'s current quotations are:—"Acklam hematite," mixed numbers, 50s. per ton; "Acklam Yorkshire"—Cleveland—No. 3, 39s.; "Acklam Basic," 40s.; refined iron, 54s. to 64s. per ton.

The demand for warrants has improved, and prices are considerably higher. At the end of last week they stood at 34s. 9d., but on Tuesday sales were made at 36s. 1½d. per ton.

The stock in Messrs. Connal and Co.'s Middlesbrough store remains almost stationary. The quantity held on Monday last was 310,798 tons, being an increase of 47 tons during the week.

Pig iron shipments are progressing satisfactorily. Up to Monday night 41,343 tons had been exported, against 26,319 tons during the corresponding portion of January.

There is no change to notice in respect of the manufactured iron trade, either as to demand or prices. The Stockton mills continue to be fairly well employed.

The case of the Attorney-General *v.* the Tees Conservancy Commissioners, upon which judgment has just been delivered by the Lord Chief Justice and Justice Stephen, has naturally excited great interest in the district to which it refers. The river Tees has been the subject of special legislation for a number of years. In 1852 the present Commission was appointed under an Act whereby the minerals were distinctly reserved to the Crown. A second Act was passed in 1858 in which they were not mentioned at all. A third Act was subsequently passed under which the Commissioners had power to reclaim foreshore land, and were entitled to half the value which might be obtained for any such, the other half being divided equally between the Crown and the frontager. The question which has just been argued was whether the property so reclaimed and disposed of carried with it the minerals under it, or whether they were reserved to the Crown. The Court decided in favour of the first alternative. It has become a matter of great importance since salt was discovered at Port Clarence, because bore holes can be put down upon foreshore sites as well as upon any others.

Among shipowners connected with the Spanish iron ore trade the greatest dissatisfaction has lately been felt at the serious delays to which their steamers are habitually subjected at the port of Bilbao. On the 14th inst. there were four steamers taking in cargo at Portugalete, and eleven waiting for berths. At San Nicholas, higher up the river Nervion, there were eight loading at the staithes and two by lighters, whilst twenty-seven were waiting for their turns. At the Franco-Belga depôts three were loading, and six waiting. At Luchana, where the Oreanera ores are shipped, four were under the drops and twenty-three expectant. Lastly, at Bilbao, beyond which sea-going vessels cannot penetrate, three were at the quays and six in mid stream. Besides all these which were in the river itself, there were others outside waiting to enter. No doubt the recent rise in ore freights has attracted an excess of tonnage. Still the ore is wanted in England and should not be withheld for want of sufficient shipping facilities. As the Bilbao Port Commissioners have an abundant revenue, and the principal mineowners are very wealthy, there is little doubt but that this grievance will ere long be removed.

It is a curious coincidence, some people would say a judgment, that the Northumberland colliers on strike are suffering more from want of coal than of any other necessary of life. Accustomed to have it plentifully supplied at their back doors at all times just as needed, they have no stocks or cellars full to fall back on. Now that the pits are stopped their supplies are stopped also. Consequently they and their wives and children are busily engaged day by day exploring the old pit heaps for such meagre quantities of combustible matter as they may haply find there. The coalowners have so far been generous enough not to interfere with work of this kind.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

WITHOUT a marked accession of business the Glasgow pig iron market has been much firmer this week, there being a considerable improvement in the quotations as compared with those prevailing last week. The scarcity of coals, resulting from the continuance of the colliers' strike over the fourth week, made it expedient to damp out no fewer than thirteen blast furnaces, reducing the number in operation to sixty-one, as compared with ninety-four at the same date last year. This curtailment of output, together with fairly good shipments of Scotch pigs, has helped the market, notwithstanding that considerable quantities of pigs have been going into the warrant stores. The past week's shipments were 8063 tons against 5866 in the same week of 1886. The United States and Italy are our best customers, but the requirements of Germany and France appear to be more easily met than they were a year ago. The total shipments to date show a comparative increase of fully 9000 tons, while the stocks in Messrs. Connal and Co.'s Glasgow stores are 155,000 greater than at this date last year.

Business was done in the warrant market on Monday at 44s. 3d. cash. Tuesday's market was firm at 44s. 5d. to 44s. 9d. cash. On Wednesday transactions occurred at 44s. 8½d. to 44s. 5d. To-day—Thursday—the market was depressed, and warrants declined to 44s. 1d. cash, closing with buyers at that price.

There is not much alteration in the market quotation of makers' iron:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, is quoted at 51s.; No. 3, 44s. 6d.; Coltness, 57s. and 46s. 6d.; Langloan, 53s. 6d. and 46s. 6d.; Summerlee, 55s. and 45s.; Calder, 52s. and 44s.; Carnbroe, 48s. and 43s.; Clyde, 48s. 6d. and 44s.; Monkland, 46s. and 42s. 6d.; Govan, at Broomielaw, 46s. and 42s. 6d.; Shotts, at Leith, 50s. 6d. and 46s.; Carron, at Grangemouth, 52s. 6d. and 44s. 6d.; Glengarnock, at Ardrossan, 50s. and 43s. 6d.; Eglinton, 45s. 6d. and 41s. 6d.; Dalmellington, 47s. 6d. and 43s. 6d.

Merchants quote Scotch bar iron, f.o.b. Glasgow, including commission and less discount, bars, £5 5s.; hoops, £6 5s.; nail rods, £5 10s.; angle iron, £5 12s. 6d.; boiler plates, £6 2s. 6d.; ship plates, £6. The inquiry is not satisfactory at present.

The malleable ironworks have been working irregularly in consequence of the scarcity of coals, which continues to be a great inconvenience; but it is expected that a full supply will soon be obtainable.

Some of the steel works have again been idle, and others but partially employed, also through the want of coals. In the meantime, consumers of sheets, &c., have been making purchases from the English markets, where the prices were not so much advanced as in Scotland. The English rates are, however, fast approximating to those here, and are expected to be soon as high, if not higher than these now quoted in Scotland.

There was shipped from Glasgow in the past week £4671 worth of locomotives for Huelva; one steamer and two barges, in pieces, worth £11,075, for Rangoon; machinery, £3350; sewing machines, £5250; steel goods, £12,200, of which £5000 slabs went to Baltimore; and £2670 plates to Calcutta; general iron manufactures, £19,950.

The coal shipments are again reduced in consequence of the colliers' strike. There was shipped from Glasgow 8000 tons; Greenock, 35; Ayr, 5889; Irvine, 1236; Troon, 5630; Burntisland, 9438; Leith, 1918; Grangemouth, 1284; Bo'ness, 1581; and Granton, 1585—total, 36,546, as compared with 61,195 tons in the corresponding week of 1886.

Several good contracts are reported to have been received at Kilmarnock. The Glenfield Company have contracted to supply pumping engines for New Zealand, while Messrs. Kennedy and Co. have received an order to supply about £60,000 worth of their water meters to the Water Company of Naples.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

THE turn of the tide in the coal trade of Wales has been signalled by another disaster, and thirty-seven victims to the Cwtch explosion must be added to the long list we all deplore in the past.

The returns, which keep well up, show that work is brisk. From Cardiff the foreign export is now kept to the average of 160,000 tons. Newport shows tolerably well in coasting trade, but Swansea indicated a slight falling off, shipments totalling 22,000 tons; but against this is to be noted the heavy consignments of patent fuel, over 10,000 tons having been despatched during the week. I am glad to see this trade looking up, and approaching its old figures.

Coal prospects are decidedly improving, prices are decidedly per ton better, and I expect best steam will be quoted at the end of this week 9s. f.o.b. The reason for this is the demand, and that, too, for prompt supply. Plymouth collieries were exceptionally busy this week in meeting the demand. I note, too, a good many contracts in the market—Irish and other railways and steamers.

House coal is in good request. Small steam is getting more plentiful, and is slightly cheaper.

The Pontypridd, Caerphilly, and Newport Railway has been passed by the Government inspector, and passenger traffic will begin as soon as arrangements can be made.

No. 1 tunnel is being taken in hand near Bath, and five miles of sidings are to be laid down there to meet the Severn tunnel traffic, which promises to be in a rapidly ascending ratio.

Sir George Elliott's collieries alone in the Aberdare and tributary valley will keep things going well, and if the coal trade goes on increasing an alternative route *viâ* Gloucester will be acceptable.

The American demands upon our rail works are not quite what one wishes to see. At several of them a quantity of blooms are being turned out, and this seems the chief requirement. Blooms for America and tin bar keep things going tolerably well. As regards rails, the demand is small.

There is no movement yet of any account in connection with Treforest Works, though there is not wanting a sign or two that if times improve the works would go.

The tin-plate trade in Monmouthshire continues bad, on account of the attitude of the men. Many works are closed. The men divided a remittance of £700 this week from "going" works. At Swansea things are different. One vessel took out 1200 tons of tin-plates this week to America. In all, the exports were over 45,000 boxes. Prices are well maintained, the present drop having been but about 3d. a box, and now makers hold abundant orders and are tolerably independent.

The market quotations—and at these large sales have been effected—are:—Coke wasters, 12s. 6d. to 13s.; Bessemers, 13s. 3d. to 13s. 9d.; cokes, 13s. to 13s. 6d. I.C.; Siemens, 13s. 9d. to 14s. 3d.; ternes, from 12s. 6d., according to quality.

The principal inquiries of late have been for Bessemer and Siemens, with coke turning.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

IT was hinted in last report that the lowering political atmosphere was likely to influence the metal markets here. The Rhenish-Westphalian iron market has, in fact, this week been so far affected by it that buyers are holding over all important orders, and only giving out smaller ones, which are pressing, or assuming a waiting attitude. In spite, however, of the many fluctuations on the Bourse, the prices have remained stable at their former level, and in industrial circles it is generally thought that when the atmosphere is once again free from political clouds an immediate rise in prices will ensue, this opinion being to some extent based on the recent stronger tone shown on all foreign neighbouring markets. In Silesia the iron market shows increasing firmness, and pig iron is being delivered to the puddling furnaces and abroad with regularity in large batches at M. 47, whilst foundry pig commands M. 53 to 54 p.t. As both large and small consumers are in the market there is an excellent demand for wrought iron of all descriptions, including boiler plates, tube strip, and stamping sheets both for home and export account. Merchant bars cost M. 107·50, and common quality plates fetch M. 145 to 150 p.t. The French market, which of late has been rather fluctuating, has begun to recover, and now shows a firm front, and strange to say, the political situation seems to have exercised no influence on the iron market. Common plates have been contracted for at 145f., and the price of "Convention" bar iron is 130f. p.t. The late lower quotations for iron in England caused the Belgian market to be somewhat unstable, but as the works in general were well supplied with orders, prices have been maintained. Only the girder and bridge-building firms complain of too little work in hand. Rolled girders are noted at 100, angles at 115, and plates at 120 to 130f. for No. 3 quality, while steel plates cost 165f. p.t. Ores in the Rhenish-Westphalian district, both native and foreign, are more quiet, nor are the prices quite so firm as they were. As the blast furnaces have sold their first quarter's make, of course it may be said there is a good sale for pig iron, and it is being regularly and promptly taken away, though on the whole the demand is quieter than formerly. Many contracts though for the next quarter are lying ready, and only awaiting the result of the elections to be signed. The stock of puddling, spiegel, Bessemer, and basic pig was reduced by 7000 t. in January. The production of foundry pig was 14,443 t. in January, and the contracts for delivery amounted at the end of that month to 92,000 t. The prices of all sorts of crude iron are well maintained. Pig for puddling is noted at M. 48, basic at 44, Luxemburg at 34, Bessemer at 51, spiegel at 54 and higher, and foundry No. 3, 50, to 55 for No. 1. Large quantities of Luxemburg pig are being exported to France and Belgium at 43 to 44f. p.t. The immense stocks of this brand, equivalent to the Cleveland iron, are almost exhausted, so considerably higher prices are in prospect for next quarter's make. Spiegel is still being sent abroad in quantities, but the demand is less urgent than it has been lately. On the whole, the rolling mills have no cause for complaint, as they have work in hand for some time to come; but bars, girders, and other section irons are not in the same request they were when last reported, and it is becoming apparent that here and there the demand is somewhat decreasing; nevertheless, the prices have suffered no diminution as yet. However, with the advent of milder weather, it is hoped the old life will be infused into this branch of the trade. The mills which roll boiler and thick plates are only partially well employed, and the demand is slow, whilst the thin plate and sheet mills are full of work. Wire rods are as ever in great request for abroad, and a great deal goes to America, where during the last month the price has risen 7 to 8 dols. the ton.

The steel works are moderately engaged on other than railway material, which comes slowly to hand; but herein there are well founded hopes of an improvement, inasmuch as rails are being now sold on foreign markets at a price which will permit the German works to compete without suffering a loss. It is now denied that any negotiations have taken place with the object of resuscitating the defunct International Rail Convention; but, on the other hand, it is stated that an English-Belgian-German protective convention—called abroad a Curtell—exists, according to the terms of which neither of the other two is to compete in the country of the other. The comparatively high tenders for rails recently sent in, reaching to nearly £6 p.t., delivered, looks almost like a confirmation of this last report. It is maintained here that in materials for shipbuilding the German houses are beating the English in price by 10 to 15 marks per ton. This at least appears to have been the case for materials for some large steamships now building in the North for Hamburg firms, and for the African Steamship Company, which Krupp and the Hœrde Works took at prices by as much, as stated above, lower than the competing English houses. The wagon works are dragging on their existence, and the foundries, engine shops, and boilermakers have a little more work in hand; but prices have not improved, and are wretchedly low.

There is, fortunately for the mineowners, a continually increasing demand for industrial coal, and the still severe weather works in the same direction to the advantage of the house-coal mines. Cokes are in better demand at enhanced prices, and those of coals are well maintained. The mines of Silesia produced last year 16,000,000 metric tons of coal. Upper Silesia delivering 81 and Lower Silesia 19 p.c. The average selling price of the coals from both districts was M. 4·25 p.t. at the mines; that for Upper Silesian coal being M. 3·88, and for Lower Silesian, M. 5·89 p.t. The coal is not first-class, labour is cheap and mines not deep, which will account for the comparative cheapness of it.

At a meeting of mineowners and colliers at Bochum, Westphalia, with the exception of one voice, it has been unanimously decided to entirely exclude black gunpowder and open lamps from the coal-mines of that important district; and as the adhesion to this decision on the part of the other coal-fields is assured, and the assent of the Government to it is certain, it will soon become the law of the land. This is probably the first time such a sweeping measure has been carried out, and the noteworthy part of it is that it has been carried out by private initiative voluntarily instead of, as is usually the case here with such matters, by Government interference or police regulation.

At the Vulcan Machine Works and Shipyard, near Stettin, where vessels and engines for the Chinese Government are being constructed, a not very common accident has just occurred, by which five workmen were severely injured, namely, through the bursting of the high-pressure cylinder of an engine which was being tried. It will be remembered that some time back it was related in THE ENGINEER that the fly-wheel of a fan-blast on board a torpedo boat, constructed by the above firm, also flew to pieces whilst the boat was exercising in China waters. In this connection it may be mentioned that judgment has just been given, on the third trial, in favour of two widows whose husbands lost their lives by a similar accident. The matter was carried through three instances, the two last of which were lost by the firm—ironworks and foundry proprietors at Düsseldorf—who are mulct in damages. It appears the engine at a works was suddenly stopped, and the pulley in question thereupon flew to pieces, killing two men. The firm who made the castings and their foreman moulder were both summoned to answer the charges against them. The court held that, as there was a flaw found in the casting—the pulley—which it was alleged led to the accident, both were answerable, as they ought to have previously known that the flaw existed. This is a salutary lesson, as everybody knows who has had any experience with German castings how much the quality of them needs improvement in every particular; and it may now be hoped that more care will be exercised in making them in the future.

It will not be considered quite out of place here if the results of the first trials of basic slag as a dressing or manure be given. They are authentic, and emanate from the Agricultural Laboratory at Brühl, near Cologne. It was in the cultivation of beetroot for sugar that the first experiments were made, with the following results, which certainly are calculated to create the basic slag into a considerable article of commerce. The percentage of sugar in the roots was in the undermentioned proportions: With superphosphate once applied, 49·06; basic slag, 48·85; without phosphoric acid, 48·11; superphosphate twice applied, 46·83; bone ash once applied, 46·28; superphosphate as top dressing, 46·97; basic slag twice applied, 47·50; coprolite twice applied, 46·80; coprolite once applied, 45·67; bone ash twice applied, 43·78. Both in quantity and quality the basic slag has shown itself to be excellent, and as seen above, is only excelled by the superphosphate. And the second year's results are expected to show up still better.

Just on closing this the news reaches me that at the Bismark Works, Schwientochlowiz, Silesia, a fly-wheel has burst, killing two and wounding six workmen.

THE first serious work on the foundations of the new Hawkesbury Bridge, for which Messrs. Anderson and Barr have the contract, began early in October. On January 1st, 1887, one pier was down 12ft. in the solid, with 25ft. of concrete in it and 50ft. of the iron shell in place, and another caisson nearly ready for launching. The *American Engineering News* says:—"Progress has been somewhat impeded by the usual transportation and other delays so common with new works of magnitude at remote localities." This is the bridge which British builders are constructing for American contractors.

AMERICAN NOTES.

(From our own Correspondent.)

NEW YORK, February 11th.

THE brokers report a freshening up of inquiry for American pig iron, with occasional inquiries for Bessemer pig and slabs and billets. The trouble in the American market at present is that large buyers have a good deal of material already contracted for, and are not willing to take the risk of buying for more remote requirements, because of the probability they entertain that prices will react. Present quotations are:—2c. to 2·25 for bar iron, 2·40 dols. to 2·60 dols. for nails, 39 dols. to 41 dols. for steel rails, 24·50 dols. for old rails, 34 dols. to 35·50 dols. for puddle bar, 2·50 for ordinary plate iron, and 3·50 to 4c. for steel plates, according to quality. Foundry irons range as usual from 20 dols. to 21 dols. for No. 2, and 21 dols. to 23 dols. for No. 1. The business for the past week, both here and furnaces and mills, has been rather light, and to-day's indications are that there will be no rush for additional supplies until after March 1st. A large amount of business is going into the locomotive works and car works, and the millowners in Western Pennsylvania and throughout Ohio are reporting a great deal of inquiry, and in consequence of this quotations for spring and early summer delivery are very firm. A good many large consumers are apprehensive that another period of activity will develope itself about the middle of March, and crowd prices up from 1 dol. to 2 dols. per ton on finished and rolled iron. Copper is quoted to-day at 11·15; tin, 22·50; lead, 4½; and spelter, 4·55c.

NEW COMPANIES.

THE following companies have just been registered:—

Bridlington Quay Pier Company, Limited.

Registered on the 12th inst., with a capital of £30,000, in £5 shares, to take over the provisional order for the construction and regulation of a pier at Bridlington Quay, Yorkshire, for which application is now being made to the Board of Trade. The subscribers are:—

	Shares.
W. T. Spark, Higher Broughton, Manchester, engineer	1
C. F. Minchin, C.E., Higher Broughton, Manchester	1
R. H. Heenan, C.E., Brooklands	1
G. D. Mertens, 2, Victoria Mansions, Westminster	1
M. Noel Ridley, C.E., 2, Victoria Mansions	1
R. Fowler, Hillsbrough, West Dulwich	1
E. C. Wicks, 50, Mervan-road, Brixton, S.W., manager	1

Registered without special articles.

Hunting and Company, Limited.

This is the conversion to a company of the business of Henry Hunting, of Bath-lane, Newcastle-on-Tyne, manufacturer of machinery for wood-working purposes. It was registered on the 16th inst., with a capital of £5000, in £10 shares. The subscribers are:—

	Shares.
W. J. Cowen, Newcastle, decorator	1
A. Tilfer, Newcastle, engineer	1
H. Hunting, Jarrow, engineer	1
E. George, Newcastle, estate agent	1
C. H. Duffell, Newcastle, draper	1
C. W. Anderson, Newcastle, engineer	1
W. H. Smithson, Newcastle, engineer	1

Registered without special articles.

Hy. Mills and Sons, Limited.

This company proposes to trade as manufacturers of, and dealers in, iron and steel plates and bars, and will carry into effect a certain scheme of arrangement of the affairs of Henry Mills, resolved to be entertained by a special resolution passed at the adjourned first meeting of the creditors of the said Henry Mills on the 1st inst. It was registered on the 10th inst., with a capital of £10,000, in £10 shares, with the following as first subscribers:—

	Shares.
G. Perry, Walsall, roll turner	1
J. Bennett, Walsall, ironwork manager	1
B. Perry, Walsall, merchant	1
G. Perry, Walsall	1
J. Rees, Walsall, stocktaker	1
J. Bridgewater-Crowther, Walsall, roller	1
W. Pymm, Wednesbury, bricklayer	1

The subscribers are to nominate the first directors; the number is not to be less than three, nor more than seven; qualification, ten shares. The company in general meeting will determine remuneration. Mr. Henry Mills is appointed managing director for five years, at a salary of £208 per annum, and a commission of 5 per cent. on the net profits divided amongst the shareholders in any year.

Incandescent Gas Light Company, Limited.

This company proposes to acquire the patent rights of Dr. Carl Auer von Welsbach, for incandescent lights for increasing illuminating power of gas and other light and heat-producing agencies. It was registered on the 14th inst., with a capital of £500,000, in £5 shares. The purchase consideration is £300,000, payable £60,000 in cash, £100,000 in fully-paid shares, and £140,000 in cash or fully-paid shares, at the option of the directors. The subscribers are:—

	Shares.
Captain M. McTaggart, Catford, Kent	1
J. A. Kennedy, 81, Graham-road, Dalston, accountant	1
G. K. Trench, C.E., 11, Derwent-grove, S.E.	1
E. T. Jones, 55, Lydner-road, Dalston, accountant	1
T. H. Smiles, C.E., 33, Stansfield-road, Brixton	1
W. T. Cameron, 81, Hatcham Park-road	1
G. A. Gibbs, 29, The Avenue, Bruce-grove, N., accountant	1

The number of directors is not to be less than three, nor more than ten; qualification, 100 shares, or equivalent stock; the subscribers are to appoint the first. The remuneration of the board will be at the rate of £500 per annum for the chairman, and £250 per annum for each other director.

Auto Machinery Company, Limited.

This is the conversion to a company of the business of Hillman, Herbert, and Cooper, of the Premier Works, Coventry, manufacturers of balls used in bearings for velocipedes and for other purposes. It was registered on the 10th inst., with a capital of £20,000, in £10 shares. The purchase consideration is £4500 in fully-paid shares and £2500 in cash. The subscribers are:—

	Shares.
*R. A. Dalton, Coventry, manufacturer	1
*A. Rotherham, Coventry, silk dyer	1
*W. Hillman, Coventry, cycle manufacturer	1
*G. B. Cooper, Coventry, cycle manufacturer	1
Mrs. F. M. Hillman, Coventry	1
F. M. Herbert, Coventry	1
Thos. Mabbutt, Birmingham, gun maker	1

The number of directors is not to be less than five, nor more than ten; the first are the subscribers denoted by an asterisk, and Mr. N. H. Herbert; qualification, ten shares. The company in general meeting will determine remuneration.

Salt Boring Company, Limited.

On the 14th inst. this company was registered, with a capital of £1400, in fourteen shares of £100 each, to bore for salt on land at Greatham, Durham, and to erect works for the production of brine and salt. The subscribers are:—

	Shares.
C. T. Casebourne, C.E., West Hartlepool, engineer	1
J. W. Cameron, West Hartlepool, brewer	1
C. Furness, West Hartlepool, shipowner	1
M. Gray, West Hartlepool, shipbuilder	1
J. T Newbegin, West Hartlepool, cashier	1
J. S. Allison, West Hartlepool, clerk	1
T. H. Tilly, West Hartlepool, solicitor	1

Registered without special articles.

Sandown Pier Extension Company, Limited.

This company proposes to acquire the pier and other works and buildings belonging to the liquidators of the Sandown Pier Company, Limited. It was registered on the 11th inst., with a capital of £10,000, in £500 preferred of £10 each, and 1000 ordinary shares of £5 each. The subscribers are:—

	Pref. Shares.
J. Joliffe, Bonchurch, Isle of Wight, builder, &c.	1
W. H. Wooldridge, Sandown, Isle of Wight, solicitor	1
R. H. Cole, Sandown, Isle of Wight, clerk	1
F. J. Webster, 3, Temple-gardens, solicitor	1
R. E. Webster, Hornton Lodge, Kensington, Attorney-General	1
J. Jobson, 306, Southampton-street, Camberwell	1
R. Loveland, 4, Hare-court, Temple, barrister	1

Most of the regulations of Table A of the Companies' Act, 1862, will apply to the company.

Upper Yang-Tsze Steam Navigation Company, Limited.

This company was registered on the 12th inst., with a capital of £10,000, in £100 shares, whereof ninety are ordinary shares and ten are deferred shares, to acquire steamships and employ the same in trading between any port or ports in China or elsewhere as the company may from time to time determine. The subscribers are:—

	Shares.
*A. J. Little, 18, Park-street, W., merchant	10
*H. S. Morris, 25, Cornhill, underwriter	5
*J. McGrigor, C.E., 78, Queen Victoria-street	3
J. A. Maitland, 21, Mincing-lane, merchant	5
E. F. Duncanson, 1, Whittington House, Leadenhall-street, merchant	5
E. Till, 24, Commercial Sale-rooms, broker	5
*A. B. Barton, 8, Lexham-gardens, Kensington	2

The number of directors is not to be less than two, nor more than five; the first are the subscribers denoted by an asterisk. The company in general meeting will determine remuneration.

Winfield's, Limited.

This is the conversion to a company of the business of R. W. Winfield, of Birmingham and Holborn Viaduct, manufacturers of every variety of metal work, including brass and iron bedsteads, art metal work, tubes, pipes and wires, chandeliers, gas, oil, and electric light fittings of all descriptions. It was registered on the 11th inst., with a capital of £160,000, in £5 shares. The subscribers are:—

	Shares.
*J. E. Spencer, M.P., 4, Brick-court, Temple	1
Arnold Trinder, 47, Cornhill, solicitor	1
F. E. Hersee, 144, Leadenhall-street, manager of a company	1
*A. C. Mitchell, 44, Cannon-street, steel pen merchant	1
R. H. Milward, 1, New-square, Lincoln's-inn, solicitor	1
H. P. Gordon, Hatton-court, E.C., stockbroker	1
W. J. Crozier, New Malden, Surrey	1

The number of directors is not to be less than three, nor more than eight; qualification, fifty shares; the first are Lord Beaumont, C. W. Torr, S. Thompson, F. Simms, and Octavius F. Thompson. The remuneration of the board will be determined by the company in general meeting, provided that the minimum be £5 5s. to each director for every board meeting, and £3 3s. for each committee meeting, in addition to travelling expenses.

KING'S COLLEGE ENGINEERING SOCIETY.—On Tuesday, February 8th, Mr. J. R. Brydges read a paper on "Telephones." In this paper the author gave a short historical account of the invention and evolution of telephones, describing the most important of those in which electricity is employed. He stated that the Greeks most probably used acoustic tubes in some of their mysteries, and that travellers tell us that the Chinese used instruments which would now be called mechanical telephones. About 1837 two events occurred which gave great impetus to telephony. In America Mr. Page made the discovery that a magnetic bar rapidly magnetised and demagnetised emitted sounds, and that these sounds corresponded to the number of currents producing them. Early in 1876 Bell and Gray independently and simultaneously invented telephones by which transmission of speech could take place perfectly, and later in the same year Edison brought forward an improved transmitter, establishing a new type of instrument. In 1878 Professor Hughes exhibited his microphone, from which invention freely given to the world the greater number of transmitters now in use are derived. The author then proceeded to define a telephone, and to describe various transmitters and receivers. The author then concluded his remarks by stating that practically an induction coil should be used when the resistance in the line and receiver becomes so serious as to swamp the variation of the resistance in the microphone. The paper was fully illustrated by numerous diagrams.

THE PATENT JOURNAL.

Condensed from the Journal of the Commissioners of Patents.

Application for Letters Patent.

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

15th February, 1887.

2321. TYPE WRITING MACHINES, H. J. Allison.—(*E. M. Hamilton and L. Goldsmith, United States.*)
2322. BUCKLES, J. Hazelton, London.
2323. SLIDING SASHES, J. Hookham, Eastbourne.
2324. ROLLER with SELF-ACTING COOLER, C. Seck, Germany.
2325. HOSIERY, W. H. Dorman, Stafford.
2326. WHEEL FELLOES, W. H. Brassington, Manchester.
2327. PENCIL CASES, S. Bott, Birmingham.
2328. FLUSH-OUT WATER-CLOSETS, J. Morley, Upper Saltley.
2329. HORSESHOES, G. H. Taylor, Sheffield.
2330. EDGES of the NECKS of GLASS BOTTLES, J. T. Creasy, London.
2331. UMBRELLAS, &c., F. Nash, London.
2332. RACK for SHOWBOARD, J. R. Richards, Whitchurch.
2333. BOILER EXPLOSION PREVENTER, S. Kilby and H. Mobbs, Northampton.
2334. FIRE ENGINES, J. C. Merryweather and C. J. W. Jakeman, London.
2335. SWING COVER for HOT-WATER JUGS, E. Taylor, Birmingham.
2336. STEERING GEAR for VELOCIPEDES, J. Reeve, Ladywood.
2337. ATTACHING DOOR KOBS to SPINDLES, E. Taylor and S. Davis, Birmingham.
2338. HOLDING DRINKING GLASSES, &c., F. Hill, Dublin.
2339. OPENING BOTTLES, E. W. Thompson, Sheffield.
2340. STRAINERS for TEA POTS, &c., A. E. Furniss, Sheffield.
2341. STOPPING TUBES BURST by EXTERNAL PRESSURE, H. T. B. Sanderson, Durham.
2342. SELF-ACTING MULES, J. Moorhouse and J. Ashton, Shaw.
2343. TAP for use in LAVATORIES, J. T. Edwards, Birmingham.
2344. COLLAR STUDS, C. H. Wilson, Birmingham.
2345. BAKER'S OVENS, D. McArthy, Glasgow.
2346. SECURING INDIA-RUBBER TIRES to BICYCLE WHEELS, W. R. Foster and F. H. Sprang, London.
2347. PREVENTING the BURSTING of the RESERVOIR of PETROLEUM LAMPS, E. Sundborg, London.
2348. ECONOMISING GAS in RAILWAY CARRIAGES, E. de Pass, London.
2349. PETROLEUM LAMP for RAILWAY SIGNALLING, W. Henley, London.
2350. BLANCHING CELERY, P. Haddan.—(*H. G. Lee, United States.*)
2351. PROTECTING GAS LIGHTING, J. Russell and J. S. Rosser, London.
2352. ANTI-FRICTION JOURNAL BOXES, A. J. Boult.—(*W. S. Sharpnecks.*)
2353. DIVIDED CAR AXLES, I. W. Lewis, London.
2354. BLEACHING VEGETABLES, &c., A. J. Boult.—(*H. K. de Pawlowski, France.*)
2355. RING SPINNING MACHINES, G. W. Shoemaker, A. Harvey, and E. Miles, London.
2356. PILLOW BLOCKS, A. J. Boult.—(*E. S. Newton, United States.*)
2357. TRIMMING the SOLES and HEELS of BOOTS, H. H. Lake.—(*C. H. Trask, United States.*)
2358. FLOWER POTS, G. A. Burrough, London.
2359. GRAVING DOCKS, &c., R. Turnbull, London.
2360. DRILLING, &c., N. Brown.—(*B. Fischer, Germany.*)
2361. FRICTION CLUTCHES, W. R. Comings.—(*J. Macdonald, United States.*)
2362. FRICTION CLUTCHES, W. R. Comings.—(*J. Macdonald, United States.*)
2363. CEMENT, D. N. Arnold and W. Young, London.
2364. SADDLE SPRINGS, J. R. Trigwell, London.
2365. AUTOMATIC SELLING APPARATUS, M. Sielaff, London.
2366. DELIVERING PREPAID GOODS, H. J. Avery, London.
2367. CRANES, H. J. Coles, London.
2368. GAS ENGINES, &c., J. Thomas, London.
2369. FOLDING TRICYCLES, G. W. Courtier, London.
2370. CROSSING POINTS, &c., W. R. Anderson and J. Raine, London.
2371. STEAM BOILERS, E. Scott, London.
2372. KNITTING MACHINES, H. H. Lake.—(*C. A. Shaw, United States.*)
2373. GRAIN, G. Epstein, London.
2374. ARMY RIFLE BORE REFLECTOR, F. A. Tull and S. F. Huxley, London.
2375. SOWING GRAIN, W. P. Thompson.—(*G. W. Kirkpatrick, United States.*)
2376. SPINDLES and BOLSTERS for SPINNING MACHINES, H. H. Lake.—(*C. H. Chapman, United States.*)
2377. ELECTRO-MAGNETIC BRAKE SYSTEMS, G. F. Card, London.
2378. DRESSING BAGS, &c., M. Wolfsky, London.
2379. OIL LAMP and GAS BURNERS, C. Crastin, London.
2380. GLASS BOTTLES, W. B. Fitch, London.
2381. MATCH BOX, G. Hampton, London.
2382. SHUTTERS for PHOTOGRAPHIC CAMERAS, E. T. Perken, London.
2383. ARM SUPPORT for BOOK-KEEPERS, R. Hynitzsch, London.
2384. LUBRICATORS, J. G. Tongue.—(*The Nathan Manufacturing Company, United States.*)
2385. SAFETY SNAP HOOK, I. M. McKay and H. E. Stafford, London.
2386. CUP and BALL VALVE or TAP, W. B. Press, London.
2387. TRANSFERRING SHIPS from one LEVEL to ANOTHER on CANALS, &c., E. J. Lloyd and W. Salt, London.
2388. PRECIPITANTS and in the TREATMENT of SEWAGE, A. Angell, London.
2389. FANS or SCREENS, E. A. Cocke, London.
2390. ELECTROLYTICAL TREATMENT of ORES for EXTRACTING GOLD and SILVER, H. Liepmann, London.
2391. INHALING APPARATUS, H. C. F. Störmer, London.
2392. PAILS or TUBS for containing BUTTER, H. H. Lake.—(*James McAdam, United States.*)
2393. WINDOWS of RAILWAY CARRIAGES, G. A. Nussbaum, London.

16th February, 1887.

2394. HARNESS to JACQUARDS or DOBBIES, P. Edelston, Manchester.
2395. TOY, M. A. Wier, Upper Norwood.
2396. FLAME EXTINGUISHERS for USE in OIL BURNERS, G. Oxley, Gateshead-on-Tyne.
2397. REVERSING the ACTION of MACHINERY in MOTION, J. Winder, jun., Leeds.
2398. CIRCULATION and PURIFICATION of WATER in STEAM BOILERS, T. Rawson, Sunderland.
2399. WATER-CLOSETS, W. J. Moore, Cheltenham.
2400. SCHOOL and other SLATES, C. W. Price, London.
2401. SECURING BEDCLOTHES, H. T. Weston, Sheffield.
2402. OBTAINING BICARBONATE of SODA, C. Wigg, Liverpool.
2403. TREATMENT of SPENT COPPER LIQUIDS, &c., C. Wigg, Liverpool.
2404. ELEVATORS, W. Adair, Liverpool.
2405. ATTACHABLE HAME DRAFT BLOCK, R. Larkin, Rye.
2406. SPEED INDICATORS, T. A. Garrett and W. Lucas, London.
2407. SECURING LAMPS to VELOCIPEDES, T. E. Bolton and E. Gilyard, Manchester.
2408. STUDS, G. Lee, Redcar.
2409. GLASS MOVEMENTS, F. W. Averill, Birmingham.
2410. REMOVING OLD CAPS from CARTRIDGE CASES, J. T. Cooper, Birmingham.
2411. REVOLVING ADVERTISER, T. H. Lidstone, Plymouth.
2412 ATTACHMENT of FIRE-BARS to GRATES, H. E. Hoole, Sheffield.
2413. BEE-HIVES, &c., J. Lee, London.
2414. SHIRTS, &c., G. Brown, R. Straughan, and W. Dotchin, Newcastle-on-Tyne.
2415. SUSPENDING a MAP from a WALL, J. Wigmore, Knowbury.
2416. SAFES, E. G. Wood, Birmingham.
2417. FIRE-EXTINGUISHING SPRINKLERS, J. H. and J. W. Galloway, London.
2418. FIRE GRATES, H. S. Moorwood, Sheffield.
2419. DYNAMO-ELECTRIC MACHINES, F. Bosshardt.—(*A. L. Hillaire-Desbois, France.*)
2420. TIP-CUPS for UMBRELLAS, &c., T. Widdowson, Sheffield.
2421. HORSESHOES, W. Tuffee, London.
2422. TRUSSES, J. Mareille, Liverpool.
2423. TREATING RHEA BARK, &c., G. I. J. Wells and S. L. Howard, Liverpool.
2424. COMBINATION of a TRANSPARENT GLASS CLOCK or DIAL FACE with a MOVABLE ADVERTISEMENT, C. Walker, London.
2425. POCKET ANTISEPTIC INHALER, F. W. Loxton and A. McSwiney, London.
2426. APPLYING the POWER to STEAM VESSELS, F. Reeves, Northampton.
2427. STRAINERS for TEAPOTS, &c., S. W. Kemish, London.
2428. LOCKS and DOOR FASTENINGS, Sir G. H. Chubb, H. W. Chubb, and H. S. Ball, London.
2429. ROLL-HOLDER, &c., for PHOTOGRAPHIC CAMERAS, J. R. Gott, London.
2430. VENETIAN BLINDS, F. W. Unterilp, London.
2431. PREVENTION of EXPLOSIONS of BATH and other BOILERS, J. Foord and W. W. Paddon, London.
2432. COMPOUND STEAM ENGINES, R. R. Bevis, jun., and J. D. Churchill, London.
2433. HYGROMETERS, &c., P. Calliburcès, London.
2434. HYDRAULIC PRESSES, L. R. Bodmer, London.
2435. AIR-TIGHT PACKING for DOORS or WINDOWS, G. B. Thornton, Glasgow.
2436. DRESSING BASS for BROOMS, R. J. Hickton, London.
2437. FURNACES for BURNING LIME, F. Labbé, London.
2438. PETROLEUM MOTORS, G. A. and V. List and J. Kosakoff, London.
2439. SEPARATING and SIFTING GRAIN, &c., J. Schlesinger, London.
2440. INVERTED GAS LAMPS, D. W. Sugg, London.
2441. FEED-WATER HEATERS and PURIFIERS, T. Seale, London.
2442. METALLIC PACKING for PISTONS, H. H. Lake.—(*T. Tripp, United States.*)
2443. BOOK SLATES, &c., E. J. J. Dixon, London.
2444. CASES or HOLDERS for PENS, &c., J. Spear, London.
2445. EXPOSING PLATES to receive PHOTOGRAPHIC PICTURES, A. H. Loring, London.
2446. REMOVAL of SNOW from STREETS, W. Duncan, London.
2447. STEEL and IRON, C. Scheibler, London.
2448. SEPARATING CREAM from MILK, W. Smith, London.
2449. CLUTCH MECHANISM for DRIVING the FEED-MOTION of SEWING MACHINES, H. Birch, London.
2450. HYDRAULIC APPARATUS for DREDGING OPERATIONS, D. T. Fender, London.
2451. DISTRIBUTING ELECTRICITY, O. T. Blâthy, London.
2452. AFFIXING CORN, &c., SHIELDS in POSITION, J. Nicholls, London.
2453. LIFT-UP WINDOWS of RAILWAY, &c., CARRIAGES, C. F. Archer, London.
2454. GAS LAMPS, L. N. Loeb.—(*S. Hamburger and Co., Canada.*)

17th February, 1887.

2455. CARDING ENGINES, W. Brown, Bradford.
2456. SEPARATING STEAM for LIQUIDS, J. E. Matthewson, Sheffield.
2457. JEYE'S ANTI-CORROSIVE COMPOUND, O. Jeyes, Birmingham.
2458. CLARIONETS, D. J. Blaikley, London.
2459. MIXING of PHOSPHATIC COMPOUNDS, A. Campbell, Upton Park.
2460. COOKING RANGES, M. Cockburn, Glasgow.
2461. BEDSTEADS, &c., I. Chorlton and G. L. Scott, Manchester.
2462. TEA and COFFEE-POTS, T. Grimwood, Woodbridge.
2463. INTERNALLY STOPPERED BOTTLES, D. Rylands, London.
2464. CAUSING PROJECTILES to STRIKE SHIPS, W. Clark, London.
2465. CARDS, LATHS, or LAGS, W. H. Tetley, Bingley.
2466. CARD SETTING MACHINES, W. Walton and J. T. Fallows, Manchester.
2467. HINGING the LIDS of BASKETS, &c., T. Humphreys and S. J. Heys, Manchester.
2468. PAPER, P. W. McGrath, Bradford.
2469. ARTIFICIAL FLIES, C. Kempster, jun., Shrewsbury.
2470. TOBACCO PIPES, E. Galloway, near Leeds.
2471. BOTTLES, &c., T. Sutcliffe, London.
2472. PEDALS for VELOCIPEDES, N. G. K. Husberg, Birmingham.
2473. DRYING LEAVES of PLANTS, &c., J. Dick, Glasgow.
2474. REGULATING FLUID PRESSURES, J. McL. McMurtrie, Glasgow.
2475. AUTOMATICALLY WORKING RAILWAY SIGNALS, J. B. Gay, Cheltenham.
2476. HYDROCARBON OIL LAMPS, J. B. Fenby, Sutton Coldfield.
2477. OBTAINING MOTIVE-POWER from the COMBUSTION of PETROLEUM, &c., A. S. Jones, Ipswich.
2478. COMBINED METALLIC BEDSTEAD and SEAT, J. Frazer, Birmingham.
2479. STAND or HOLDER for CUT FLOWERS, B. Lane, Birmingham.
2480. TOILET SPONGE BASKETS or HOLDERS, G. Rodger, London.
2481. GALVANIC BATTERIES, &c., R. Marsh, Liverpool.
2482. PORTLAND CEMENT, W. Tuffee, London.
2483. PHOTOGRAPHIC SHUTTERS, H. E. Davis, London.
2484. STRAIGHTENING STEEL WIRE, J. Thornton and W. Walker, London.
2485. CONDENSING STEAM, J. J. Moffat, Birmingham.
2486. ROLLER BEARINGS, J. H. Adams, London.
2487. DOGS or RESTS for FIRE-IRONS, C. Meason, Birmingham.
2488. STEEL, W. Macfarlane, Leeds.
2489. RIMS of WHEELS for VELOCIPEDES, &c., W. Bown, London.
2490. SPOKES of WHEELS for VELOCIPEDES, &c., W. Bown, London.
2491. LAMP BRACKETS, W. Bown and R. B. Chalmers, London.
2492. HANDLES for BICYCLES, &c, J. Pasfield and F. J. Biggs, London.
2493. RECORD RACING GLASSES, F. J. Biggs, London.
2494. SECURING, &c., SHIPS' BOATS, W. Andrew, London.
2495. SAFETY LAMPS, E. H. White, London.
2496. SIFTING CINDERS, E. Dummer, London.
2497. SAFETY ATTACHMENT for WATCHES, A. M. Clark.—(*H. D. Martin-Pouget, France.*)
2498. PROTECTIVE VARNISH, W. Dick, London.
2499. FORGING PROJECTILES, C. Fairbairn and M. Wells, London.
2500. STEAM TRAPS, C. Richard, London.
2501. SECURING CUFFS on the ARMS, E. H. Anderson, London.
2502. SWITCHES for ELECTRIC LIGHTING, G. V. Fowler and E. W. Lancaster, Birmingham.
2503. BAT, LAWN TENNIS, and STICK RACK, H. M. Turner and E. W. Glanville, London.
2504. FURNITURE of LOCKS and LATCHES, J. Pollock, London.
2505. EXTENSIBLE ROOFS, &c., E. Horbaczewski, London.
2506. APPARATUS for CONVEYING GRAIN, J. B. Stoner, London.

2507 Glass Show Cards, J. Baird, Glasgow.
2508. Mortising Machines, J. Sutherland, Glasgow.
2509. Carrying Artists' Canvasses, I. Carruthers, London.
2510. Preventing Oil from Leaving the Reservoir, W. W. Meadows, London.
2511. Oil Lamps, S. A. Johnson and W. R. Oswald, London.
2512. Vermin Trap, W. F. Lotz.—(*H. Abbott, United States.*)
2513. Timber Roofs, R. R. Little and J. Hall, London.
2514. Portable Article of Furniture, T. Opel, London.
2515. Stopping and Steering Ships, H. Kranz, London.
2516. Launching Boats from Ships, H. Kranz, London.
2517. Telegraph Poles, D. Wilson, London.
2518. Reversing Apparatus, J. Russell, Manchester.
2519. Treating Coffee, H. W. Hart, London.
2520. Motor Engines, T. Browett and H. Lindley, London.
2521. Frames for Satchels, &c., T. R. Weidemann, London.

17,165. Milk, C. A. Wahlin, A. Forssell, and F. L. Enquist.—(*A. T. Pfieff, Sweden,*—[Received February 18th, 1887. Antedated August 19th, 1886, under International Convention.]

18*th February*, 1887.

2522. Preventing Falsification of Receipts, J. H. Betteley and R. J. Rastrick, London.
2523. Guns, A. C. Koerner, Paris.
2524. Tent Poles, H. Francis and A. E. Carey, Liverpool.
2525. Toy Musical Boxes, J. Manger, London.
2526. Metallic Rollers for Mangles, J. T. Key, Sheffield.
2527. The Unus Capsule, J. Forster, Dublin.
2428. Straightening Angle Iron, T. W. Haswell, Hartlepool.
2529. Cylinders, C. H. Taylor, Manchester.
2530. Props for Mines, H. Hibbert and W. Horsfield, Nottingham.
2531. Gas Stoves, A. Hill, Birmingham.
2532. Knife, J. Brailsford, Sheffield.
2533. Mattresses, T. Hanson, Halifax.
2534. Cements, J. W. T. Stephens and R. Clark, Cardiff.
2535. Closing Doors, G. J. Harcourt and E. Shaw, Bristol.
2536. Side Temples for Looms, W. Nelson, Lancashire.
2537. Door Knobs, J. Walker, Birmingham.
2538. Rulers, W. Leggott, Bradford.
2539. Wear of Leathers on Combing Machines, A. W. Drabble, Bradford.
2540. Counting Newspapers, T. G. Dawson, Yorkshire.
2541. Safety Lamp, G. Thew, Bolton.
2542. Clips for Springs of Carriages, G. Skidmore, Wednesbury.
2543. Doughing Tub, J. Howie, Glasgow.
2544. Elevator, C. G. Doran, Cork.
2545. Lamp Extinguisher, W. G. Cloke, Peckham, and R. Pilcher, Canterbury.
2546. Displaying Bill of Fare, A. W. Hosking, Manchester.
2547. Fire-holders, A. W. Parkes, London.
2548. Screw-propellers for Ships, A. J. Sedeley, London.
2549. Pivoting Fan-lights, &c., W. J. Payne, London.
2550. Vertical Steam Boilers, R. and W. Astley, Manchester.
2551. Hoists, S. Kirkham, London.
2552. Toe Tips, G. Burton, London.
2553. Treatment of Sewage, A. Angell, Middlesex.
2554. Envelopes, H. W. S. Brown.—(*G. A. Seychelles.*)
2555. Shutters, W. D. Richmond, London.
2556. Centre Boards for Boats, F. B. Crowe, Norwich.
2557. Ornamenting Lace with Beads, W. C. L. Unwin, London.
2558. Polishing, &c., Tubes, R. J. Edwards and A. Edwards, London.
2559. Fork Rest, F. Bennet, London.
2560. Railway Sleeper, Chairs, &c., F. A. Durnford, Lewisham.
2561. Ratchet Wheel Feed, J., J. A., W. K., and G. S. Baker, London.
2562. Printing Blocks, E. Ward, G. and J. H. Lock, J. Bowden, and H. G. Wells, London.
2563. Electrical Primers, G. Stuart, Newcastle-on-Tyne.
2564. Preventing Copper Vessels being Attached when used for Evaporation, A. M. Clark.—(*M. Honigmann, Germany.*)
2565. Cooling Ingots, A. M. Clark.—(*H. A. Brustlein, France.*)
2566. Stud and Fastener, B. Baden-Powell, London.
2567. Junction-box for Electrical Conductors, E. W. Beckingsale, London.
2568. Clothes Peg, L. Libby, London.
2569. Melting Snow on Roadways, O. Richter, London.
2570. Locking Apparatus for Railway Points and Signals, J. Saxby, J. S. Farmer, and P. Black, London.
2571. Extractor Mechanism for Guns, C. D. Abel.—(*W. Lorenz, Germany.*)
2572. Sugar-cane Mills, C. D. Abel.—(*T. Roussélot, The Antilles.*)
2573. Blocks, P. Jochum, London.
2574. Stop-cocks, R. T. Baines, London.

19*th February*, 1887.

2575. Delivery of Prepaid Articles, F. Foster, London.
2576. Regulating the Tension of Warps in Looms, T. H. Brigg, Weston.
2577. Self-acting Mules, B. A. Dobson, Manchester.
2578. Fluid Meters, &c., H. Frost, Manchester.
2579. Fluid Meters, &c., H. Frost, Manchester.
2580. Internally Stoppered Bottles, D. Rylands, Barnsley.
2581. Lamps, W. Davis and A. W. Turner, Birmingham.
2582. Screw Propeller, A. Langdon, Lincolnshire.
2583. Chenille Machines, T. Johnston, London.
2584. Hydraulic Cranes for Ships, A. B. Brown, Glasgow.
2585. Dobbies, C. Catlow, Halifax.
2586. Lead, &c., Holders, J. Appleby, Birmingham.
2587. Hoists, J. Boardman and D. Halstead, Halifax.
2588. Armature, L. Hanson, Halifax.
2589. Warming Dishes, &c., F. Bennett, London.
2590. Roofing Tiles, E. Y. Poole, Weston-super-Mare.
2591. Earthenware Tea-pots, J. Hollins and E. C. King, Longport.
2592. Ropes, G. H. Hebblethwaite, Halifax.
2593. Steam-traps, J. Boardman and D. Halstead, Halifax.
2594. Anchors, F. D. Taylor, Birmingham.
2595. Applying Brake Mechanism to Carriages, J. K. Starley, London.
2596. Wrenches, &c., J. K. Starley, London.
2597. Concentration of Sulphuric Acid, R. Fullarton, London.
2598. Electric Gas-lighters, T. P. Hewitt, Liverpool.
2599. Centrifugal Machine Filters, W. Fager, Liverpool.
2600. Folding Hoods of Barouches, &c., J. Clinch and J. Coleridge, London.
2601. Automatic Hoist Guard, H. Ramsay, Pollokshaws.
2602. Aluminium, C. A. Burghardt and W. J. Twining, Manchester.
2603. Tricycles, &c., R. J. Powell and S. Watts, Bath.
2604. Teaching the Rudiments of Music, A. Cooper, Stonham Aspal.
2605. Multiple Expansion Engines, W. Y. Fleming and P. Ferguson, Glasgow
2606. Self-extinguishing Safety Lamps, G. S. V. Godfrey, London.
2607. Sunshades, &c., A. C. Henderson.—(*M. Colin, France.*)
2608. Supporting Tarpaulins of Vehicles, J. Henderson, Glasgow.
2609. Extinguishers for Oil Lamps, W. Snelgrove, London.
2610. Ball Castors, G. W. Heath, London.
2611. Grindstones, &c., J. G. Gibbon and T. Moore, London.
2612. Pipe Couplings for Air, &c., Brakes, J. Manson, Glasgow.
2613. Compressing Hay, Straw, &c., J. S. Hoodless, London.
2614. Incandescence Lamp Holders and Switches, H. F. Joel, London.
2615. Extracting, &c., Fat, &c., W. Büttner, J. G. Haller, and I. Magnus, London.
2616. Fencing, F. H. Street, London.
2617. Twin-screw Ships, T. R. Oswald, London.
2618. Plates, &c., F. Bennett, London.
2619. Giving Alarms of Fire, H. MacDonnell, London.
2620. Lock Nuts, D. Wilson, London.
2621. Saddle Frames, C. D. Abel.—(*W. Wilhelmy, Austria.*)
2622. Apparatus for Cooling, W. T. Ramsden and T. Moy, London.
2623. Motor for Driving Sewing Machines, J. Thomas, London.
2624. Dress Collars, J. G. Tongue.—(*O. Engau, Germany.*)
2625. Feed Water Heaters, R. R. Little and J. Hall, London.
2626. Stoppers for Jars, &c., J. H. Johnson.—(*E. Fournier, France.*)
2627. Eyes of Needles, E. R. Villegas, London.
2628. Treatment of Dynamite, &c., H. S. Maxim, London.
2629. Aerating Devices, J. Dixon, United States.
2630. Children's Toys, G. F. Lütticke, London.
2631. Locomotives, C. Tellier, London.
2632. Labels for Bottles, D. Minvielle, London.
2633. Treating Waste Products from the Manufacture of Gas, Coke, &c., T. Lishman, London.
2634. Photographer's Lantern, F. Bishop, London.
2635 Turning Over the Leaves of Books, &c., P. F. Murphy, London.

21*st February*, 1887.

2636. Mouthpiece for Cigars, &c., J. Close, Birmingham.
2637. Water-closets, J. Duckett, London.
2638. Dental Engine and Attachments, J. S. Campbell, Paris.
2639. Metal Rowlocks for Boats, J. Cosens, Southampton.
2640. Eye Protectors, W. Vale, Birmingham.
2641. Hydro-electric Battery, G. W. Rhodes.—(*L. Lambotte, Brussels.*)
2642. Controlling the Grinding of Carding Engine Flats, J. M. Hetherington, Manchester.
2643. Ships' Anchors, W. Rose, Birmingham.
2644. Checking Apparatus for Cabs, &c., W. Hutchinson, Leeds.
2645. Decorations for Metallic Bedsteads, J. Brookes and H. Garner, Smethwick.
2646. Metallic Bedsteads, J. and H. J. Brookes and H. Garner, Smethwick.
2647. Reeling and Winding Frames, W. Noton, Oldham.
2648. Knitting Machines, J. Schmitt, J. B. Coblenzer, and C. G. Rommenhöller, Berlin.
2649. Rack Pulley, D. F. Sorfleet, London.
2650. Dutch Oven, &c., J. Lee, Blackpool.
2651. Drawing Pens, W. Riddiough, Bradford.
2652. Ruling Pens, W. Riddiough, Bradford.
2653. Breech-loading Small-arms, T. Woodward, Birmingham.
2654. Propulsion of Air for Ventilating, &c., C. W. Crossley, London.
2655. Holder for Cork and Vent-peg for Barrels, C. Smith, Northampton.
2656. Coal Stoves, &c., J. and J. Lind, Liverpool.
2657. Fastening Knobs to Spindles, R. T. Grocott, Longport.
2658. Money Checks for the use of Guards upon Tramways, &c., W. H. Edmunds, Birmingham.
2659. Cardboard Boxes, J. M. Baines and H. Taylor, Bradford.
2660. Artificial Salmon Fly, S. Allcock and Co., Redditch.
2661. Venetian Blinds, C. W. Fuchs Berlin.
2662. Photographic Film Paper, L. Warnerke Silverhouse, London.
2663. Steam Motors, W. Schmidt, Germany.
2664. Stoppering Bottles, G. Bradley, London.
2665. Rescuing Persons from Burning Buildings, J. A. Avery, London.
2666. Fire Hose, J. C. Merryweather and C. J. W. Jakeman, London.
2667. Armature Keyless Winder, J. Brecknell, London.
2668. Repeating Wood Carving and Shaping Machine, A. J. Smith and T. J. Roome, London.
2669. Metallic Signal Posts, S. T. Dutton, London.
2670. Padlocks, G. Harrison, Birmingham.
2671. Padlocks, G. Harrison, Birmingham.
2672. Bicycles, R. J. Russell, South Hornsey.
2673. Portable Hanging Emigrant's Berth, H. J. Carter and J. Aynsley, London.
2674. Oleaginous Vapour Lamps, W. H. Luther and G. Rose, Glasgow.
2675. Velocipedes, W. W. Ford, London.
2676. Suspenders for Umbrellas, &c., H. Whitfield, Birmingham.
2677. Gauges for Steam Generators, T. Gautreau, London.
2678. Tubes for Steam Generators, T. Gautreau, London.
2679. Explosives, C. Roth, London.
2680. Treatment of Ammoniacal Liquor, A. A. Croll, London.
2681. Iron, W. F. Richards and J. Roberts, London.
2682. Rolled Wire, &c., J. Coninx, London.
2683. Feed Apparatus, E. Blakey, London.
2684. Truck Wheels and Bearings, G. H. Denison and W. Ward, London.
2685. Door-closing Appliances, R. Adams, London.
2686. Flexible Bath Brush, J. Moore and C. F. Molony, London.
2687. Sewing Machines, J. Bühr, London.
2688. Cushions for Trusses, &c., J. Achard-Milhet, London.
2689. Printing Presses, J. Jordan and E. Howard, London.
2690. Turning and Screw-cutting Lathes, E. Blakey, London.
2691. Improving the "Set" of Shirt Fronts, H. C. Seddon, London.
2692. Marking the Weights of Packages, E. Carr and W. Snelgrove, London.
2693. Railway Coupling Apparatus, C. L. Hancock, London.
2694. New Composition, A. M. Clark.—(*M. P. E. Gérard, France.*)
2695. Textile Fabrics, A. M. Clark.—(*M. P. E. Gérard, France.*)
2696. Packing Material for Piston and Stuffing-Boxes, J. Y. Johnson.—(*J. M. Gaibal, France.*)
2697. Miners' Safety Lamps, E. Patterson and W. H. Strype, London.

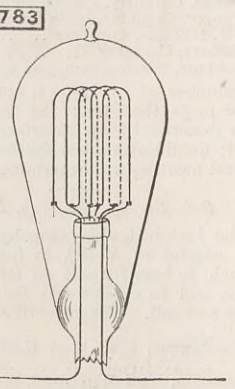
SELECTED AMERICAN PATENTS.

(*From the United States' Patent Office Official Gazette.*)

353,783. Incandescent Electric Lamp, *Thomas A. Edison, Menlo Park, N.J.—Filed November 9th*, 1882.

Claim.—(1) The coiled or looped carbon filament of an incandescent electric lamp provided with intermediate supports for the coils or loops, substantially as set forth. (2) In an incandescent electric lamp, the combination, with the coiled or looped carbon filament, of a number of wires attached to the coils or loops and all sealed in the glass stem of the lamp, substantially as set forth. (3) In an incandescing electric lamp, the long and fine flexible carbon filament made in one piece, in combination with leading-in wires connected to the ends of the same, and intermediate supports, substantially as set forth.

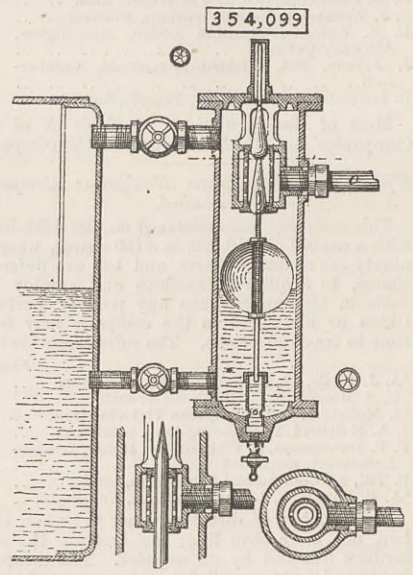
353,783



354,099. Feed-water Regulator, *F. Cook and B. Thoens, New Orleans, La.—Filed May 6th*, 1886.

Claim.—(1) In a feed-water regulator, the combination, with the boiler, of a regulator chamber having communication with the steam and water space at its upper and lower end, respectively, a steam chamber within the regulator chamber having communication with a pipe leading to the pump, an inner chamber within the steam chamber having lateral openings, a double conical obstructor moving vertically in openings in the ends of the inner chamber, a float connected with the obstructor, and guides for the float in both ends of the regulator chamber, the conical obstructors being a little less in diameter than the openings in

354,099

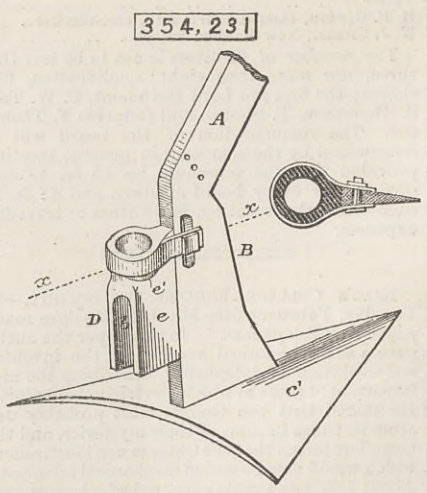


which they move, substantially as described. (2) A feed-water regulator having in combination a chamber connected to boiler above and below the water-line, a float resting on water-line, a double or single cone for regulating the supply of steam to steam pump, a double steam chamber around the cone or cones, the inside chamber being provided with an upper and a lower steam opening, and side holes for exit of steam, a steam pipe leading to steam pump supplying the boiler, which pipe opens into the second or outside chamber encircling cone or cones, substantially as described, and for the purpose specified.

354,231. Combined Subsoiler and Planting Attachment, *W. F. Reeves, Miltonvale, Kans. — Filed September 25th*, 1886.

Claim.—The combination of the standard A and vertically slotted coulter B, formed of a single piece, the subsoil blade C, secured to the sole of the coulter, the vertically adjustable tubular guide D, having an opening, *b*, through its back, backwardly diverging sides *e e*, ribs *e'* near its upper end, and the strap and bolt securing this guide to the vertical back of the coulter, all as described and shown.

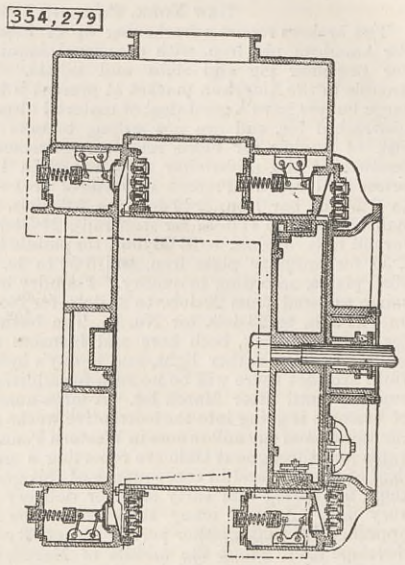
354,231



354,279. Blowing Engine, *P. L. Weimer, Lebanon, Pa.—Filed April 12th*, 1886.

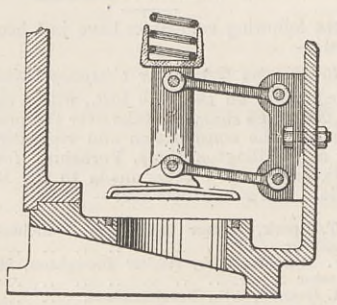
Claim.—(1) In a blowing engine a valve having movement at a right angle to the plane of its seat in combination with a swinging link attached thereto and provided with a foot or projection the face of which is in a plane corresponding with the back of the valve, whereby the rise of the valve is controlled, substantially as described. (2) In a blowing engine, a valve having parallel guide bars projecting from its back, in combination with swinging links attached thereto, one of which is provided with a foot or projection crossing a portion of the valve, and adapted to be struck thereby to limit the lift of the valve, substantially as shown and described. (3) In a blowing engine, a valve having swinging links pivotally connected thereto and to a fixed portion of the structure, in combination with a spring interposed between the valve and one of the walls of the valve chamber, substantially as described. (4) In a blowing engine, a valve chamber having a series of removable covers

354,279



provided with recesses or sockets, in combination with a valve having swinging links pivotally connected thereto and a spring interposed between the valve and

354,279

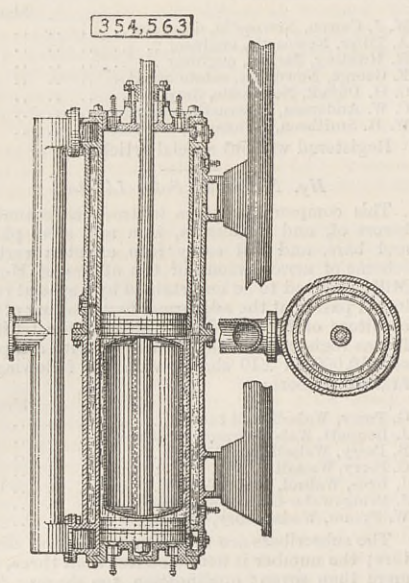


the cover and seated in sockets, substantially as described.

354,563. Device for Cooling the Cylinders of Compressors for Air and other Gases, *William De Courcy May, Philadelphia, Pa.—Filed June 3rd*, 1884.

Claim.—(1) The combination, with the compression cylinder having at or near its longitudinal centre a water inlet and a water supply communicating therewith, of a pair of pistons arranged one on each side of said inlet, and a closed air-tight vessel arranged between the pistons, substantially in the manner and for the purposes described. (2) The combination o

354,563

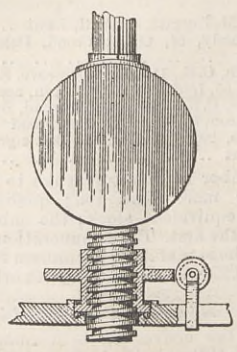


the compression cylinder divided longitudinally in two compartments of different diameters, and having an aperture leading into the interior between said compartments, and a water supply communicating with said aperture, of differential pistons adapted to the respective compartments, and inlet and outlet valves controlling the admission and discharge of water to and from the interior, substantially in the manner set forth.

354,605. Portable or Traction Engine, *T. A. Long, Howard, Pa.—Filed June 14th*, 1886.

Claim.—(1) In a traction or portable engine, the combination of the boiler, the stationary screw secured to the forward end thereof, a nut provided with an internal screw thread and external teeth arranged

354,605



upon the screw, the axle provided with the recess to form a seat for the nut, and means, substantially described, for engaging the teeth of the nut to revol the same to raise and lower the boiler in relation the axle, as set forth